PARADIGMS, MODELS, SCENARIOS AND PRACTICES FOR STRONG SUSTAINABILITY

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In Appreciation

This book was inspired by the symposium "Paradigms, Models, Scenarios and Practices for Strong Sustainability", located in Clermont-Ferrand (France) in December 2019. This symposium was organized and managed by the Jean Monnet Excellence Center on Sustainability (ERASME), funded by ERASMUS + programme.

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IT'S SUCH AN HONOR TO RECEIVE THIS PRIZE TODAY.
and IF I HAD TO THANK EVERYBODY ...
... I'D START WITH HUNTERS
WHO TEACHED ME SO MUCH ...
AND ALL THE OTHERS.
BUT IT WOULD BE TOO LONG, SO... THANK YOU
@BarbaraBELLIER

While the notion of sustainability continues to be associated with the Brundtland Report (1987) and the concept of sustainable development, a community of sustainability researchers and practitioners increasingly seeks to emancipate the concept to be consistent with the knowledge and aspirations of the moment. Nowadays everything is said to be sustainable: agriculture, food, natural resources, biodiversity, water, energy, cities, tourism, etc. There is an inherent risk that sustainability is becoming an empty term and that in the long run weak sustainability will not deliver truly sustainable societies. A sustainable future must go beyond the domain of purely environmental issues. Unless crucial social issues, such as overconsumption, inequality, poverty, access to education, and democratic participation are addressed, policy efforts for sustainability will fail to mitigate either the drivers or impacts of the environmental crisis.

While the weak sustainability paradigm holds that developments on social, economic and environmental issues are interchangeable, strong sustainability demands their combined development. Academics and practitioners should be critical towards untenable trade-offs that originate from a weak sustainability paradigm, for example greenwashing, green growth and decoupling. Economic, social and environmental capital provide complementary services within society and it is not possible to substitute one for another. Indeed, if reducing our ecological footprint is a necessity, it is associated with other objectives. This has been clearly emphasized by the integrated character of the Sustainable Development Goals in the UN 2030 Agenda. The eradication of poverty, the reduction of inequalities, access to education, electricity and water, the development of 100% renewable energy, etc. are part of a strong international political discourse, targets of major international institutions. But these goals are also increasingly the demands from the world's citizens. The recent events in France, the movement of yellow vests, is an excellent illustration of this. Motivated by the increase in the domestic consumption tax on energy products, this movement has gradually extended to other social demands (the increase in purchasing power, maintenance of public services, improvement of democracy and more). It spread to a large number of countries, including Germany, Belgium, Spain, Ireland, and the United Kingdom. These social demands are inseparable from the environmental crises of the modern world. Global warming, air pollution, health pandemics or food scandals are manifestations of the need to transition to a strong sustainability-based society.

Also academic debates have crystallized around the distinction between weak and strong sustainability. Weak sustainability is based upon the works of neoclassical economists, mainly those of Robert Solow (1974, 1977, 1986, 1993) and John Hartwick (1977, 1978, 1990). Continuous growth in both capacity (stocks) and income (flows) is a central part of the neoclassical growth paradigm. Herman Daly (1973, p. 5) called this "*the growthmania synthesis*": if aggregate wants are infinite, they should be served by making aggregate production infinite. Weak sustainability advocates that perfect substitution between production factors (land, natural resources, labor, capital) and technology will get us out of any growth-induced problems, such as pollution. While weak sustainability is built upon a well-established core of neoclassical welfare economics, strong sustainability is not (Neumayer, 2003). It is more difficult to define and position strong sustainability within academic streams. The Steady State paradigm proposed by Herman Daly

(1972, 1973, 1977) or the bioeconomic program initiated by Nicholas Georgescu-Roegen (1971, 1978) have contributed to develop different views on what strong sustainability could be. The main proposal coming from these works is that, in a finite world, continual growth is impossible. According to these scholars, it is necessary to re-embed the economy within physical (the entropy law) and biological limits (endosomatic and exosomatic organs). Thus the strong sustainable paradigm could not only be developed by economists. On the contrary, ecologists, biologists, physicists, earth and climate scientists contributed to the theory of strong sustainability. Arguments were developed concerning the scarcity of mineral resources, the impact of population growth, the new biology paradigm, the tragedy of commons, the buddhist economics, ethical alternatives, the basic income, and many more theoretical and practical applications. A number of economists (Robert Constanza, John Cumberland, Herman Daly, Robert Goodland or Richard Norgaard, 1995) associated strong sustainability with steady state paradigm and the fact that natural capital has to regarded as non-substitutable. Neumayer (2003, p. 1) explicitly called Strong Sustainability, "*the non-substitutability paradigm*".

However, strong sustainability is primarily a theoretical framework with few, often small-scale, real-world implementations. Many questions remain regarding its theory, implementation and assessment. It is in this context that the Jean Monnet Excellence Center on Sustainability (ERASME) organised a symposium in December 2019 to question and advance paradigms, models, scenarios and practices that embody strong sustainability. This book is a compilation of the symposium discussions. To initiate wide ranging discussions, the following questions were raised.

1° How do the different sciences (e.g. Social, Engineering, Earth Sciences) approach the question of sustainability? Are there important differences between these approaches?

2° What are the dimensions, topics, and themes that are part of or, on the contrary, escape the discourse on sustainability? This question introduces new fields of sustainability (urban agriculture, sustainable cities, education for sustainability, sustainable mobility, gender, etc.) or solutions reflecting a certain idea of sustainability, such as universal income, complementary currency, zero unemployment territories.

3° Which are the paradigms embodying the idea of strong sustainability today? Should we position strong sustainability at the level of so-called alternative paradigms, such as Social and Solidarity Economy, Collaborative Economy, Economy of sharing, Ecodevelopment, Degrowth, Buen vivir, Ecological Economics, Political Ecology, Industrial Ecology, Bioeconomy, Bio-based Economy?

4° Which models, methods and scientific tools consider strong sustainability? The latter refers to the modelling of complex and dynamic systems. System thinking or system dynamics are often presented as appropriate methods to address system complexity of sustainability challenges (feedback loops, emergent behaviour, delays, tipping points). Models such as the World Model (Forrester, 1972) and Integrated Assessment Models (eg. GEM 3E, IMACLIM, IMAGE, MESSAGE, REMIND...) propose to integrate energy, economic, climate and environmental issues (air quality, biodiversity, etc.) in order to suggest mitigation and adaptation strategies to policy makers by developing long term scenarios (population, food, agriculture, natural resources). How do these models fit (or not) into a strong sustainability framework?

5° Which future scenarios embody the idea of strong sustainability the most? Should scenarios such as green growth, steady state, degrowth or collapse be seen as sustainable or not? Where do the so-called utopian scenarios (100% renewable energies) fit in contrast with so-called pragmatic scenarios (the energy mix)? Does the idea of transition finally move us away from a strong sustainability scheme? Could some scenarios be seen as an abuse of the weak sustainability paradigm, distilled by lobbies that are not ready to make the radical changes necessary to move towards a better life society?

6° How to finance strong sustainability? If governments and major international institutions are investing in renewable energies, organic farming and sustainable mobility, the question arises today as to how to finance these actions and strategies. Taxes and subsidies, public spending (at national or European level), the reform of financial markets or the implementation of an active monetary policy could all be tools that help to commit our societies to greater sustainability.

7° How to assess sustainability? What can be assessed in terms of sustainability objectives? Who can evaluate, in the sense of expertise? How to evaluate, in terms of procedures, methods and indicators?

Each contribution in this book answer to one or more of the above questions. They build on the foundations of strong sustainability to provide new theoretical insights or practical implementations of the concept. Subsequent to a preface by key speakers of the symposium, the contributions have been arranged in five key sections: paradigms, transition, education, developing countries, the place of arts and culture.

The first part, titled Digressions on Strong Sustainability*,* includes four contributions. We asked to Basarab Nicolescu, Joseph Tainter, Paul James and Valeria Jana Schwanitz - four key speakers of the Symposium "Paradigms, Models, Scenarios and Practices for Strong Sustainability" - to propose an analysis of strong sustainability from the philosophical, historical, anthropological and economic point of view.

The second part introduces strong sustainability as a new paradigm. The term "Paradigm" (and "Paradigm shift") comes from Thomas Kuhn's book, *the structure of scientific revolutions*, in which Kuhn (1962) explores the ways in which entire patterns of thought are established and changed. Kuhn contends that historical accidents, occasional discontinuous and revolutionary changes have an important effect on scientific development. They form the necessary complement to normal science: " *Normal science, the activity in which most scientists inevitably spend almost all their time, is predicated on the assumption that the scientific community knows what the world is like*" (1962, p. 5). This part proposes a collection of representations on strong sustainability based on interdisciplinarity, systems thinking, complexity and social innovation. Cyrille Rigolot argues that transdisciplinarity may be seen as a promising paradigm for strong sustainability. He distinguishes two modes of transdisciplinarity, a theoretical mode largely inspired by quantum theory and a practical mode involving multi-stakeholder approaches. He shows that a generalization of the quantum principle may suggest powerful sustainable pathways, by enlightening subjectivity, the possibility of free-will add the co-arising of personal and systemic change. Anne Snick redefines sustainability in the Anthropocene era from crucial lessons learned from the fates of Viking and Inuit settlers in medieval Greenland. In spite of their advanced technologies and trade systems, the Viking collapsed whereas the Inuit kept thriving. This case could reveal that sustainability can be understood as a dynamic balance of three spheres : biophysical processes generating life and evolution; human narratives on the meaning of life; economic and technological processes to access nature's offerings. Sustainability would depend on a civilization's capacity to adapt its narratives and its techno-economic systems to Earth's biophysical realities. Pietro Beltramello proposes to use the bioeconomic conceptual framework of Nicholas Georgescu-Roegen to investigate *Social and Solidarity Economy* (SSE) organizations and their ability to spread societal innovations (employing different values and farway from market-based rationality). The case study of the Association Sahel Vert explores the opportunity and the limits to use Bioeconomics to assess the sustainability of SSE organizations. Anthony Fardet and Edmond Rock discuss the degradation of food systems by ultra-processed food and animal calories in the diet of consumers. To counteract this evolution, they propose a paradigm shift, the three golden rules for Healthy, Ethical and Sustainable food systems. The rule of three V (Végétal, Vrai et Varié) suppose *Planted-based food* (maximum of 15% animal calories); *Real food* (maximum of 15% daily ultra-processed calories) and Varied Food (organic, local and seasonal diversified food). Decreasing ultra-processed food consumption will have positive impacts on sustainable food system, covering small farmers, culinary tradition, biodiversity and socioeconomics drivers. Anna Horodecka identified sustainable consumption as the one of current challenges of the global world, especially for climate change. Sustainable consumption is not only a behavior, it's also a paradigm shift from neoclassical economics to heterodox economics. Anna Horodecka considers that behavioral, institutional, ecological and humanitic approaches in economics may solve the dilemma between individual and collective needs in the context of sustainable consumption. David Perez-Rebolledo and Katia Romero-Leon use game theory to solve the problem of individual economic behavior within the environmental action. They argue that when agents in relation to Nature are in conflict of interest, the problem is not anymore an economic problem but an ethical problem. The environmental crisis requires incentives to achieve strong sustainability. Manuel Morales introduces the industrial symbiosis as an inter-firm innovation aimed to optimize biophysical flows and to engage companies into a strong sustainable pathway. The case-study of Bazancourt-Pomacle Platform is considered as a circular bioeconomy strategy and is providing a better understanding of the stakeholders' influence (causal effects and complex interactions) in the sugar industry at the local level. Arnaud Diemer and Florian Dierickx propose a large and broad vision of circularity for european policies in which circular economy should not be reduced to an economic model whose objective is to produce goods and services in a sustainable way, limiting the consumption of resources and the production of waste. Circular economy is mainly a paradigm shift to strong sustainability. The study and the promotion of Industrial symbiosis plays the key role. To develop more sustainable societies, industries have to better understand how to respond to environmental, economic, social, cultural, technical and political challenges. The industry 6.0 has to transform industrial behavior. At the same time, the knowledge of complex system redesigned circular economy. Integrated tools (Material Flows Analysis, Life Cycle Analysis, Causal Loops Diagrams, Stocks and Flows Diagrams, Physical Input and Output Tables, Circles of Sustainability…) and System Thinking Methodology are helpful to challenges different issues and define the new pillars (resilience, creativity, proximity, eco-efficiency and cooperation) of circular economy. Following this framework, Europe could be engaged in a strong sustainable pathway.

The third part considers strong sustainability not as a state but as a transitional process. Sustainability transitions are long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption. Le bel, Marques, Moraes Curan, De Souza Leao and Santos discuss the question of land's access through the perspective of food sovereignty. Examples from urban and peri-urban agriculture in Sao-Paolo examine the discourses of the actors and stakeholders involved in sustainable development practices or strategies. Smith and Christie develop the same argument for climate change. A global cooperation is not only a requirement but also an emergency. Climate action is the catalyst for rapid transition (values, norms, political discourses) towards strong sustainability. Citizen need to become extraordinarily engaged with a compelling narrative that mobilizes a global movement, one that can sustain political influence, overcome powerful denialist and lay the foundations of strong sustainability. O'Mohany and Luukkanen argue that human consumption of natural resources has grown so rapidly that we are now at a critical point in the Earth's history. Forging a viable future for humanity requires transformation of our consumption practices. If income and consumption contribute to happiness and well-being, their growth increase damages to Nature and also to Human Wellbeing. The authors propose to reverse this trend. A new approach of sustainable wellbeing has to re-balance wellbeing across life domains. Taddeo, Morgante, Simboli and Raggi consider that the transition to sustainable industrial system is one of the cornerstones of European Union policy. If many initiatives have been developed at national and local level, the authors highlight the advantages of a "bottom-up" collaborative approach. The promotion of local government initiatives in the Abruzzo Region could be a good case study for implementation at the european level. The article describes the principles of this governance tool - the choice of stakeholders, the structural process, the selection and definition criteria of ranking, the rewarding mechanism - relevant to design a strong sustainable european policy. Wierling, Zeiss, Hubert, Candelise, Gregg and Schwanitz argue that public participation and ownership - through collective action initiatives (CAIs) - are indispensable for the sustainable energy transition. Their contribution discusses how energy CAIs are classified and how they related to democratic participation of the memberships. Using case studies from Sweden, Denmark and Germany, they find that energy cooperatives are typically initiated by well-off, rural, male sexagenarians. The participation between women and men (including decision-making) is below parity. Thus, they conclude that the mechanism of recruiting and engaging members falls behind the theoretic ideal of socially sustainable development. Sciullo, Wierling, Arrobbio, Delvaux, Gilcrease, Gregg, Henfrey and Padovan also address the issue of CAIs in the energy sector. However, they investigate energy communities, cooperatives and purchasing groups as a trigger for the implementation of a strong sustainability paradigm. They assume that the active involvement of citizens in the energy chain is a crucial requirement when considering the diverse dimensions of sustainability. A description is provided of the potential that CAIs have in supporting the UN Sustainable Development Goals, seen as an attempt to operationalise a strong sustainability paradigm. Then, through the analysis of a selection of case studies, the authors argue that CAIs development might create the conditions for supporting SDGs through the provision of relevant social and economic changes. They explore the effect these changes might have in addressing three layers of sustainability (the long-term horizon, the energy transition and the local dimension). Levarlet, Galassi and Gramillano examine how european sustainability policies at different level of governance are evaluated and periodically re-examined. They consider that evaluation of sustainable development policies is a specific field of public policy. A specific focus is given on EU cohesion policies (article 174 of the Treaty) and how evaluation s concretely addressed the sustainability dimension. Levarlet and Alessandrini developed the same argument but in the field of european sustainability funds. They consider that the question has been renewed with the approval of Agenda 2030 at international level. New scenarios for the European Union are in discussion under the next Multiannual financial framework, with clear budgetary implications. The EU budget financed sustainable development through a large range of policy instruments over the last period, including grants and financial instruments. In the next future, the involvement of private sector would probably be determinant to supplement public intervention and to achieve sustainable development goals (SDG).

The fourth part provides contributions relating to sustainability challenges in developing countries. It is a balanced collection of five studies investigating sustainability in the agricultural sector and different aspects of sustainability dimensions in development in general. With increasing climate change effects, agriculture is undoubtedly one of the most affected sectors. As such, the livelihoods of farmers - and in particular small- to medium-scale farmers - is at high risk and in some cases poverty is only one crop failure away. In the first study of this chapter, Dury and Biao explore index insurance for farmers. Index insurance is perceived as a welcoming replacement of the traditional insurance model, which can no longer deal with climate uncertainty and offers little or no protection to high-risk farmers. The second study by Some is an additional contribution to sustainability in agriculture and investigates four categories of climate change mitigation interventions in India, which aim to reduce greenhouse gas emissions. The author connects these interventions to the Sustainable Development Goals (SDGs) and finds that all four intervention categories have benefits other than climate mitigation. However, in order to deal with trade-offs arising in each of the four cases, more institutional development and capacity is needed. Keeping the focus on India, the third study by Shome and Mal examines low-cost indigenous farming techniques to be used for seed hardening, seed treatment and pest and disease management. In the context of the zero-budget farming promoted by the Indian authorities, these are welcomed findings that can make adaptation to climate change impacts, such as prolonged and frequent droughts, more affordable for farmers. Journeying from India to the Mediterranean basin, the fourth study by Ouchen moves the focus to the tourism sector, an important revenue source of foreign direct investment. It finds that tourist attractiveness of a region is mostly dependent on political stability in that region, the absence of terrorism and the level of human development. These last three aspects can be much improved by providing employment for the youth. Last but not least, shifting the focus on Africa and Latin America, the fifth study by Afrika analyses sustainable financing for the achievement of universal social coverage, a prerequisite for achieving development itself. It concludes that government revenues that are derived from the exploitation of natural resources are more volatile, and thus their share in financing social protection should decrease.

The Fifth part predominantly addresses Education for Sustainability in different countries around the globe. The first study by Pellaud, Gay, Blandenier, Massiot and Dubois, however, is a general exploration into self-confidence as the driving force behind learning for pupils. Deeming our unprecedented sustainability challenges, the authors make the case for self-esteem as a prerequisite for being able to deal with planetary problems and actively participating in solving them. They find that the current academic system is unfit for developing self-confidence in pupils and propose some practical approaches to set the foundations of a dialogue-based evaluation system between teachers and pupils. The second study by Kageura and Tatsumi builds on the need to improve the academic system in order to make it more fit for the purpose of sustainability education. The authors investigate Japan and Malaysia and discuss the robustness of service learning projects started by universities in the two countries. Their main findings are centred around the role communication plays in achieving the expected results of service learning in target communities. Local communities are also at the core of the third study by Manero Monero, which explores environmental behaviour at a family level in Mexico. Its conclusions are that in order for such a system to be successful, families need to first incorporate environmental knowledge and values and then develop competences that would allow them to implement the system. The fourth study by Diemer and Khushik moves the focus to the progress of SDG 4 on Education Quality in Senegal and Pakistan. It finds that synergies with the other SDGs are not ambitious enough to make SDG 4 an instrument of real social change, which threatens the achievements of SDG targets to 2030. In the fifth paper of the chapter, a comparative survey-based analysis on inter-generational perception of SDGs in Poland and France was carried out by Zalewska. As a general trend, the study identifies an agreement across generations with regard to the importance of SDGs in improving the livelihoods of all people. It also concludes that a positive perception of the level of sustainability decreases from individual level to national and international level. Individuals often consider they live sustainably, while they judge municipalities, states and the world as developing in a less sustainable manner.

The Sixth and last part of this book provides perspectives on the communication of sustainability challenges that were brought forward during the conference. Participants dove into alternative communication channels that are available for the communication of strong sustainability to the general public. During the conference, there were several creative activities and sessions, such as poetry and flash-fiction writing workshops, a sustainability concert with open-mic as well as a communication panel with four diverse science communication experts that closed the conference. This section includes a reflection on the communication panel by two of the participating experts, an introduction to the writing workshop materials by the workshop leader, three flash-fiction short stories, and ten poems.

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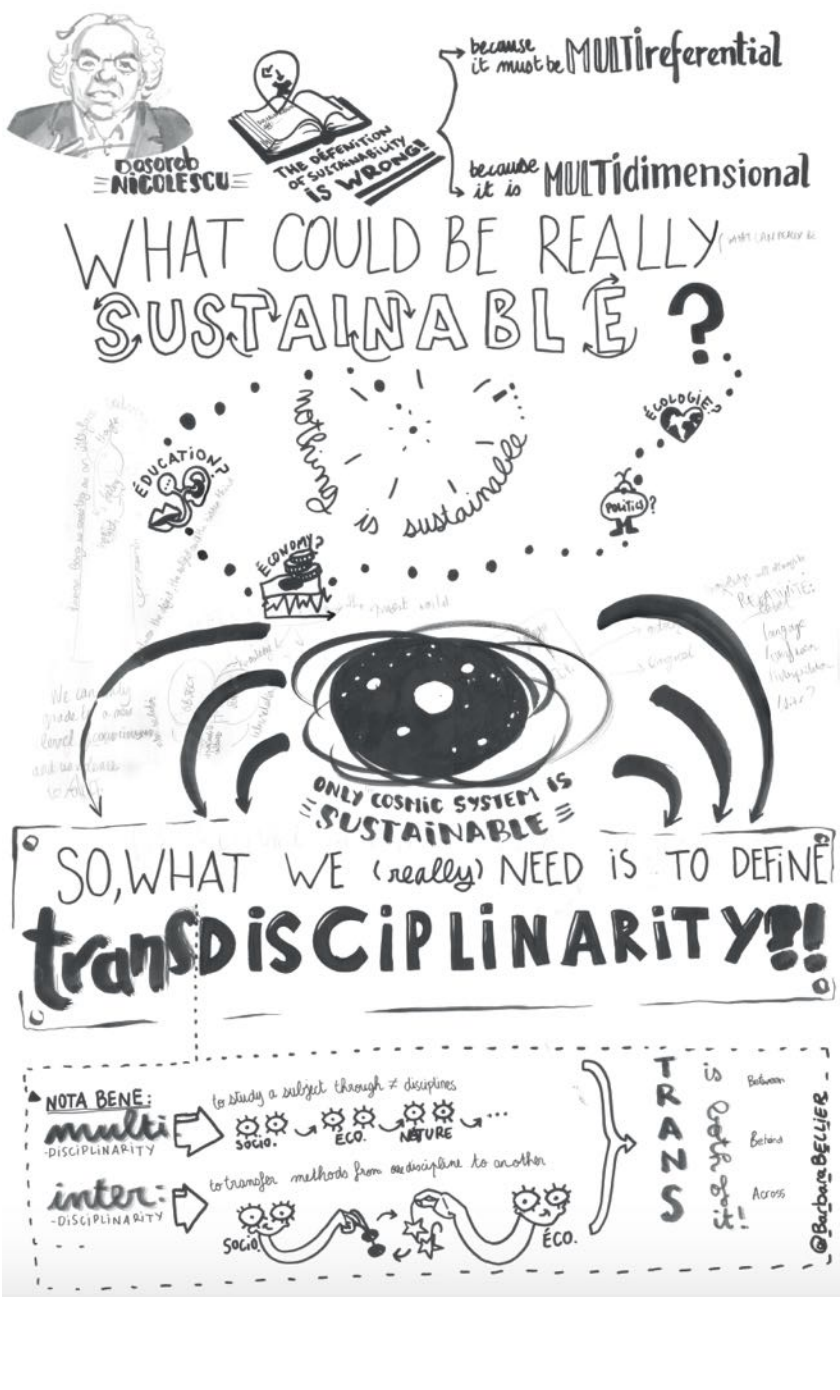
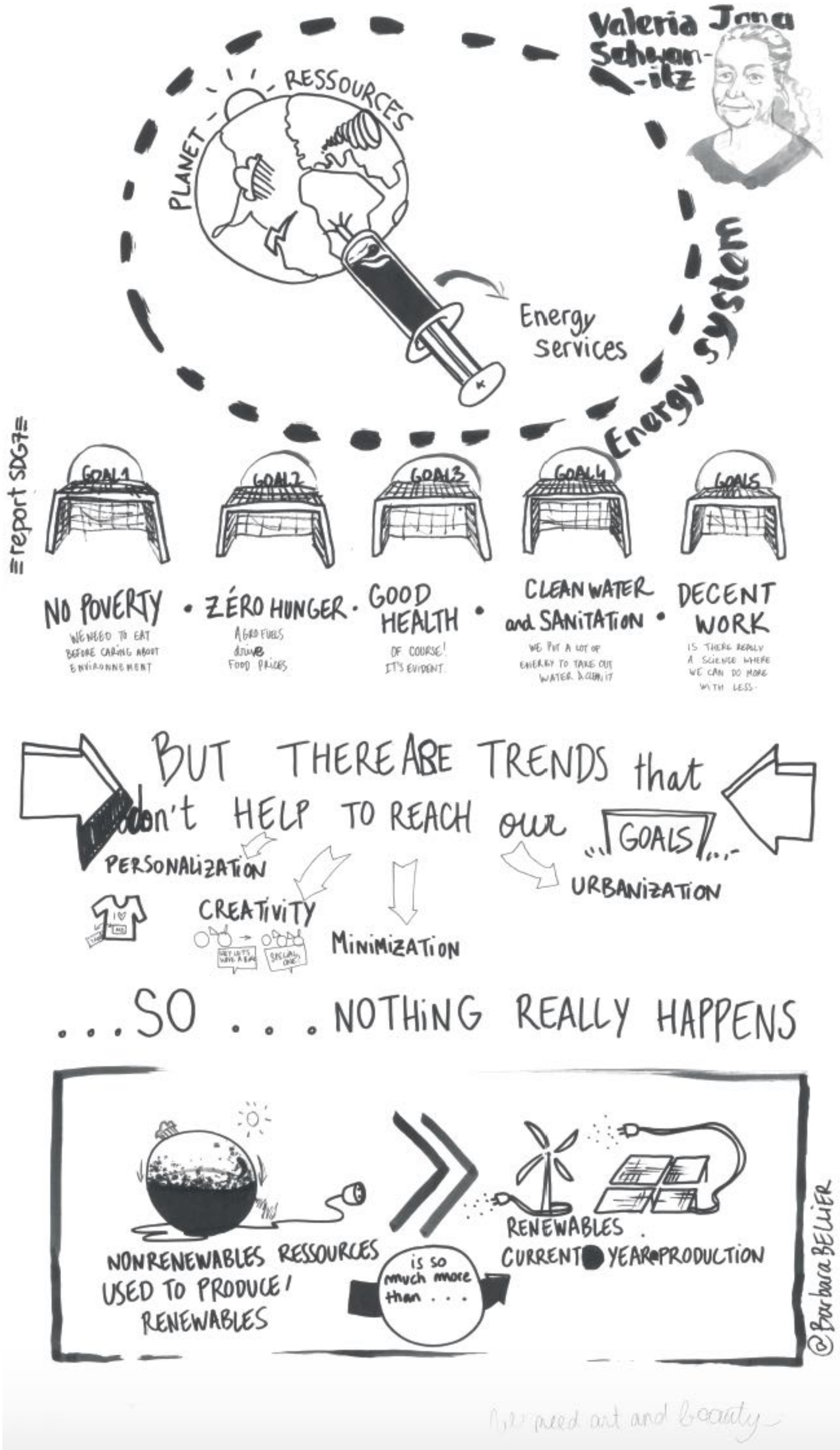
PART 1

DIGRESSIONS ON STRONG SUSTAINABILITY

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we need art and beauty

Transdisciplinarity Approach to Strong Sustainability

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Studies on sustainability underline the necessity to consider the interaction of a bigger and bigger number of disciplines. Complexity is more and more increasing: there are 17 goals and 169 targets.

The concept of sustainability is not well defined: it is multidimensional and multireferential. It is inevitably fragmentary and reductionist.

Some approaches try to formalize sustainability in a mathematical way. One speaks even about a « science of sustainability ». But the methodology of science excludes the human being (the Subject), which is an important paradox: the human being must be in the center of a sustainable world.

The big question is the following: what could be really sustainable? Environment? Economy? Society? Education? Politics? Religion? Spirituality? Future? Nation? World order? The answer is: no one in itself. *All of them are inter-related.* Transdisciplinarity (TD) is therefore a necessary approach. TD shows that the only known sustainable system is the cosmic system, in all its dimensions, from the quantum particle till the most distant galaxy. Every level of Reality sustains every other level of Reality.

The methodology of Transdisciplinarity (Nicolescu, 2002) is founded on three axioms: the ontological axiom (there are different levels of Reality of the Object and, correspondingly, different levels of Reality of the Subject), the logical axiom (the logic of the included middle) and the epistemological axiom (complexity). These three axioms constitute the rigorous definition of Transdisciplinarity.

Reality is that which resists our experiences, our representations, our descriptions, our images, and even our mathematical formulations. The Reality is accessible to our knowledge and it involves a trans-subjective dimension. It has to be distinguished from Real, which is veiled forever.

"Level of Reality" means a set of systems invariant under certain general laws (in the case of natural systems) or under certain general norms and rules (in the case of social systems). It is important to note that there is discontinuity between levels.

The zone between two different levels and beyond all levels is a zone of *non-resistance* to our experiences, representations, descriptions, images, and mathematical formulations. Quite simply, the transparency of this zone is due to the limitations of our bodies, of our sense organs and of our brain, limitations which apply regardless of what measuring tools are used to extend these sense organs.

The unity of levels of Reality of the Object and its complementary zone of non-resistance constitutes what I call *the transdisciplinary Object.*

The different levels of Reality of the Object are accessible to our knowledge thanks to the different levels of perception which are potentially present in our being. These levels of perception permit an increasingly general, unifying, encompassing vision of Reality, without ever entirely exhausting it. In a rigorous way, these levels of perception are, in fact, *levels of Reality of the Subject.*

As in the case of levels of Reality of the Object, the coherence of levels of Reality of the Subject presupposes a zone of non-resistance to perception.

The unity of levels of Reality of the Subject and its complementary zone of non-resistance constitutes what I call the *transdisciplinary Subject.*

The two zones of non-resistance of transdisciplinary Object and Subject must be identical for the transdisciplinary Subject to communicate with the transdisciplinary Object.

Knowledge is neither exterior nor interior: it is simultaneously exterior *and* interior. The studies of the universe and of the human being sustain one another.

The zone of non-resistance plays the role of a *third* between the Subject and the Object, an Interaction term which allows the unification of the transdisciplinary Subject and the transdisciplinary Object while preserving their difference. In the following I will call this Interaction term the *Hidden Third.*

The transdisciplinary Object and its levels, the transdisciplinary Subject and its levels and the Hidden Third define the transdisciplinary Reality. It is important to note that the Hidden Third restores the continuity of Reality.

The human being appears as an interface between the Hidden Third and the world. The eradication of the Hidden Third in knowledge leads to a one-dimensional human entity, reduced to their cells, neurons, quarks, elementary particles, and electronic chips. The role of the Hidden Third is to establish the link between the Reality and the Real. Catalyst of movement, it possesses an infinite number of faces. The Hidden Third is the guardian of our irreducible mystery and the only foundation of human dignity.

The TD definition of strong sustainability (TDSS) is the following: *sustainability which takes into account all levels of Reality and the Hidden Third.*

At face value, this kind of sustainability may seem an asymptotic aim and therefore utopian. But the Hidden Third has the virtue of unifying the levels of Reality.

Let me stress some key points of TDSS.

The roots of violence are inside the human being. Our thoughts, feelings and instincts are in perpetual conflicts. Only if we can harmonize our thoughts, our feelings and our instincts we can discover a new intelligence which erases the violence in ourselves. And only when we become non-violent in ourselves, by accessing to a new level of consciousness, we can act to erase the violence in the world.

TDSS revolves around the problem of violence: violence made to the human being by acting on his nature and made to the earth, everywhere today, by the modification of the cosmic conditions of existence of our planet. Violence is everywhere: poor countries against rich countries, religious and ethnical wars, terrorism, urban violence.

TDSS is incompatible with violence. Violence eradicates the Hidden Third.

We therefore need to imagine a Strong Sustainability of Peace (SSP). TDSS offers an overall methodology for SSP in the world.

The most extraordinary proof of the violence is the fact that there are currently a number of nuclear weapons (more than 25,000 nuclear warheads, divided among nine countries). A small fraction of them could eliminate life on earth. The man invented the *balance of terror*: an agreement between all those who have the nuclear weapon not to use it, because that will lead to the disappearance of the adversaries. In English, the title of the agreement is "MAD" (Mutual Assured Destruction), which, by a funny coincidence means "crazy" in English. Who could prevent a dictator from triggering the nuclear apocalypse? SSP requires the destruction of all nuclear weapons.

Transdisciplinarity expresses the hope for a new era - *cosmodernity* – founded on TDSS by the fruitful contemporary interaction between science, culture, spirituality, religion, and society (Nicolescu, 2014).

A new spirituality, free of dogmas, compatible with all existing spiritualities, is already potentially present on our planet. This would give full meaning to the already existing notion of sustainable spirituality. The old idea of cosmos, in which we are active participants, is resurrected.

Everything is interconnected. All levels of Reality are interwoven.

The ethical imperative of cosmodernity is *togetherness*.

Only through transdisciplinary dialogue can we face the challenges of the contemporary world: dialogue between human beings, dialogue between human beings and non-human forms of life (animals, plants), dialogue between human beings and the cosmos, dialogue between human being and the divine, dialogue between cultures, religions, spiritualities.

In other words, the key-point is the access at a new level of consciousness, individual and collective. This obviously requires a new civilization, which does not suppose a revolution but a gradual transition from our own civilization.

This new level of consciousness involves a global education for TDSS, which must be a noble aim of UNESCO and of all countries.

We are, in spite of everything, at the threshold of a New Renaissance, founded on the TDSS.

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Strong Sustainability, Weak Sustainability, and the Challenge of Innovation

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The middle of the 20th century was a time of growing concern over the reach and scale of human impacts on the planet. Thought leaders and governments began to consider the depletion of natural resources and the legacy of pollution that would be left to future generations. Would future generations inherit a sustaining world or would they be doomed to resource poverty and a degraded environment by the consumption levels of past and present generations? The uneven distribution of wealth also posed a dilemma for balancing the needs of people in the present and future. Could sustainability goals be compatible with the desire for the world's poor to achieve an equitable standard of living? How could economics guide a fair intergenerational distribution of resources? Two approaches to sustainable development attempt to answer these questions: weak sustainability and strong sustainability.

When *The Limits to Growth* was published (Meadows et al., 1972), the authors argued that unending economic growth in a finite world is not possible. Economists Robert Solow and John Hartwick responded (Solow, 1974a, b; Hartwick, 1977, 1978a, b). In what has come to be known as weak sustainability (WS), they formulated an economic vision of sustainability in the sense that it is "*an obligation to conduct ourselves so that we leave the future the option or capacity to be as well off as we are*" (Solow, 1993b, p. 181). Solow argued that future generations are not owed a share of any particular resource. What present and following generations are obligated to bequeath to future generations is the generalized capacity to create well-being according to their own definitions (Solow, 1993a, b).

Forms of capital do not matter for WS. Natural capital, (which encompasses all nonrenewable materials, and renewable goods and services), human capital (labor), and human-produced forms of capital (such as machinery, knowledge, and technology) are all interchangeable (Hartwick, 1978b; Solow, 1974b, 1993a, b). One can be substituted for another in the production of goods and provision of direct benefits to humans. A development path is sustainable if the total stock of capital in all its forms does not decrease. Hartwick theorized that this could be accomplished by the requirement that the proceeds from non-renewable resources and overharvests of renewable resources be invested in other forms of capital rather than merely consumed (Hartwick, 1977, 1978a, b; Solow, 1993b).

Strong sustainability (SS) rejects the substitutability premise of WS, arguing that different forms of capital are complementary but limited in their substitutability (Costanza & Daly, 1992). SS is not an entirely different conception of sustainability from WS. It encompasses many of the premises of WS but imposes additional, more stringent requirements, particularly in ways that restrict substitutions for natural capital (Neumayer, 2013).

Natural capital provides sources of materials and sinks for pollution. It delivers essential services such as fresh air and clean water, and contributes directly to human welfare. As such, natural capital cannot always be fully replaced by human or human-produced capital. Irreversibility, uncertainty, risk, and a lack of knowledge require current generations to preserve some types of natural capital, particularly those that are essential for supporting life (Ekins et al., 2003; Neumayer, 2013). SS requires that natural capital and human-produced capital must be maintained separately, and neither can decrease (Costanza & Daly, 1992; Daly, 1990).

Technical Innovation in Weak and Strong Sustainability

Positions on substitutability mark the key difference between WS and SS, yet both require innovation to meet the overarching goal of sustainability.[1] Innovation, both in terms of technological advances and the systems that make them possible, is essential to WS insofar as it facilitates the substitution of forms of capital, strives to reduce dependence on natural resources, and combats the negative externalities of growth (Chaminade, 2020). WS requires technological advances to counteract negative impacts on social well-being and environmental sustainability. Technical progress is also critical for WS to keep consumption constant under conditions of population growth (Solow, 1986).

SS also depends on innovation. Because SS constrains the expectations of substitutability, however, the directions for innovation will differ. WS calls for innovation to substitute forms of natural capital, or human for natural capital. SS requires innovation in such areas as technical efficiency, so that resource consumption is minimized. In other ways, both weak and strong sustainability require innovation in efficiency and substitution. For example, in the face of anthropogenic climate change, both WS and SS would call for efficiency in the use of fossil fuels. WS would direct innovation efforts toward such mitigation technologies as carbon scrubbing and sequestration, and detecting and controlling methane leakages in production and supply. The innovation investments under SS would support transitions to less carbon-emitting and renewable resources along with social-structural changes that reduce the need for carbon-emitting activities. Both look to efficiency, but the technological innovations required for continued reliance on fossil fuels (WS) require a different commitment of innovative effort than for energy transitions (SS).

Under either the WS or SS paradigm, sustainability requires an ongoing process of problem solving. Current sustainability problems include population growth, depletion of non-renewable resources, overharvesting of renewable ones, and degradation of production systems. To meet challenges such as these, innovation is a necessary problem-solving tool. Confronted with problems, we often respond by developing more complex technologies, institutions, systems, and data processing. Problems continually arise, so there is constant pressure for problem-solving innovations. For SS, problem-solving will be centered on replacing non-renewable with renewable resources, increased efficiency, and systems improvements. In meeting the WS imperative for maintaining a growth economy, WS problem-solving will prioritize innovations that provide efficiency and substitutions in natural capital and technology.

[1] Innovation is defined here as the creation of conceptual or technical novelties, often by combining existing elements in new ways.

WS is a paradigm of resource and environmental optimism (Neumayer, 2013). We propose that both theories of sustainable development are overly optimistic regarding technology and innovation. Rather than seeking to determine which form of sustainability is right, we discuss prospects for innovation and technical development applicable to both approaches. The future of innovation is largely unknowable, as are the preferences of future generations. It is possible, however, to evaluate trends in the productivity of innovation and thereby assess the prospects for continued technical advances.

Sustainability and Technological Optimism

Near the end of World War II, President Franklin Roosevelt asked Vannevar Bush, director of the wartime Office of Scientific Research and Development, to prepare a report on the post-war role of government in promoting science. In his famous report, Bush wrote: "*Advances in science will…bring higher standards of living, will lead to the prevention or cure of diseases, will promote conservation of our limited national resources, and will assure means of defense against aggression*" (Bush, 1945, p. 10). This statement, so characteristic of our faith in science, became the basis for the emphasis on innovation that we know today. It is a system that has brought material prosperity in the industrialized countries and high levels of employment. Innovation has generated the complexity of modern societies. Bush's statement reflects technological optimism, a faith in technology to solve problems.

Technological optimism lies at the heart of contrasting narratives about prospects for sustainability, and about how our future might emerge. The following quotations are representative of our cultural belief in technology:

> "*No society can escape the general limits of its resources, but no innovative society need accept Malthusian diminishing returns*" (Barnett & Morse, 1963, p. 139).
>
> "*All observers of energy seem to agree that various energy alternatives are virtually inexhaustible*" (Gordon, 1981, p. 109).
>
> "*By allocation of resources to R&D [research and development], we may deny the Malthusian hypothesis and prevent the conclusion of the doomsday models*" (Sato & Suzawa, 1983, p. 81).

The alternative view, expressed, for example, by Jared Diamond, is that innovation will not offset resource depletion. Diamond states: A modern societal collapse would be "*triggered ultimately by scarcity of environmental resources*" (Diamond, 2004, p. 7). There are significant literatures concurring with technological optimism (e.g., Chu, 2009), and with the contrary view that human activity is approaching earth's limits (e.g., Röckstrom et al., 2009; Brown et al., 2011).

Technological optimism incorporates the belief from classical economics that resources are never scarce, they are just priced wrong. When a resource is abundant, or there are limited uses for it, the best quality or most readily available deposits will be mined first. This is known as the best-first principle. As higher quality resources are depleted or demand increases, resources become less immediately available, and they will rise in price. The market then signals that there are new opportunities for innovation. Innovation produces resource substitutions, new technologies, more efficient ways of using existing resources, or better ways of extracting lower quality deposits. Supply and demand will always find balance. Resource production is automatic, and need never be a concern. Recent examples include the expansion of food production through the Green Revolution, and the development of technologies to extract petroleum from deposits that are increasingly difficult to access. WS depends on these beliefs.

The contrasting narratives of technological optimism and earth limits illustrate what we propose is the fundamental dilemma of sustainability. This dilemma is: Will humans *always* be able to offset resource depletion with innovation, as required by weak and strong sustainability? If the answer is yes, then the technological optimists and WS proponents are correct, and sustainability may be less of a concern than many believe. If the answer is no, there is indeed reason to be concerned about our future. The intent here is to explore whether we can confidently expect that innovation will forever offset depletion, by the programs of either weak or strong sustainability.

Evolution and Productivity of Innovation

In both weak and strong sustainability, continuous innovation must provide constant or increasing returns to innovative efforts. Our capital investments in research and development (R&D) must yield the results we want. Should this cease to be the case, innovation costs would rise and the incentive to continue to invest in R&D would diminish. To maintain a constant level of welfare for current and future generations, innovation investments need to produce returns, either as new forms of capital or consumable goods and services, that repay investments at a nondeclining rate.

Innovation is a complex system embedded within other complex systems. Complexity is here defined in the anthropological sense of increasing differentiation and specialization in structure, combined with increasing integration of parts (Tainter, 1988). Complex systems have evolutionary histories, and innovation is no exception. The popular image of science is that of the lone-wolf scholar, an idiosyncratic but persistent genius peering through a microscope or trekking through unexplored jungles (Toumey, 1996). This was indeed how science was conducted through most of the 18th and 19th centuries, the age of naturalists such as Charles Darwin and Gregor Mendel. Yet the naturalists made themselves obsolete as they depleted the stock of general questions that an individual, working alone, could resolve. The principles of gravity, natural selection, and inheritance no longer wait to be revealed.

The point overlooked in both weak and strong sustainability is that knowledge production, like other human activities, grows complex and produces diminishing returns (Tainter, 1988). Innovation, in both the system and human-produced capital, grows in complexity and costliness, and exhausts easy solutions to problems. The productivity of innovation is therefore not constant. Research problems over time grow increasingly complex and difficult to solve, so that they require interdisciplinary collaboration. In response, research and development grow increasingly complex, and correspondingly more costly.

In every scientific field, early research plucks the lowest fruit: the questions that are least costly to resolve and most broadly useful. As general knowledge is established early in the history of a discipline, that which remains axiomatically becomes more specialized. Specialized questions become more costly and difficult to resolve. Research organization moves from isolated scientists who do all aspects of a project, to teams of scientists, technicians, and support staff who require specialized equipment, costly institutions, administrators, and accountants. The size of research teams grows, as illustrated in the increasing size of science authorship teams (Wuchty et al., 2007; Jones et al., 2008). There is evidence that teams now produce higher quality work with greater impact than individual researchers (Adams et al., 2005; Wuchty et al., 2007). Thus fields of scientific research follow a characteristic developmental pattern, from general to specialized; from wealthy dilettantes and lone-wolf scholars to large teams with staff and supporting institutions; from knowledge that is generalized and widely useful to research that is specialized and narrowly useful; from simple to complex; and from lower to higher societal costs.

Research and development rely on education, which also grows complex and produces diminishing returns (Tainter, 1988: 102-105). Mastery of scientific knowledge and methods becomes more involved as the body of existing knowledge grows more specialized and in-depth. Rigorous education is the foundation for creating and maintaining this kind of human capital and producing innovation (Taylor & Tainter, 2016). When education begins earlier, more children are enrolled, and people stay in school longer, society makes investments in the form of the direct costs of schooling and the opportunity costs of more young adults spending their time in education. As a consequence, education is in a cycle of increasing costs and lower, perhaps shorter, benefits to society. The extent and costs of education rise, even as the returns to society are declining (Taylor & Tainter, 2016).

It has long been known that within individual technical sectors, the productivity of innovation reaches diminishing returns. Hornell Hart (1945) showed that innovation in specific technologies follows a logistic curve: Patenting rises slowly at first, then more rapidly, and finally declines. Rostow (1980, p. 171) extended this observation in his attempt to explain why economic growth slows in developed countries. The question before us is: Does the phenomenon of diminishing returns to innovation in individual sectors apply to innovation as a whole?

Nicholas Rescher has addressed this question. Paraphrasing Max Planck, Rescher observed that "*…with every advance [in science] the difficulty of the task is increased*" (1980, p. 80). Writing specifically in reference to natural science, Rescher suggested: "*Once all of the findings at a given state-of-the-art level of investigative technology have been realized, one must move to a more expensive level.... In natural science we are involved in a technological arms race: with every "victory over nature" the difficulty of achieving the breakthroughs which lie ahead is increased*" (1980, pp. 94, 97).

Rescher terms this "Planck's Principle of Increasing Effort" (1978, p. 79-94). Planck and Rescher suggest that *exponential* growth in the size and costliness of science is needed just to maintain a *constant* rate of innovation. Science and innovation must therefore consume an ever-larger share of national resources in both money and personnel. Jacob Schmookler, for example, showed that while the number of industrial research personnel increased 5.6 times from 1930 to 1954, the number of corporate patents over roughly the same period increased by only 23 percent (1966, p. 28-29). Such data prompted Dael Wolfle in 1960 to pen an editorial for *Science* titled "How Much Research For a Dollar?" Derek de Solla Price observed in the early 1960s that science even then was growing faster than both the population and the economy and that, of all scientists who had ever lived, 80 to 90 percent were still alive at the time of his writing (Price, 1963).

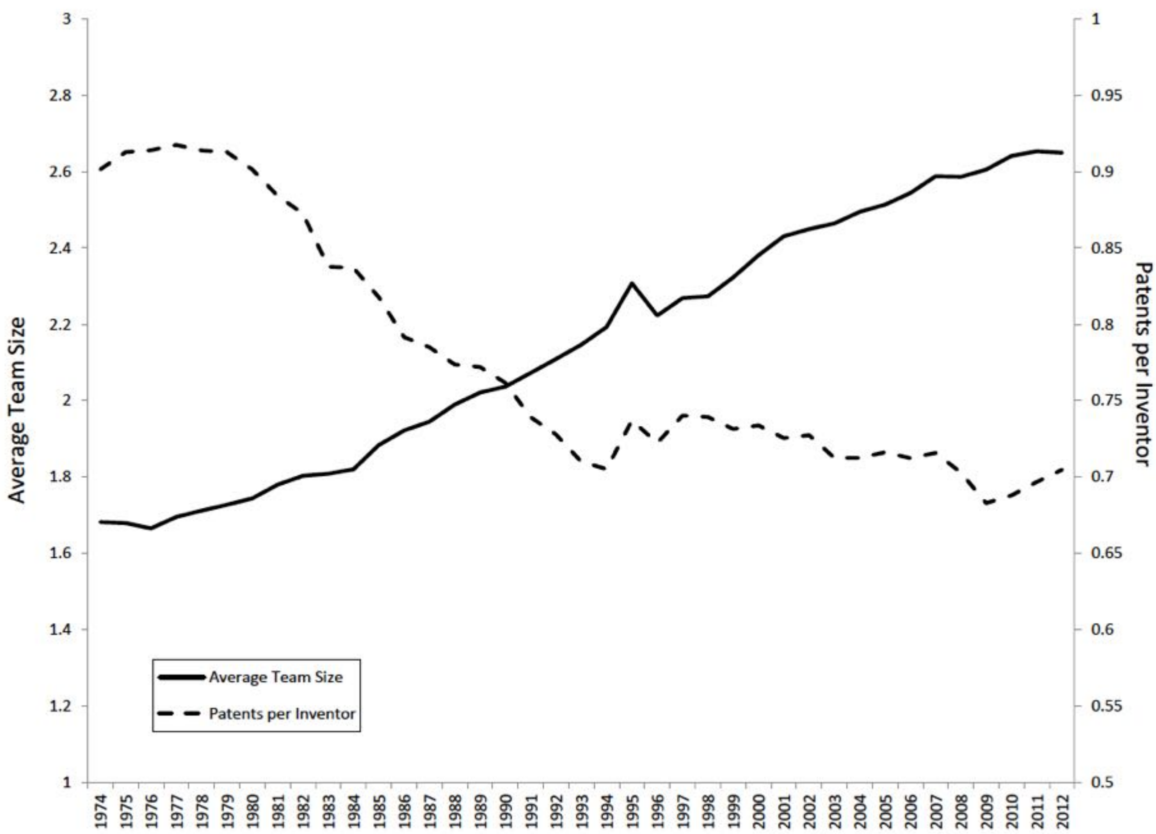
In academic research, Wuchty, Jones, and Uzzi (2007), and Jones, Wuchty, and Uzzi (2008), have shown that the ongoing challenges of research have been met by increasing complexity in the form of larger research teams. These teams are complex in that they are differentiated–incorporating diverse specialties–and require the organization of any differentiated system.

The possibility that innovation overall may produce diminishing returns on capital investments calls into question the narrative of weak and strong sustainability. As Price (1963, p. 19) pointed out, continually increasing the allocation of personnel to research and development cannot continue forever or the day will come when we must all be scientists. It is therefore important to determine whether the research enterprise overall produces declining marginal returns.

With our colleagues Deborah Strumsky and José Lobo, we have employed a database of all patents, and patents issued in specific fields of technology, to assess the productivity of innovation between 1974 and 2012 (Strumsky et al., 2010; Tainter et al., 2018). These dates were chosen to ensure high quality data. Strumsky's database consists of just under three million patents. About half of United States patents are granted to non-U.S. applicants, so the data reflect global innovation.

The process foreseen by Rescher and others is underway in the research that leads to patents. Figure 1 shows that, from 1974 through 2012, the number of authors per patent has consistently increased (Tainter et al., 2018), from 1.7 in 1974 to 2.6 in 2012. It is taking more and more innovators to achieve a patentable invention.

Figure 1: Average Size of Patenting Teams and Patents per Inventor, 1974-2012



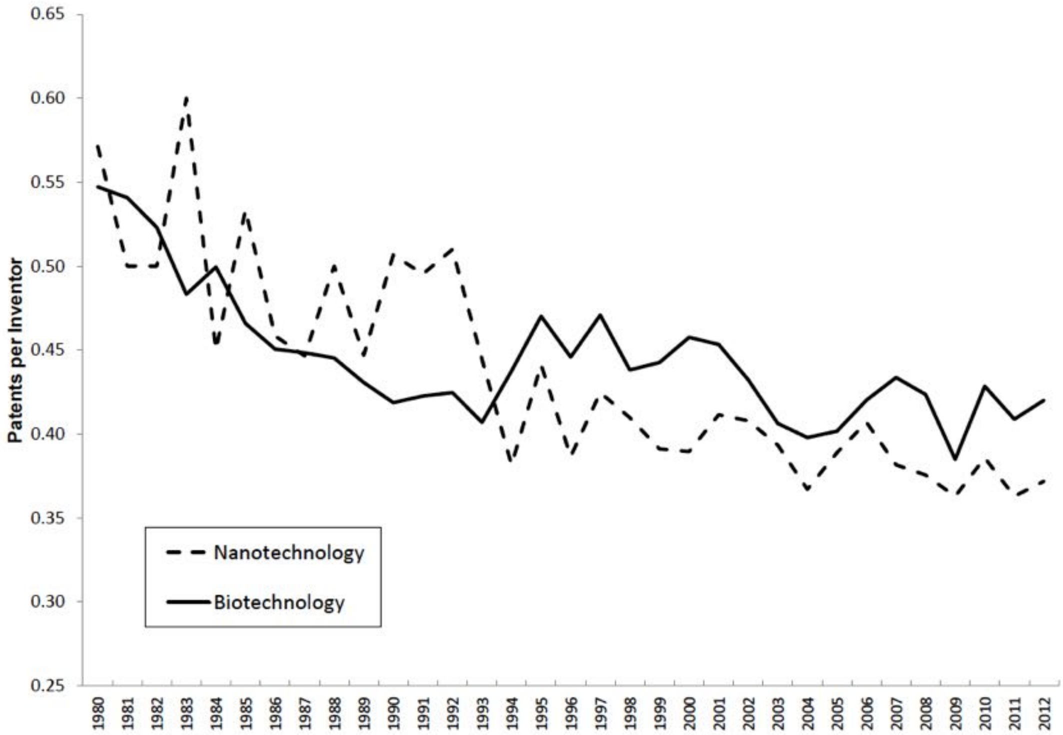
Corresponding to the increase in size and complexity of patenting teams, the productivity of those teams, measured as patents per investor, has been declining.[2] Over the 39 years shown in Figure 1, the productivity of innovation declined by 22 percent (Tainter et al., 2018). This indicates that the productivity of innovation is declining at a rate of about 0.56

[2] Our measure of the productivity of innovation, patents per inventor, corresponds to the measure of productivity in the economy as a whole, output per worker.

percent per year. Our data do not allow us to say when the decline in productivity began. A study by Huebner (2005) that measured innovation as important technological developments per capita concluded that major innovations peaked in the 1870s. The problem of increasing complexity in the research enterprise has been suspected since the same period (Peirce, 1879).

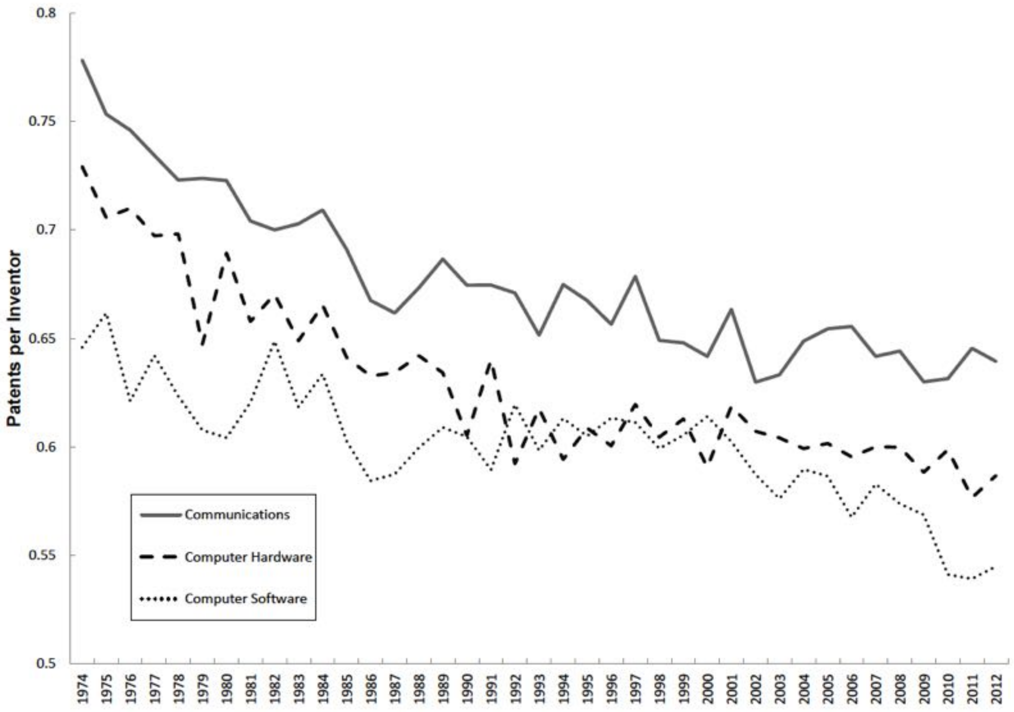
New fields of innovation are thought to be more productive than old ones, since in new fields simpler, basic discoveries can still routinely be made. It is appropriate therefore to ask whether there are increasing returns to innovation in newer technical fields and, if so, whether these offset diminishing returns in older fields. Even the newest technical fields, biotechnology and nanotechnology, show the same trend of declining productivity (Figure 2). Inventive efforts in these sectors are already producing declining rates of innovation. If this is characteristic of newer fields more broadly, then in industrial economies there may no longer be increasing returns in newer sectors to offset diminishing returns in older ones. If true, these findings indicate that the overall system of innovation cannot be supported by the marginal returns of new technological innovations.

Figure 2: Patents per Inventor in Biotechnology and Nanotechnology, 1980-2012



Information technology (IT) is a sector that is expected to produce some of the transformations that weak and strong sustainability require, especially in the area of Green IT (García-Berná et al., 2019). IT has indeed transformed many aspects of life in ways that support sustainability goals, such as allowing teleconferencing and remote work, and by facilitating access to information, education, and technology in developing countries. Patenting data indicate that productivity of innovation in this sector has been in decline since the mid-1970s (Tainter et al., 2018). Figure 3 tracks patents per inventor in the fields of information technology, both hardware and software. These are some of our most dynamic technical sectors, and the sources of much recent economic growth and high investment. Yet each of these technical sectors shows a long-term trend of declining output per inventor.

Figure 3: Patents per Inventor in Information Technologies, 1974-2012.



The decline in patent numbers and the increase in inventors per patent suggest that new patents are incremental improvements on the original discoveries. Computing and digital technologies appear to be following in the path of declining productivity of innovation seen in other more materially intensive sectors.

IT and computing technology demonstrate how innovations create demand for new resources and substitutions. Rare earth elements are essential to information and communication technologies. These minerals have become economically important due to increasing demand and emerging markets (Coulomb et al., 2015). The use of rare earth elements supports sustainability goals through technologies intended to improve efficiency, limit fossil fuel consumption, and control greenhouse gas emissions (Pell et al., 2019). Consumption of rare earth elements and other materials used in electronic components has grown significantly in past decades and is expected to accelerate with demand for green IT (Coulomb et al., 2015). The need for batteries has created increased demand for metals such as lithium, cobalt, manganese, and nickel (Olivetti et al., 2017). Battery technology supports IT, communications, and computing, and is also critical for electric vehicles and storage of renewable energy. Energy efficiency and renewable energy transitions are in some ways a substitution of one set of non-renewable resources (fossil fuels) with another (rare earth elements, lithium, cobalt, etc.).

The fundamental conclusion to be drawn from these charts is that innovation is requiring the investment of more and more resources in the technical arena. The productivity of innovation is declining, as the authors cited above foresaw. This calls into question the suitability of relying on innovation to ensure future sustainability, whether we seek to follow the paradigms of weak or strong sustainability.

Assessment

Innovation is part of the cosmology of industrial societies. We believe it to be innate, immutable, and inevitable. We have fetishized innovation, and consider it a primordial characteristic of our species. It takes on a religious character when we place our faith in it as the ultimate source of material salvation.

Our cultural belief in innovation places it at the center of sustainability aspirations, both for WS and for SS. The critical debate is between technological optimists, who believe that resource constraints can always be overcome by innovation, as in weak sustainability, and those who believe that resource constraints are pressing and cannot be overcome forever. WS and SS both seek to establish intergenerational equity and the ongoing welfare of human beings. They share the need for substitutions where possible and improvements in efficiency. SS imposes additional constraints on growth and substitutions for natural capital. It also requires social-structural innovations. SS depends on innovation as much as WS does. The specific requirements of WS and SS drive innovation in different directions, but they are both technologically optimistic.

Classical economists, as quoted above, believe that resources are never scarce, just priced wrong. As long as markets are unfettered and there is a price mechanism, rising costs of resources from a scarce supply should spur innovation. Innovations would come in the form of finding new sources of the resource, developing technical approaches to using the resource more efficiently, or finding substitute resources. The theory of WS requires that this rule holds true. Under SS, conditions of natural resource scarcity would also drive innovation, although innovation investments would be directed into efficiency improvements, renewable replacements, or systemic changes.

Technological optimism will, in time, falter over the matter of incentives. Firms and governments will invest in R&D provided that the costs are affordable and the returns are constant or increasing. If investment in innovation yields declining marginal returns, the outlook is less favorable. Yet diminishing returns are precisely what our data reveal. Over a period of 39 years, the productivity of innovation, measured as patents per inventor, declined at a rate of 0.56 percent per year, even as investments in research have increased. To produce a constant rate of innovation into the future, ever greater investments would need to flow into systems of innovation in order to maintain the perfect substitution of WS or the efficiency and production improvements of SS. Innovation would consume the economy, and Price's prediction that someday we must all work in the scientific enterprise would be realized.

This trend is driven by increasing complexity and costliness in the research process, and cannot be reversed. As the trend continues, our system of innovation will inevitably become too expensive and/or too unproductive to continue in its present form. Firms and governments will be forced to curtail investment in innovation. In some areas of research this is happening already.

The weak sustainability economic model proposes that technology or labor can substitute for renewable resources such as fish or trees, and non-renewable resources such as minerals. To be interchangeable, technology and innovation must constantly keep up with the depletion of non-renewable resources or the overharvesting of renewable resources. Solow believed that "[u]*nlimited technological progress may be unlikely, but it is not, like unlimited population growth on a finite* *planet, absurd*" (Solow, 1974a, p. 40). The evidence shown here suggests that this position places unwarranted faith in innovation's long-term potential.

The role of innovation in substituting forms of capital in SS may be narrower than for WS, but it will be important in different ways. Maintaining overall stocks of natural and human-produced capital while protecting critical natural capital will require physical, technological, and systemic innovations. These additional requirements will likely make the challenge of sustainable development more difficult. SS is no less technologically optimistic than WS. It is not clear that innovation systems can keep pace with accelerating changes in natural systems and depletion of resources, especially since the productivity of innovation is declining.

Innovation is a form of human capital that is critical to sustainability. Its importance is on par with other forms of capital. It is the form of human capital upon which we build aspirations for future sustainability. Given that innovation has plucked the low-hanging fruit, and will continue to grow in complexity, investments in innovation will yield lower returns in the future. The reason underlying the declining productivity of innovation – the complexification of the research process – will not change. As we answer questions in science, subsequent questions are more difficult to resolve. As research questions grow more challenging, the research enterprise grows larger, more complex, and more costly. As research grows complex and costly, it produces diminishing returns. This process is inexorable, in both weak and strong sustainability.

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Changing the System: From Urban Metabolism, System Dynamics and the Circular Economy to Circles of Sustainability

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Leaving aside comforting (and misleading) stories about the *gradual* changes that global warming is bringing, there is no way around the underlying reality. Over the next half-century, the planet will rapidly become increasingly uninhabitable for humans—except perhaps for uber-wealthy who can afford to shield themselves from some of the intensifying changes (Wallace-Wells, 2019). The world is in crisis, and cities are at the centre of the current maelstrom. We are living in a complicated period during which we are struggling to find adequate ways to characterize the dominant sustainability challenges, let alone respond adequately to those challenges. In the face of this, a multitude of sustainability methods have been developed to better measure processes of human activity and their effect upon the planet. Methods of urban metabolism, industrial symbiosis, circular economics, and different kinds of system dynamics all offer alternative modes of measurement—some incredibly sophisticated.

What they all tend to lack is a way of mitigating self-generated tensions. First, the more *quantitatively* rigorous the modelling becomes, the more it seems to lose the capacity for *qualitative* critical analysis. That is, at a time of incredible complexity when we desperately need evidence-based critical interpretation, computer-generated numbers have come to drive the conclusions of much systems' work.

Secondly, the more finely tuned and 'certain' the modelling becomes—such as by setting up increasing numbers of variables or more tightly defining the system in question—the more its proponents seem to lose insight into the limits of its conclusions for policy-making. This phenomenon of *false certainty* is compounded by choosing further variables within the same broad fields as the other chosen variables, usually leaving out critical political and cultural considerations (all while claiming to be socially aware).

Thirdly, since the middle of last century, as the domain of economics has moved from the immaculate child of capitalism to be enthroned as its demanding monarch, all considerations of the value of measures—weights and volumes, the speed of transactions and the number of persons impacted, etc.—have come to turn on one universal logic of commensurability: money. This means that, despite an increased attention to wellbeing, human flourishing, and ecological sustainability, the bottom line is still economic value accumulation.

Fourthly, the more computer-generated algorithms have grown to become the king's favoured accounting method, the less and less interested we have become in the 'black box' of ecological, economic, political and cultural assumptions that frame such algorithmic calculations. Who has time these days to read the fine print or to work out the hidden premises around which the algorithms are built.

Fifthly, the more sophisticated and discipline-refined the language of sustainability has become, the more it seems to be captive to resource economics. Even the concepts of 'weak' and 'strong sustainability' need completely redefining. Both come out of environmental economics with weak sustainability meaning that 'human capital', resources such as labour, knowledge and built infrastructure, can substitute for 'natural capital' or environmental resources such as fossil fuels, wind for generating power, minerals, diverse species, the ozone layer, etc. It sounds innocuous, but this means that weak sustainability proponent suggests that natural resources can safely decline so long as human capital is increased. So-called strong sustainability assumes that these are not interchangeable and nature has a right to exist and be passed onto later generations. But this is hardly a form of *positive* sustainability, defined as the flourishing of social and natural life, both for themselves and in inter-relation.

In face of these issues, this essay argues for a paradigm change. Without wanting to throw the baby out with the bathwater—that is, abandon the search for good systems methods for measuring change and impact just because existing methods are limited—the essay seeks to rework dominant approaches to modelling social and environmental challenges. This will be done in terms of four analytical tests, tests that provide the point of departure for the Circles of Social Life approach:

1. *The Test of Practical Usefulness*. Is the method useful? In particular, does it provide a way of ordering our understanding for doing things—that is, for making a positive difference in the world.

2. *The Test of Analytical Coherence*. Is the method coherent in the way that it develops its categories of explanation and sets up the relationship between its overall claims and its parts? Can it integrate different considerations into a larger analytical whole?

3. *The Test of Simple Complexity* Can the method render the complexity of the social and natural whole in relatively simple ways without distorting or reductively abasing the knotted meaning of the complexity? That is, can its figurative and expressive representations work simply and clearly without being reductive in way that distorts what it means to be human, living within the limits of complex natural systems. This test requires the capacity to move between the global, regional and local.

4. *The Test of Normative Reflexivity*. Is the method based on considerations that provide a sound basis for reflexively assessing the forces and critical issues within and upon the social or natural environment, and then acting upon those forces and issues in a way that recognizes its own normative assumptions (James, *et al.* 2015).

We work with the concept of 'systems' here, because the material boundaries of what is being analysed need to be simply delineated (the test of simple complexity). However, this concept of 'system' needs careful definition that meets the test of analytical coherence. A system is only 'closed' through an act of analytical simplification. It is an abstracted bounding of a spatial relation. In these terms, a system needs to be defined as *a conditionally named*, bounded configuration of related elements that interact with each other in complex living ways that over time establish patterns of practice (what can contingently be called 'structures'). Here the concept of 'conditionally named' means that there are no completely closed or perfectly definable systems in the world. Rather there are overlapping sets of more or less recursive interactions that we can *call* 'systems'. In turn, then, *system dynamics* needs to be understood through much more than the very limited notion of stocks (or material objects of defined value) and flows (the movement of those 'resources'). This essay will argue that system dynamics needs to be defined in the broad context of *forces*, *critical issues* and human *responses* that bear upon the 'system' in question (these concepts will be defined later in the essay). In the hands of a blinkered 'system dynamics' analyst this tends to be reduced to a commodity chain analysis. It needs to be remembered that modelling or even describing a *system* and its *dynamics* is only possible while drawing away (abstracting) from the inter-relational complexity of any chosen social or environmental object of enquiry. Such analytical abstraction is a necessary process, but can be dangerously misleading when the elements of analysis are reduced to money and commodified resources or eco-services.

Working through these tests, the Circles approach abstracts four social domains as critical to all human activities: ecology, economics, politics and culture. Here, the essay operates predominantly at the level of empirical generalization, but this is sufficient for present purposes. As will be developed, these domains are treated as equally important to understanding any system, at least for a holistic analysis. Perhaps the most radical move entailed in this approach is the domain of economics is always-already social. Economics, defined as the practices, discourses, and material expressions associated with the production, use, and management of resources, thus no longer gets lifted out as separate from the social or the natural. The central argument of this essay is that a holistic approach, something akin to the Circles approach, is necessary for making system-dynamics approaches work more sensitively and adequately.

The essay begins by exposing the difficulty of responding adequately to the coming planetary catastrophe. It proceeds with two orienting sections that provide critical elaborations of the system dynamics and Circles of Social Life approaches respectively. Finally, it poses a series of questions as a way of refining the two broad approaches in relation to each other. What do the metaphors of 'metabolism' or 'circles' mean for systems complexity? Can the notion of a circular economy as one form of systems approach generate more than a rhetoric of holistic interpretation? Can a variation on the Driving Forces Model (DPSIR) provide a different and co-extensive frame for understanding systems dynamics holistically?

Responding Adequately to the Coming Catastrophe

Why is the dynamic modelling of systems important? System dynamics is simply and powerfully important because the social world that humans have made is incredibly complex. This world compounds the entangling of 'systems' of life on planet earth. It is indicative of this *social* complexity that we live in a period that is simultaneously being criticized as 'the Anthropocene' and, more optimistically, called 'the Urban Age'. This is the era in which humans have had a profound impact upon the earth's ecological systems, outstripping all others (Bonneuil and Fressoz, 2017). It is also the period during which the planet has become overwhelmingly urbanized (Gleeson, 2014). Bringing together these contentions has led to the 'obvious' but somewhat misleading claim that cities provide the basis of a sustainable future.

Rather than the simple point that it appears to be, the claim that cities provide the basis for a sustainable future presents us with a confronting paradox. Yes, developing a positive and sustainable mode of urban living is the only way that we will be able to sustain social life as we know it past the end of this century. But it is equally the case that cities are at the heart of the ecological problems facing this planet. Let us be clear here. For all of its distortions, the double equation that 'cities are the future' and 'cities are the engines of economic growth' is based on the skewed presumption that high mass-consumption—anathema to *positive* sustainability—continues as the assumed promise of contemporary urban life. Even the Sustainable Development Goals are hostage to the dominant economic growth paradigm. This is one small point in the political complexity of the contemporary human condition.

The other side of the equation is also confronting. Because the world's current population growth has reached a tipping point, returning to a predominance of rural living is no longer viable for the future of humanity—ecologically, economically, politically *and* culturally. In ecological terms alone, sustainably increasing the density of our urban settlements along with increasing energy-efficiency and using less resources *is* the only alternative, at least when treated as one part of a comprehensive revolution in how we live. But this is not because cities are essentially more sustainable than rural settings. It is rather because, given current global population, building on small, self-contained plots of land can no longer save the planet. Well-planned density is necessary to slow down our colonization of the planet.

This paradox is associated with a second distorting contradiction (this time, an economic contradiction). The very activities that have been the basis for mainstream human flourishing—often summarized in the hope-filled concept of 'economic progress'— have come to be the prime reason for our current crisis. When Charles Dickens wrote *A Tale of Two Cities*, seventy years after the French Revolution, his words appeared to confront this very point: "*it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way—in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only*" (Dickens, 1859, p. 3).

However, most commentators since then have missed the point of this passage. It was not for Dickens the 'best of times' or 'the worst of times' *per se*. It was rather a new time where 'superlative degree of comparison' began to reign supreme. Hence, a third (political) contradiction. It had become the age of hyperbole, through which we are still living. Dickens' words speak of a new world of starkly different descriptions and prognoses of hope and despair, with little expressed publicly in between. The people of the two cities, Paris and London, or at least their less-than-democratic planners and politicians, were confronted with difficult choices to make about their future—and rhetorical excess ruled.

Perhaps as a consequence, over the next century to the present, with limited exceptions, neither of those cities found ways of getting beyond the vacillating rhetoric and the galloping problems of urban bloating. Nor, for most part, did other cities and urban communities on this planet. For all of the good work of committed infrastructure planners and urban activists, problems ranging from tedious traffic congestion and privatisation of common spaces to bloating resource-use and urban violence continued to confront social life. Now, in the early part of the twenty-first century, we are still too-often engaged in Dickens' 'superlative degree of comparison'. On the one hand, it suggested that technological renewal or ecological modernization can save the planet. On the other hand, it is proclaimed that individual actions in response to planetary crisis will not add up to making a significant difference. In continuity with earlier competing descriptions of what needs to be done—and with a thousand qualifications—both responses are defensible. However, they need to be brought into a synthetic relation with each other that meaningfully confronts the planetary crisis (Wallace-Wells, 2019). And this needs to be done in the context of the searing recognition that significant changes have occurred over the past few decades to make debates over superlatives increasingly empty.

First, the concepts of 'the Anthropocene' and 'climate change' have become mired in very debates that were meant to be clarifying. The notion of 'the Anthropocene' goes back to the nineteenth century when Antonio Stoppani, an Italian contemporary of Dickens', coined a cognate term, but it has taken until the last few years, following Paul Crutzen and Eugene Stoermer's intervention in 2000, for the concept to gain any traction. And, almost as soon as the concept entered contemporary discourse, it was either reduced to its technical meaning—a measurable impact upon the geological substrate of the earth through leaving sedimented traces—or alternatively, like the contestation of climate change, its meaning was variously disputed by right-wing populism as a relative truth or a post-truth scam.

Secondly, the modern dialectical struts of hope and despair have now allowed for the long-term deferral of fundamental action on basic questions—whether structural or individual. Fundamental action has slipped into tragic inertia. Leaving aside the continuing passions of populism or the despair of nihilism, there is now a constant deferral in much of the mainstream of more than incremental structural changes to business–as-usual. This is carried by the contradictory idea that, on the one hand, we must do 'something', but on the other, that life on our planet can go on much as before if it is supported by enhanced technological platforms.

Thirdly, the stakes are now much higher. Something new is clearly happening, vaguely signalled by the concept of 'the Anthropocene'. We are the first human civilization with the capacity to override prior senses of planetary boundaries and limits. In other words, while continuing to degrade nature, we have begun to re-constitute the nature of nature. We can now split atoms, recombine genetic material, disrupt ripples in space and time, and play with nucleotides and chromosomes, the building blocks of all life-forms on earth. This is a qualitatively step beyond belching out black smoke or clearing tropical rain forests for beef production, and signals the constitutive level of the crisis.

In the meantime, the earth's climate patterns continue to be fundamentally destabilized. According to a recent report by the Intergovernmental Panel on Climate Change (IPCC), the world reached 1°C global warming above pre-industrial levels in 2017, and is heading towards 1.5°C within a decade or so—the *high confidence* range predicted for this threshold is between 2030 and 2052. With more than 2°C global warming, it has been suggested that the world will head towards global chaos, albeit with more severe impact in the equatorial regions. To give some sense of the difference between the two thresholds, at 1.5°C, the IPCC estimates that around 80 per cent of coral reefs will be gone; at 2°C it will be 99 per cent destroyed (IPCC, 2018).

Some critics have talked about how we are sleep-walking towards our own demise. However, while the possibility of degrading life as we know it is simply real, the deferral of structural change in the form of the economy and culture is much more active than that. Nobody is asleep. Keeping social life on course for disaster entails real effort. In effect, it amounts to an energetic projection of business-with-a-changed-rhetoric while supercharging the technological infrastructure to support social life as we know it. The Smart Cities' rhetoric, for example, is replete with 'green' images of the planet, while doing little to attend to the coming chaos. And hyperbolic announcements continue to be made about relatively weak (even if sometimes useful) alternatives—traffic management systems that will supposedly give people the capacity to skirt neatly around traffic snarls; cloud systems that mean that we can collect even bigger data sets for (questionable) interpretation; mobile phone apps that allow people to learn more about the streets through which they move without stopping to use their senses to fully experience those streets. All these developments tend to defer the need to rethink fundamentally the form of the hyper-mobile, consumption-heavy and growth-based social freedom that presents itself as the *raison d'être* of 'sustainable development'. This is the paradoxical 'revolutionary' stasis that allows us in the metropolitan West to stay basically within the same growth paradigm, while everything swirls around us suggesting basic reconsideration.

Given this context, how can we best map the challenges of urban sustainability as a guide to positive practice? How can we influence mainstream decision-making that requires assessment processes, statistics, indicators and markers in order to defend change? This essay sets out to bring together two very different approaches to sustainability—the urban metabolism approach, and the Circles of Social Life method. These are both systems approaches. There is no attempt to reinvent the wheel here. What is being proposed is only new in the juxtaposition—a more reflexive synthesis of old and new work, bringing new sensitivities to old problems.

The strength of the various urban metabolism and system dynamics approaches is that they can dynamically map and measure the material inputs and outputs to a system. This is what some call 'stocks and flows', defined as entities that can be accumulated or depleted in relation to processes or flows across time, processes that effect the measurable levels of those entities. Measuring urban metabolism thus tends to be operationalized in *quantitative* terms (e.g., Kennedy, *et al.* 2007). The strength of the Circles method is that it sensitizes researchers and practitioners to the intersectional *qualitative* complexity of social life, bringing together domains, perspectives, and aspects across all of social life in relation to cross-cutting critical issues. The Circles method thus has its basis in qualitative assessment of relational values.

System Dynamics and integrated Assessment Models

The study of system dynamics—that is, the study of closed systems with attributed determinative factors which can be analysed algorithmically—began in the mid-twentieth century. It translated engineering tools for studying load problems and business methods for modelling the growth of corporations into broader systems models. This was not an auspicious beginning. But in some hands, it proved to be quite radical, particularly in opening up questions of causation. The key issue to be resolved was the difficulty of discerning the core causes of change in complex systems. As Jay Forrester, one of the early translators of the system dynamics approach, put it, "*a complex system is even more deceptive than merely hiding causes. In the complex system, when we look for a cause near in time and space to a symptom, we usually find what appears to be a plausible cause. But it is usually not the cause. The complex system presents apparent causes that coincident symptom*" (1969, p. 9–10).

His pioneering work and subsequent book *World Dynamics* (1971) became the basis for the famous *Project on the Predicament of Mankind*, one of the earliest attempts to map algorithmically the Anthropocenic crisis. It mathematically modelled what it said were the five basic factors that determine the sustainability of this planet: population, agricultural production, industrial production, consumption of non-renewable resources and pollution. That project in turn became the basis for one of the most important and controversial books of the twentieth century, *Limits to Growth*, produced by the Club of Rome (Meadows, *et al.,* 1972). That book had two conclusions:

first, "*If the present growth trends in world population, industrialization, pollution, food production, and resource depletion continue unchanged, the limits to growth on this planet will be reached sometime within the next one hundred years.' Computerized modelling was fundamental to this conclusion. Secondly, they projected, 'It is possible to alter these growth trends and to establish a condition of ecological and economic stability that is sustainable far into the future*" (Meadows, *et al.,* 1972, p. 23–4). This would require decision-making based on answering some basic questions. Here the test of normative reflexivity is taken very seriously: "*Should there be more people or more wealth, more wilderness or more automobiles, more food for the poor or more services for the rich? Establishing the societal answers to questions like these and translating those answers into policy is the essence of the political process. Yet few people in any society even realize that such choices are being made every day, much less ask themselves what their own choices would be. The equilibrium society will have to weigh the trade-offs engendered by a finite earth not only with consideration of present human values but also with consideration of future generations*" (Meadows, *et al.,* 1972, p. 181–2)

Like Jay Forrester, the Club of Rome authors argued for the existential necessity of moving from a paradigm of developmental growth to one of equilibrium. It is worth looking back at these contested books from nearly half a century ago, because we can now test some of their projections against realized trends. For example, the Club of Rome authors broadly estimated that there would be 7 billion people on the planet in the year 2000 (we did not reach that figure until 2011). However, the predictive power of the method is not the key point of the testing. This became part of the unhelpful defense of 'business as usual' by a thousand critics at the time. As the Club of Rome authors themselves wrote at the time, 'In terms of exact predictions, the output is not meaningful' (1972: 94). Rather, the key here is the relational output understood in terms of alternative scenarios. They could not have known for example that China would introduce their one-child policy in 1979, with around 500 million births said to have been prevented across the ensuing four decades. From the perspective of the central argument of this essay, the key question was not how good were their predictions, but why were critical political and cultural decisions seen as *post facto* issues raised by the method rather built into its core from the beginning (more of this later). There are a number of writers such as Arnaud Diemer and Claudiu Nedelciu (2020; see also Spittler, 2019) who are sensitive to the limitations of these models while working with their strengths, but it is not the norm.

In summary, the Club of Rome authors worked with only a small number of economic and ecological themes (their way of handling the test of simple complexity)—population, agricultural production, industrial production, non-renewable resource use and pollution—and did so aware of the limits of what they were doing. Given the new capacities of computers for handling algorithmic complexity, we would expect that more recent work to provide more integrative dimensions in their calculations. However, this does not appear to be the case. There are now numerous different *Integrated Assessment Models* (IAM), with one emphasis on data-tracking and other on moving from forces to responses. In the subfield of climate modelling alone there are a baffling number of systems approaches that emphasize data-tracking. However, as summarized by Zheng Wang, Jing Wu, Changxin Liu and Gaoxiang Gu using an already-established breakdown of types of Integrated Assessment Models, these different models are all narrowly conceived:

(1) Cost-benefit analysis IAM for policy optimization, such as CETA, DICE, FUND, ICAM-3, MERGE, and the MiniCAM. These models firstly care about the economic consequences of climate change, such as comparing costs for climate change adaption and emissions reduction to assess possible alternative policies. In these models, climate

modules are under 2 dimensions, some even are 0 dimension ... they can be used to rapidly evaluate emissions reduction agreement, such as Kyoto Protocol.

(2) Biophysical-impact based IAM for policy evaluation, such as CLIMPACTS, ESCAPE, IMAGE and IGSM. These models are more focused on quantitative evaluation of the biophysical rather than economic policy evaluation. They tend to be analyze at the regional level, some analysis can also be integrated into the global level. The advantage of these models is to analyze the impact of climate change on the high spatial resolution ... Economic module often contains only GDP, population and energy use.

(3) Policy guidance IAM, such as ICLIPS. It transfers economic losses (plants, agriculture, water resources) module through climate impact response function into tolerable windows. Tolerable window is generally expressed by the rise of temperature, rainfall and sea level rise level. These restrictions are input into greenhouse gas emissions-climate change module to calculate carbon emissions that can keep consistent with tolerate window. This model can be used to calculate the threshold value of climate change (2017, p. 3. Note, the grammar is as in the original)

All these variations seem to meet the test of usefulness, however despite the range of these approaches, and for all of the good intentions of the authors of various Integrated Assessment Models, the radicalism of the Club of Rome has largely been lost in the search for increasing micro-certainty about economic-environmental relationships. More pointedly, for our argument, none of the dynamic systems approaches have gone beyond economic-environmental variables in their understanding of the determinatives of change. To be sure, there are impressive developing systems such as the MEDEAS-World model, a global economy-energy-environment model that presents a global dynamic system encompassing the period 1995 to 2050 (www.medeas.eu/model/medeas-model). The strength of this model is that it does not attempt to be predictive, but rather it projects possible scenarios in energy transition given changes in different domains of activity. And it does appear to bring in broader social questions: apart from the core domain of renewable and non-renewable energy resources (laudably considering biophysical and temporal parameters that are usually ignored), the other domains are economy, infrastructure, materials, land-use, climate change and what they call 'social and environmental impact'.

Yes, with the naming of that last domain, questions of social impact appear to be under consideration. However, there are a number of major problems with this model which mean that the naming of the social is counterproductively misleading. In short, it fails the test of analytical coherence. The last domain is not dynamically connected to the rest of the model. It does not feed back into the outcomes of the different scenarios (Capellán-Pérez, 2017). And, it is certainly not treated as meaningfully determinative. In other words, human practices across the domain of culture (that is, meaning, including ideologies of climate-change denial or deferral) and politics (that is, power, including through the practices of global corporations or the work of state-based policy-change) are given no bearing on the variables of change. In a world where, arguably, humans and their culture and politics play a pivotal role in the direction of the planet—one of the reasons why this period is called 'the Anthropocene'—this remains a significant problem.

Akin to the first point, when one goes into the fine detail of the model it becomes apparent the variables in this 'social' domain are not actually cultural or political at all. What they call 'social indicators' are limited to the domains of economics and ecology—many variables of which are already being measured: fuel consumption, electricity consumption, water consumption, the potential Human Development Index level given energy-use, consumption of renewable energy sources (RES), share of RES in total final consumption, annual penetration of RES in the total final and primary energy consumption, Gross Domestic Product (GDP) per capita, jobs associated to RES technologies, the 'estimation per electricity generation technology' of the system, green-house gas emissions, atmospheric green-house gas concentration levels, and temperature increases over pre-industrial levels. There are thus lots of 'social' variables, but none are cultural or political in their primary orientation.

Moreover, it is made ideologically worse by the authors of MEDEAS arguing that because they have taken one of the indicators of the Human Development Index, namely GDP, the whole set provides an indication of wellbeing—as if the Human Development Index itself, much less GDP, is a *good* proxy for measuring wellbeing. All of this makes the model circular, but in an almost tautological rather than holistic or integrative way.

Finally, there is the practical question. Given the urgency of the issue, one much overlooked point is worth considering. In the relatively short period since the Club of Rome wrote their report, substantially more human-produced greenhouse gases have entered the atmosphere than during all the prior years, centuries, and millennia of human history.

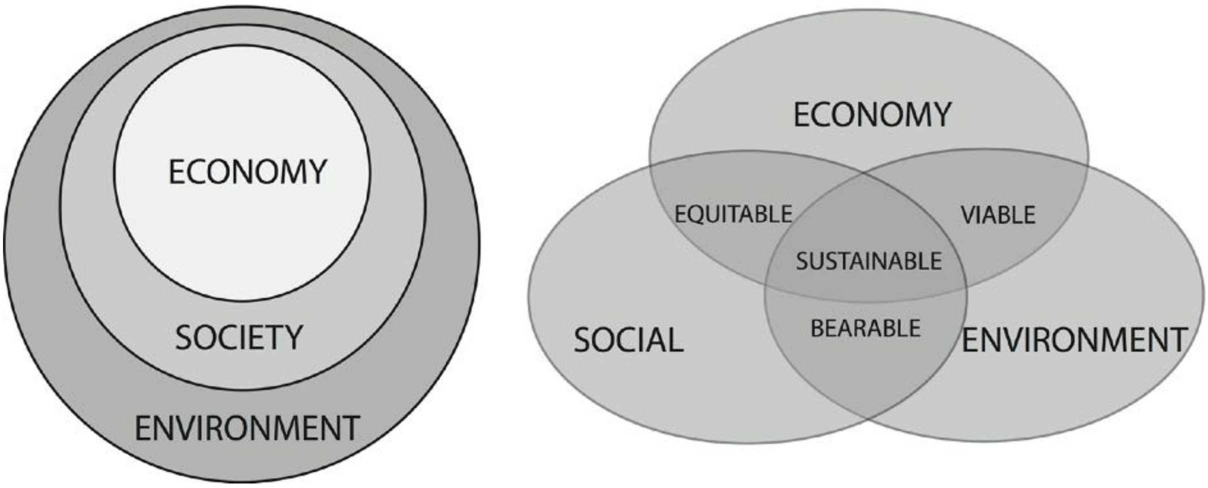
The 'Circles of Social Life' Method

The *Circles* method starts from a very different theoretical place, an integrative systems model that is qualitative at its basis *before* deriving quantitative indicators or variables. It is grounded in claims about the integral importance of politics (power) and culture (meaning) to all human practice—at the same time as recognized two other domains that are now always in contention: economics (resource-use management) and ecology (integration within and with the environment). These domains are 'interwoven', to use Liam Magee's felicitous metaphor (2016). Figuratively they are bound together in a *circle* of social life (see Figure 2 below).

The method had its beginnings in the early 2000s with a small secretariat of the United Nations, the Global Compact Cities Programme. That program sought an alternative framework for guiding cities towards positive sustainability from the dominant Triple Bottom Line approach (Figure 1), an approach that still holds rhetorical sway in policy discourse. The ever-more dominant position of economics was distorting urban development. An alternative was needed that was both practical and conceptually sensitive to the way in which dominant ideologies of growth, return on investment and technological fixes were driving (and skewing) social practice, including urban policy-making and corporate priorities.

To cut a long story short, the Circles method begins by making the claim that it is both heuristically useful—and now existentially necessary in the Anthropocene—to consider all questions of social life holistically across integrated set of *social* domains: ecology, economics, politics and culture (James, *et al.*, 2015). These domains were chosen through an extended period of global consultation as the simplest contingent set that most effectively represents the full complexity of human engagement in the world (see Figure 2 below). This does not just involve adding the domain of culture as a fourth domain to the Triple Bottom Line domains of the economic, environment and social. Rather, it involves recasting the meaning of all current approaches, in particular those which treat domains as separate or autonomous areas of practice and meaning that are partially brought back into intersection (Figure 1).

<u>Figure 1</u>: Two Versions of the Triple Bottom Line



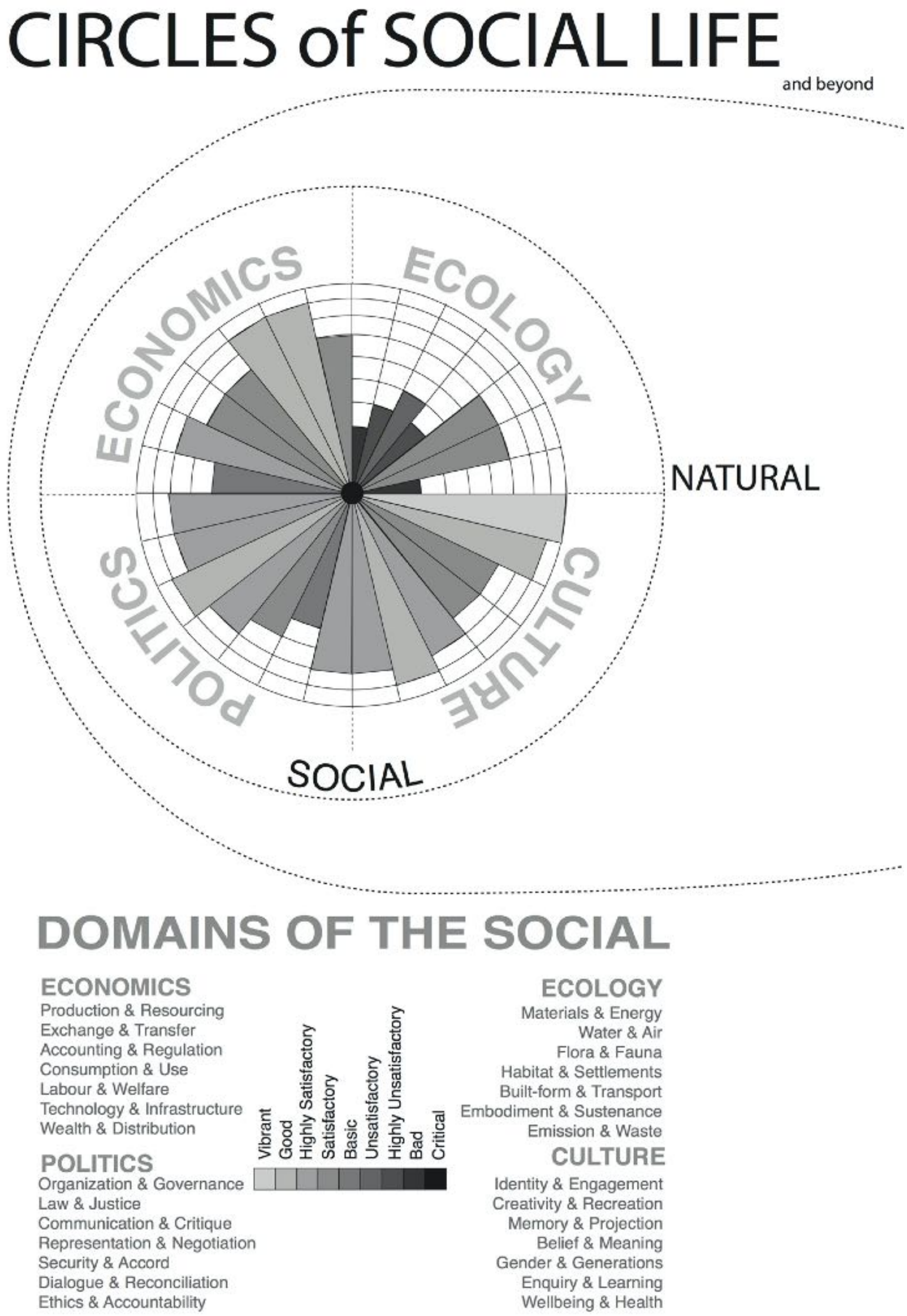
By comparison with the Triple Bottom Line argument and kindred approaches, the Circles method treats the economy and its avatar 'the market' as always-already inside the social rather than running free as a self-managing master system—a magisterial status that was conferred on it as late as the middle of the twentieth century. In this sense, the Circles method rejects particularly those approaches which treat sustainability as the narrow intersectional outcome of economic 'restraint' or involves treating elements of the environment as externalities to be treated in accountancy terms as mere resources or 'ecosystems services'. It does not attempt to cover the environment-in-general, a never-ending materiality that goes far beyond the human. Rather it focusses on 'ecology', understood—by a metaphorical extension of the original Greek sense of *oikos*—as the place, the terrain, the earth, in and through which humans live as environmentally bound beings.

It should also be said that the concept of domains—and the four domains analytically lifted out for consideration: economics, ecology, politics and culture—cannot themselves be treated meaningfully as systems. Yes, it is possible to talk for example of *an* 'economic system', such as the car industry, but this is merely to evoke the starting point of the analysis: the domain of economics. The car industry makes little sense as a system if the analysis leaves out the ecological consequences of car manufacturing, the politics of legislation and government policy, and the culture of fetishizing the car as a commodity, lived as if it gives people identity and status.

Much more than just a domain-based figurative representation, the Circles method builds on this conceptual base to offer an integrated set of tools for practically responding to issues of intersecting social complexity: sustainability, vitality, productivity and relationality. These are not idly thrown-together terms, but integral to the method (James, 2018). The Circles method takes an urban area, city, community or organization through the difficult process of responding to complex or seemingly intractable problems and challenges, defined as sets of critical issues.

The method thus provides a way of responding to a series of questions. First, how are we best to understand and map the vibrancy of social life in our cities, communities and organizations, treating this question in all its complexity across those four domains—economics, ecology, politics and culture? Secondly, what are the central critical issues that relate to making the city or community more vibrant? Thirdly, what should be measured and how? Instead of designating a pre-given set of indicators, the method provides a process for deciding upon indicators and analysing the relationship between them. Fourthly, it provides a process pathway for showing how positive responses can be planned. The method provides a series of pathways for achieving complex main objectives. It offers a deliberative process for negotiation over contested or contradictory critical objectives and multiple driving issues in relation to those main objectives. Finally, it supports a monitoring and evaluation process and a reporting process.

Figure 2: A Representation of the 'Circles of Social Life' Domains



What do the Metaphors of 'Metabolism' or 'Circles' Mean for Understanding Systems Complexity?

Most systems approaches are built around the metaphors of metabolism (flows), networks (connections) or circles (domains). The key issue here is not which metaphor we use, but how we use it, sensitive to its orienting ideologies and framing imaginaries. The first two metaphors tend to emphasize mobility and change, while the third tends to emphasize relations—the relationality of domains of social life, built in turn on the relation between the social and the environmental. The problem here is not the metaphorical emphasis, but the way in which the first two tend to be uncritically favoured, either because mobility and change are central to the contemporary global imaginary (Steger, 2008) or because it is easier empirically to measure flows than relations. Perhaps a third reason is a concern with metaphors of boundaries and limits. For example, Bruno Latour, who favours the concept of networks, argues that because the centring of humans in a circle of relations has commonly been treated anthropocentrically, and because. 'even more bizarre ... this circle has such well-defined boundaries', that we should drop such talk of circles altogether (2017: 86). Here he is strangely forgetting that the figure of a circle is only a metaphor (and that it can be represented with dotted lines as in Figure 2 to signal the issue of contingently bounded relations). He is equally overlooking the issue that when he falls back to treating networks as simple flat actualities, rather than as the ideologically imbued metaphorical *descriptions* of the world that inform practice, he effectivity annuls our understanding of structures of power. Over the past two decades, the notion of 'networking' has come to be treated a normatively charged 'virtue', and writers such as Latour comfortably ignore the consequences of this history (the test of normative reflexivity).

The metaphors of metabolism and networks have an intersecting conceptual history in pre-nineteenth century discourses on the human body that tends to hide their ideological meaning. They are the metaphor for the flows that keep a living organism alive. As such, they can be sensitizing metaphors that bring time, connectivity, and change to the fore. Alternatively, they can be reduced to medicalized models of social processes that naturalize the ideology of flows, as if to slow down a flow is to confront death, stasis, or recession—all anathema to today's emphasis on movement and progress. As Grant Bollmer writes, 'this discourse has a history—one that depends on "truths" so deeply held that the materiality of the network seems to realize the promise of nature through the technological' (2016: 45). When treated akin to William Harvey's classic focus on the circulation of blood in the human body, part of what came to be known in the medical sciences as an automatic system, the focus on measuring metabolic flows accurately can also miss out the critical contingency of social action as more than just an outside driver or pressure to be noted in the background while describing the larger schema.

Paulo Ferrão and John E. Fernández in their book *Sustainable Urban Metabolism* set out a sensitive version of the standard industrial ecology perspective. They use the metaphor of metabolism to emphasize the flow of material things: a 'city can thus be viewed as an organism with a metabolism that can be studied' (2013: 13). Metabolism in this sense is a necessarily reductive metaphor for a complex changing organism—including the social as a whole. It is necessarily reductive, and that is not bad in itself—all abstracting systems are reductive in different ways. However, the problems arise when, in reducing social complexity to a few material components in a stocks-and-flows chart, the metabolic model forgets that this is a redoubling reduction. As Neil Smith points out: "*The notion of metabolism sets up the circulation of matter, value and* *representations as the vortex of social nature. But, as the original German term, Stoffwechsel, better suggests, this is not simply a repetitive process of circulation through already established pathways. Habitual circulation there certainly is, but no sense of long-term or even necessarily short-term equilibrium. Rather Stoffwechsel expresses a sense of creativity in much the same way that Benjamin talks about mimesis: the metabolism of nature is always already a production of nature in which neither society nor nature can be stabilized with the fixity implied by their ideological separation. Society is forged in the crucible of nature's metabolism, for sure, but nature is equally the amalgam of simmering social change*" (Smith, 2006, p. xxiii).

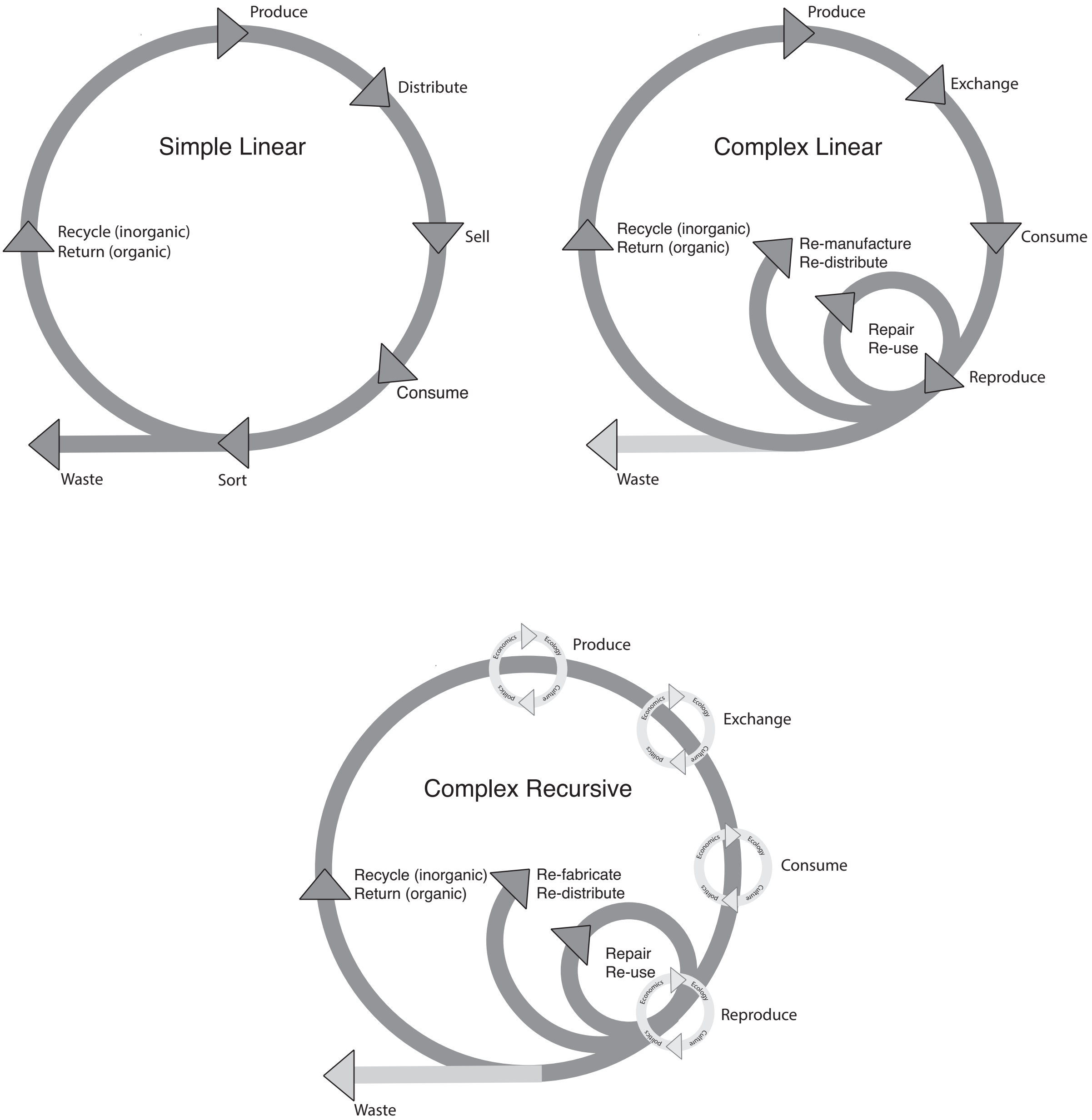
As Erik Swyngedouw similarly argues: "*Metabolism as a biochemical process is a contradictory one, predicated upon fusion, tension, conflict, and ultimately transconfiguration, which, in turn, produces a series of new "entities", often radically different from the constituting components, yet equally re-active"* (2006, p. 26). The trouble with some of the radical and important intervention into metabolic systems-building is that algorithmic mathematics cannot handle contradictory and tension-produced changes in form.

The Circles method builds on a different and no less difficult metaphor: the circle. The circle also has its own tendency towards being treated as virtuous, but this is much more mixed: the 'virtuous circle' is qualified by the equally possible 'vicious circle'; the 'circle of life' includes the stages of death and decay. The figure of the circle also faces the problem of presenting a pseudo-holism, with a modern line of sequencing such as 'paddock to plate' (the food system) or 'resourcing to using' (the circular economy) that are simply drawn into a circle without addressing the problems in the original line of sequencing.

Can the Circular Economy Approach Generate More Than a Rhetoric of Holistic Interpretation?

The concept of the circular economy appears to be holistic, but its circularity operates more like a self-confirming ideology than an opening to rethink neoliberal versions of sustainable development (see (Figure 3. the top left-hand circle). The definition of the circular economy put by Jouni Korhonen, Jouni Honkasalo, and Jyri Seppälä illustrates this problem of pseudo-holism perfectly: "*Circular economy is an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow*" (2017, p. 39). They proudly proclaim that theirs is "*the first attempt to present a scientific research-based definition of CE*" (p. 41), but the definition is locked within an economistic paradigm where the circle is just the usual straight line, except drawn into a ring of rigorous resource-management with loops of enhanced resource extraction (Figure 3. right-hand top circular diagram). It is possible to develop a version of the circular economy that is appears to be less economistic but even this needs to be rethought by recognizing that it is not more than a refinement within paradigmatic capitalism, still treating nature as eco-system services. That second circle is redrawn with recursive circles of restoration, repair, re-use, as well as remanufacture and redistribution. However, it needs also to be recognized that as well as economic and ecological dimensions each of the steps in that circles should have political and cultural dimensions (Figure 3. the bottom or third circle). In the third circle, further sub-circles have been added to each phase in the commodity chain—production, exchange, consumption and reproduction—as a way of signifying that a full Circles' assessment has to be done at each point along the pathway of a circular economy. For example, without including a cultural understanding of consumption, including the pressures of commodity fetishism, the circular economy as a process is likely to go the way of the triple bottom line. It will become an excuse for ever-increasing consumption, only tempered by a machinery of waste recovery—aka 'green' mass consumption.

Figure 3: Three Versions of the Circular Economy



Work on 'holistic' food systems tends to confront the same problems as that of the circular economy. In this case, they tend to draw the commodity-chain relation from paddock (production) to plate (consumption) into a weak circle by recycling food into the production cycle as green compost for manure. If food is part of the human condition—and, to take one example we know that food is foundational to defining cultural identity and sociality—then how can we begin to depict that condition in a way that at once remains holistic and allows us to demarcate the domains and subdomains that are relevant to food policy? Most pressingly, how can we do so without being overwhelmed by the usual starting point of economics (production)? Some food systems approaches have begun to do this, but they tend to pass too quickly over the issue of what constitutes *the circle of social life*. Usually, it is just a straight-line economic supply-chain: production-distribution-consumption-waste, with waste drawn back into a circular connection with production through composting organic matter.

One of the early classic versions of the food system tried to be circular in more holistic way through a three-domain model that begins with the biological, namely, "*the living processes used to produce food', then moving to the economic and political, the power exercised over the food system; and the social and cultural, 'the personal relations, community values and cultural traditions which affect people's use of food*" (Tansey and Worsley, 1995, p. 4). This version has a wonderful generality and is much better than the usual Triple Bottom Line approach (Figure 1).

However, as soon as we start to interrogate the starting point for Geoff Tansey and Tony Worsley's work, as one example among many, it quickly becomes clear that they should have started from somewhere else (the test of analytical coherence). A few quick thought-experiments will be enough to complicate the directions we give for developing a positive model of food sustainability. If the first of their domains is the biological, 'the living processes used to produce food', where in this approach are non-organic fertilizers or fence-posts, cadastral maps or farms—non-living, non-biological things, all critical in the vast ecology of things, processes and spatialities that are part of the food system?

If their second domain is the economic and political—that is, the power exercised over the food system, does this mean that all economic questions are only or primarily issues of power? It is certainly the case that power relations beset the economics of production. But in trying to understand what it means when a peasant-farmer in Andes sows seed into harrowed ground, we need, even if only for policy and analytical purposes, to separate out questions of power—who controls the legal rights to the reproduction of that seed, for example—from economic questions such as what form of agricultural production frames the seed sowing.

And, if their third domain is cultural, 'the personal relations, community values and cultural traditions which affect people's use of food', where do we analyse the culture of capitalism, commodity fetishism, and ideologies of growth and technocratic development? These too are cultural issues, but none of them begin with personal relations or cultural traditions, even as they are instantiated in people's life-worlds and local practices. In short, their domains do not meet the requirements of adequate generality and analytical coherence.

Can a Variation on the Driving Forces Model (DPSIR) Provide a Different Frame for System Dynamics?

An alternative form of integrated assessment was attempted through what is known as the DPSIR model, mapping driving forces, pressures, states, impacts and responses. This remains a thought-provoking schema, but unfortunately it has the same problems as other system dynamics approaches. Jean-Paul Hettelingh, Bert J. M. de Vries, and Leen Hordijk provide an early definitive account of the DPSIR framework: *Driving forces* behind environmental problems include a variety of human activity, such as production and consumption processes *structured around economic sectors* [emphasis added], and other underlying causes of environmental problems. *Driving Forces* are generally in consequence of meeting the needs of a society at individual and collective levels. Driving forces lead to '*Pressures*' on the environment exerted by proximate causes (e.g. use of natural and biological resources, and emissions). *Pressures* affect the quality—the '*State*'—of the various environmental compartments (air, water and soil) in relation to their functions. Changes in the '*State*' may have '*Impacts*' on ecosystems, humans, materials and amenities, and resources. This sequence of causes and effects is finally appraised through the assessment of different policy options as '*Response*' to an undesired impact … The DPSIR analysis of policy alternatives often involves the interpretation of a (set) of policy measures in terms of a change in driving forces and related pressures, and the way in which these changes propagate impacts, both in time and space (390).

Instead of the Pressure–State–Response (PSR) framework adopted by the European Organization for Economic Cooperation and Development (1990, later extended to the DPSIR model (Drivers–Pressures–State–Impacts–Responses), the Circles of Sustainability approach offers a variation on that framework, considering some of the helpful extensions and critiques of the DPSIR framework (Hettelingh, BJM de Vries, L. Hordijk, 2009; Patrício, et al., 2016). The DPSIR extension incorporates two additional elements beyond the original Pressure–State–Response framework: driving forces and impacts. In the classic DPSIR framework, *driving forces* are usually understood as the underlying and general forces that affect the natural and social environment. They are often configured around (and reduced to) the economic system. *Pressures* are the more immediate and proximate cause of change in the environment. They affect the changing *state* or condition of the environment. The notion of *impacts* covers the implications of the *state*, in particular trends in environmental quality on the 'functioning of ecosystems' and human health. Finally, *responses* are policies and practical activities implemented to address the forces and pressures. This information is reported through the use of indicators.

The proposed alternative *Forces-Issues-Responses-State* (FIRST) framework is arguably 1. simpler, 2. more comprehensive, and 3. better integrated into an overall guiding approach. First, it is simpler (Test 3) in that it does not have a separate category of *impacts* (these are implied by changes in the *state*, with which *impacts* are often confused anyway in the DPSIR model). It also clarifies the relationship between *driving forces* and *pressures*, defining forces in a more systematic way (Test 2), and, in effect, replacing 'pressures'— that is, proximate causes of changes in the *state*—by *critical issues*, understood as discrete, contingent, and variously clustered issues. Critical issues are not presumed to be one-to-one or more precisely described causes. In this way, we can move from general *forces* (such as climate change), understood as broad frames that the direction of change, into variables that can be tested in relation to each other. For example, the east-coast Australian drought beginning in 2017, the political denial of the 'climate change crisis' by the Australian Morrison government across the period of 2019 in 2020, the 2019 budget cuts in NSW and Queensland to the volunteer fire brigades, the current culture of mass consumption in Australia signified by the global spread of Black Friday across 2018–2020, and the 2019 intensification of the east-coast fire season, etc., are all critical issues in understanding the climate crisis in Australia in 2020, but they are not driving forces as such.

Second, the *Forces-Issues-Responses-State* framework is more comprehensive in that the materiality being affected is much broader than the environment (or human health, the other variable that is sometimes added to a DPSIR framework). With the FIRST framework, the thing being assessed is a designated materially bounded entity, either a chosen and carefully defined spatial region such as a community, city or urban region; an organization such as a state or corporation; or a system (or set of connected systems)—all considered across the four domains of ecology, economics, politics and culture. The assessment here is based on an independent, expert-driven approach.

This qualitative approach has been explicitly developed to avoid setting up a reductive one-to-one determinative relation between *forces*, *pressures* and the *state* of the entity in question, to avoid treating metrics as the driving interpretative basis of the work, and make sure that indicators of stocks and flows are treated as just that—indicators.

Third, FIRST is better integrated into an overall underlying approach, one that is reflexive about its own assumptions (Test 4)—in this case, *Circles of Social Life*. Most DPSIR models, even when they mention political and cultural issues, tend to take the economy as central to all analyses and the environment as an externality. And more deeply concerning, DPSIR models tend to have a thin theoretical foundation of empirical mapping, based on the logic of a 'stepwise chain of cause-effect-control events that describe the progression from identification of a problem to its management' Patricio, *et al.* 2016: 8–9). This stepwise chain is the key strength of the DPSIR model, but also its crashing weakness. And here is the key point of the present critique. The DPSIR model assumes a one-to-one causal relationship between the variables, thus losing the continuing element of interpretation at all points in the chain. This has the effect of shaking off much of the uncertainty that interpretation brings, to be sure, but it also means losing collective creativity and the 'ah-ha' insights of learned, relational and qualitative interpretation. In Wittgenstein's famous phrase, 'light dawns slowly over the whole' (169: 21). To mitigate against the reductiveness of this closure, some DPSIR models add increasing and multiple variables, now made possible by massive computing power. However, this 'complexity' hides the fact that such a mapping can never anticipate the key changing variables, or combination of variables that make *the* difference. By comparison, the Circles approach treats the metrics-based chain as a set of indicators, contributing to a qualitative (not just a reductive metrics assessment of sustainability).

All of this makes the definitions of the terms of the FIRST alternative crucial. The method retains the emphasis on usefulness (Test 1), while striving to be more systematic, integrated and holistic. In this context, *issues* are defined as immediate and critical considerations, positive and negative, that bear upon a particular condition of sustainability. *Forces* are more complicated. In the Circles approach, *forces* are the current background determinants that form the integral context of a particular materially bounded entity. They are complex *processes* that can be understood as the global-local context of that contingently named system, bearing upon the current condition (state) of that entity under consideration and the spatial region in which it is being considered. Mapping these forces should, in the first instance, ideally be done across the same four domains that the Circles always treats as primary to any empirical mapping:

- *Ecological forces*, including such forces as climate change, demographic change, resource-use bloating, waste-mitigation challenges, and intensifying urbanization with spatial sprawl.
- *Economic forces*, including most prominently global capitalism associated with global financial crises, pressure on commodity prices, and deepening inequalities of wealth.
- *Political forces*, for example, the unsettling of policy-making by populism, increasing intrusive data surveillance, different expression of corruption and the thinning out of the democratic system.
- *Cultural forces*, unsettling values and beliefs about ecological, economic and political matters, including contradictions in cultural practice such as high-expectations with a legitimation crisis of the state and declining trust in public and private institutions.

This descriptive generalization of *forces* should then ideally be taken through more abstract layers of analysis: from conjunctural analysis of dominant and subordinate modes of practice—production, exchange, consumption, organization, communication, inquiry and mobility—to categorical analysis which considers dominant and subordinate modes of being: namely forms of temporality, spatiality, embodiment, epistemology, performativity, objectivity and subjectivity (Steger and James, 2019). There is not absolutely necessary to use these further levels of analysis, but at least they are there as a reminder that thick description or simply following activities across networks or down rabbit holes is not sufficient to understand massive complexity of patterned practice.

The definition of *responses* in this model refer to much more than policy changes or responses by states and other institutional entities. Here we are interested in the responses of constituents across the vast range of 'regimes of social activity' from kinship relations, communities and networks to institutions (such as the state), fields, events and assemblages. Reading this list of regimes of social activity prompts the question, why are some social theorists so convinced of the primacy of their own theoretical categories that they make them either the *explanandum* or theoretical base of all meaningful descriptions of social activity. In the Circles method, they are no more than contingent concepts to sensitize a theorist or practitioner to the complexity and range of social relations. They can then be used with their full sociological complexity and rigour, drawing on the various writers associated with their deployment, but preferably shorn of their often ideologically driven framing (that question needs further elaborating but it is for another time).

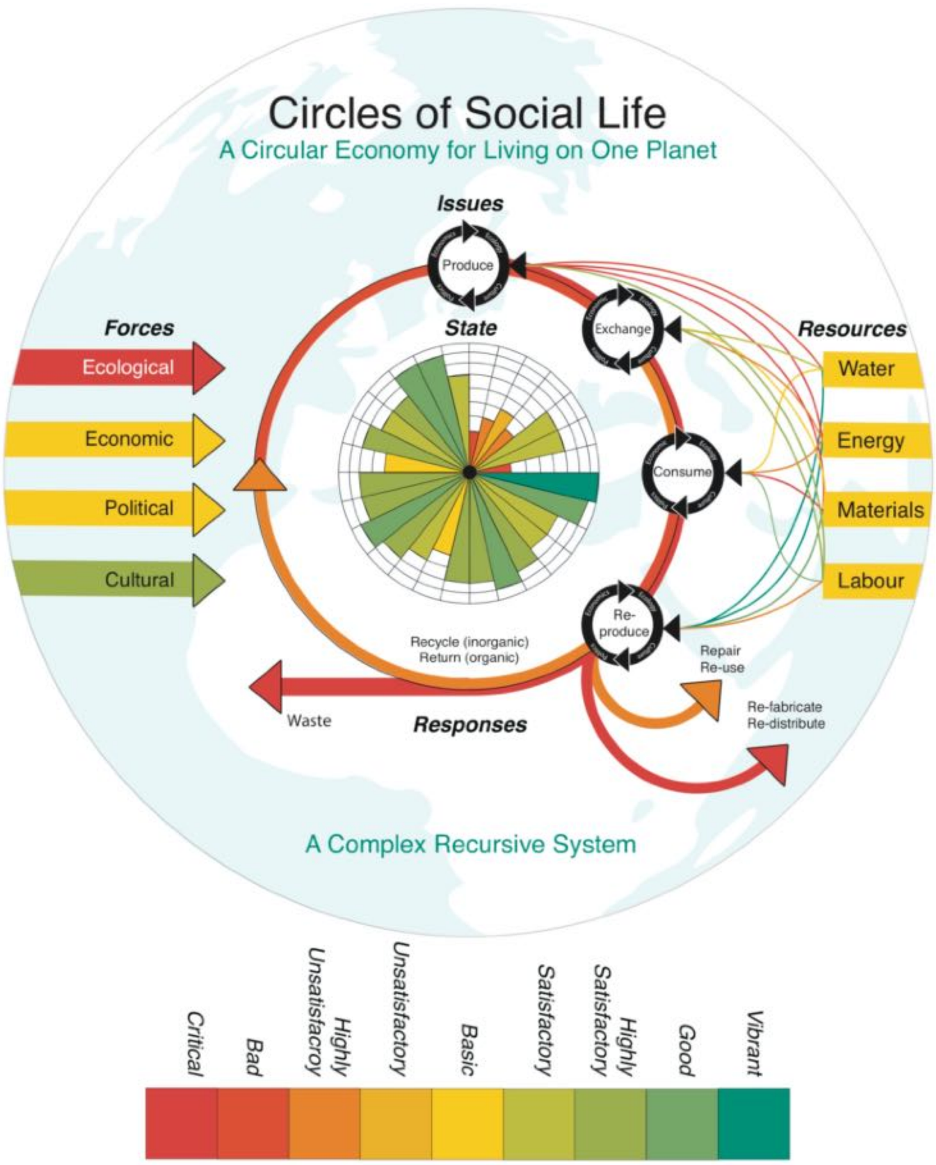
Finally, the concept of 'state' refers to the current ecological, economic, political and cultural state of a particular materially bounded entity. This definition is broader that the DPSIR concept of *state* which classically focuses on the environment, and it does not emphasize activities of change. With the Circles approach, mapping the *state* of a given entity needs to be considered synchronically across the four social domains and their systematically derived subdomains. Understanding change only occurs through analysing *and* interpreting the quality and intensity of change across different assessment periods, thus the mitigating the conceptual doubling up of *pressures* and *state* as both conditions of change.

Conclusion: Living with the Crisis, or a Return to the *Art of Living*

Putting all of this together, and synthesizing the various approaches—1. the FIRST version of DPSIR; 2. the urban metabolism mapping of resources (in this case suggesting that water, energy, materials and labour provide a minimal starting point); and 3. the Circles emphasis on holistically considering all four domains of social life—ecology, economics, politics and culture—we arrive at a composite reconfiguration of the circular economy (Figure 4). There are a number of keys to understanding this synthesis. Most importantly, each of the data-collecting parts is set up to contribute to an integrated whole, where *mapping* contextual sustainability *analysing* data variables, *investigating* the relation between forces and the flows of 'resources', and *understanding* these in relation to each other to formulate the best responses to critical challenges come together as interpretative acts. These all involve practices of interpretative translation rather than just reading conclusions off the figures. In other words, the process requires abstracting from the details of social life, but it gives pre-eminence to mapping, analysis, investigation and understanding (that is, *interpretation*) rather than one-to-one or algorithmic data-based deduction.

Secondly, the new model treats the circular economy as requiring a series of decision-making points at each stage of its commodity processing: production, exchange, consumption and re-production (with last being a confirmation of the circular relation between the social and the environmental—not a new mode of practice). In a production-to-reproduction process pathway, a slowing down occurs at each conjuncture, each of which entails considerations across all the domains of social life: ecological, economic, political and cultural considerations (Figure 4). This means, for example, at the production stage, a producer would, in relation to relevant constituents, work through the ecological, economic, political and cultural consequences of the chosen method of production (see Figure 2 above, considering each of the subdomains). In the ecological domain, what, for example, are the ecological effects of energy-use from the local and regional to the global? How economically sustainable is the production process? How does the production process align with political issues such as ethics and accountability? What are the cultural meanings of the production process, including how does it relate to gender and generations?

Figure 4: The Circular Economy Reconfigured in Terms of Circles of Social Life



Reconsidering the dominant paradigms of the circular economy, urban metabolism and other system dynamics becomes imperative as we find ourselves faced with existential questions about the sustainability of humans on this planet. As the Club of Rome researchers write in 1972, 'Any human activity that does not require a large flow of irreplaceable resources or produce severe environmental degradation might continue to grow indefinitely. In particular, those pursuits that many people would list as the most desirable and satisfying activities of man [sic]—education, art, music, religion, basic scientific research, athletics, and social interactions—could flourish.' (Meadows, *et al.,* 1972: 175). Their words echoed those of John Stuart Mill, writing a century earlier in 1857: 'It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for the Art of Living and much more likelihood of its being improved' (cited in Meadows, *et al.,* 1972: 175).

Where is that kind of thinking in the contemporary dominant paradigm of the circular economy? The difference now in the early part of the twenty-first century is that the poignancy of Mills' words, it 'is scarcely necessary to remark', have a new resonance. The art of living sustainably cannot be taken for granted. More than a century-and-a-half later we certainly can no longer take such a sentiment for as given. We have to voice those sentiments clearly and precisely. And even then, they tend to fade into the global cacophony of superlative comparisons. Even the Club of Rome largely took for granted, questions of culture and politics. We can no longer do so.

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The sustainable energy transition - A critical view on the monitoring of SDG 7

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The transition towards sustainability has been prominently put on the global agenda when in 2015, the Member States of the United Nations adopted the 2030 Agenda for Sustainable Development. Among the 17 goals, SDG 7 targets the provision of "Clean energy for all." This chapter critically reflects on the sustainable energy transition and its relation to SDG 7. For purposeful steering of transition processes, the main challenges of the energy system and the trends shaping it have to be analyzed rigorously. SDG 7 targets and indicators fall short in this respect, undermining trust in monitoring and implementing the 2030 Agenda.

Sustainable Development & Sustainable energy systems

Sustainable Development Goals – SDGs

With the UN Resolution 70/1, the United Nations General Assembly agreed in 2015 to transit to a global sustainable development pathway ("Transforming our world: the 2030 Agenda for Sustainable Development", UN 2015). The shared understanding of sustainable development has led to the adoption of 17 goals, known as Sustainable Development Goals (short: SDGs). The goals cover a broad range of topics, such as poverty reduction, access to education, the protection of land and water resources, climate change mitigation and adaptation, as well as economic and social participation for all. The progress of SGDs is officially monitored and reported regularly at the national level. Among the 17 SDGs, SDG 7 is the one on the topic of energy.

SDG 7 aims at ensuring access to affordable, reliable, sustainable, and modern energy for all. Its short title is "Clean energy for all". For one, the aim stresses the importance of energy for human development (Schwanitz & Wierling, 2019). Second, with emphasizing "access," "affordable," and "reliable," the focus of SDG 7 shifts firmly towards developing and emerging economies. Indeed, given their large share in the current and expected global population, these countries are shaping current global trends, and they will continue to do so. The pathways, which developing and emerging economies are taking, will be pivotal for achieving or failing the 2030 Agenda for Sustainable Development.

The sustainable provision of energy services depends on technical, social, economic, and environmental factors. The latter is mainly targeting the minimization of resources consumed in the energy system to reduce the environmental impact (covering energy resources, minerals, materials, goods, waste, land, and water). The other factors concern topics such as technological and social change, energy justice, or economic development. All underline that the provision of sustainable energy services has to be approached from an interdisciplinary and integrated perspective (Schwanitz & Wierling, 2019).

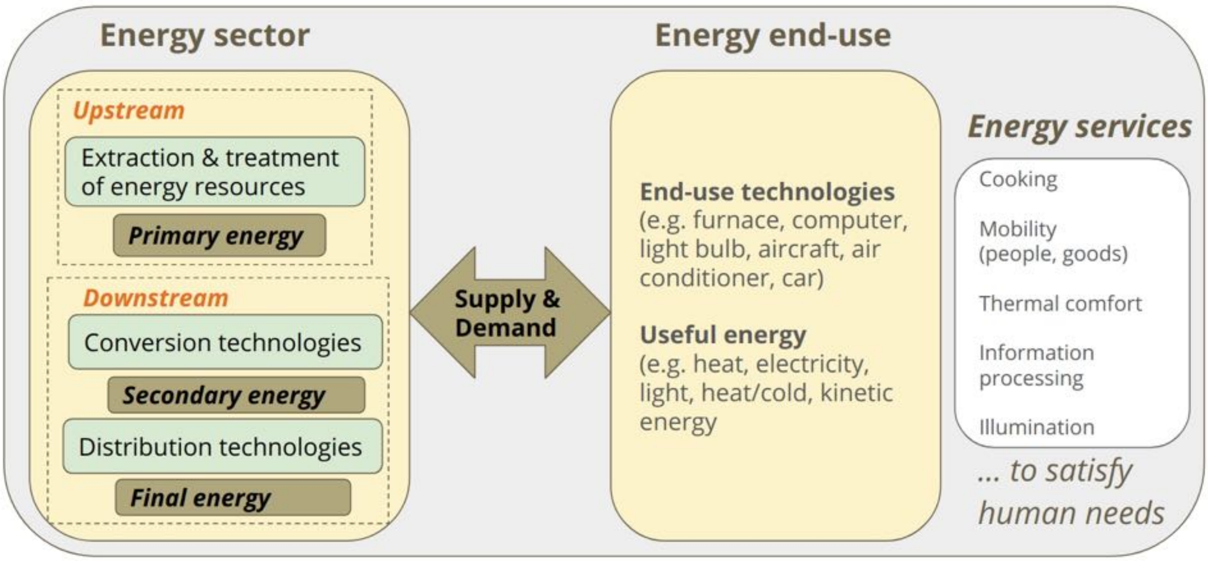
At the same time, targets and indicators established to measure the progress of SDG 7 are limited, poorly reflecting the complex problem in question. Details are provided in the following sections, but in short, the targets of SDG 7 cover the provision of access to energy services for all, an increase in the share of renewable energy and energy efficiency, and the support for energy technology transfer. The observed shortcoming is the starting point for this chapter. In the following, a critical view of the role of energy for sustainable development is taken.

The main point raised, concerns the inadequate acknowledgment and accounting of trade-offs - if not conflicts - between the provision of sustainable energy services for all, trends shaping the energy system, and other goals of the Sustainable Development Agenda. The argument is that without a rigorous analysis and monitoring of the role of energy for sustainable development, attempts to transit to sustainability are prone to fail.

An introduction to the energy system

The energy system (Figure 1) describes the transformation of energy resources into useful energy that can provide energy services, such as cooking, the transportation of people and goods, heating, or information processing. Energy services are delivered with the help of end-use technologies, such as light bulbs, cars, or computers. The total amount of energy consumed has to be supplied by the energy sector. Economic activities of this sector cover the transformation of primary energy (e.g., in the form of extracted oil or coal) to secondary and final energy, including their distribution to the places of consumption by households, the industry, or the agriculture.

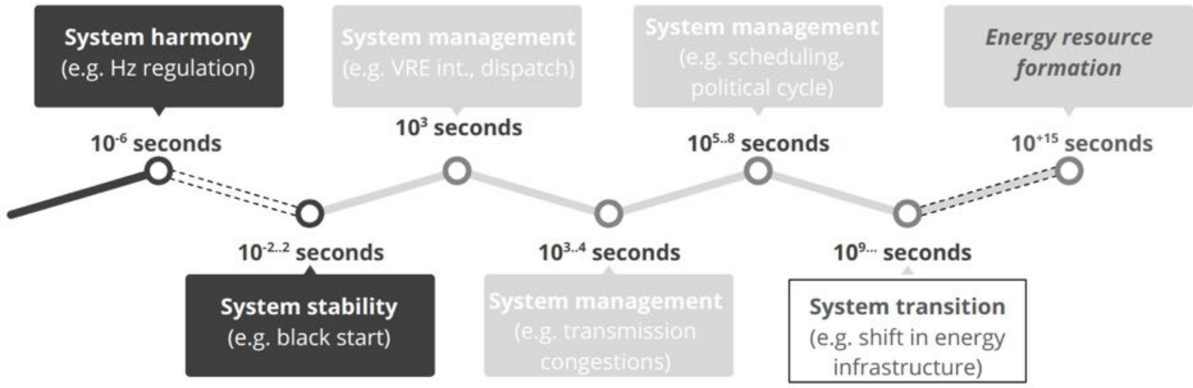
Figure 1: The structure of the energy system



Source: own figure

The secure provision of energy services depends on the functioning of the energy system across time and space. Relevant **timescales in the energy system** span an enormous range (see Figure 2). Electrical power is, for example, restored at the scale of picoseconds, but processes can also literally last ages, such as the formation of energy resources. Depending on actors and activities, time scales of energy system management also differ. For example, the typical planning horizon of a politician who wants to be re-elected is 4-5 years, but a person building a house is typically planning to have the house to last for some decades. Similarly, infrastructure for the delivery of energy services (e.g., oil pipelines, electricity lines) are also established to last decades rather than just a few years, given their high up-front investment costs.

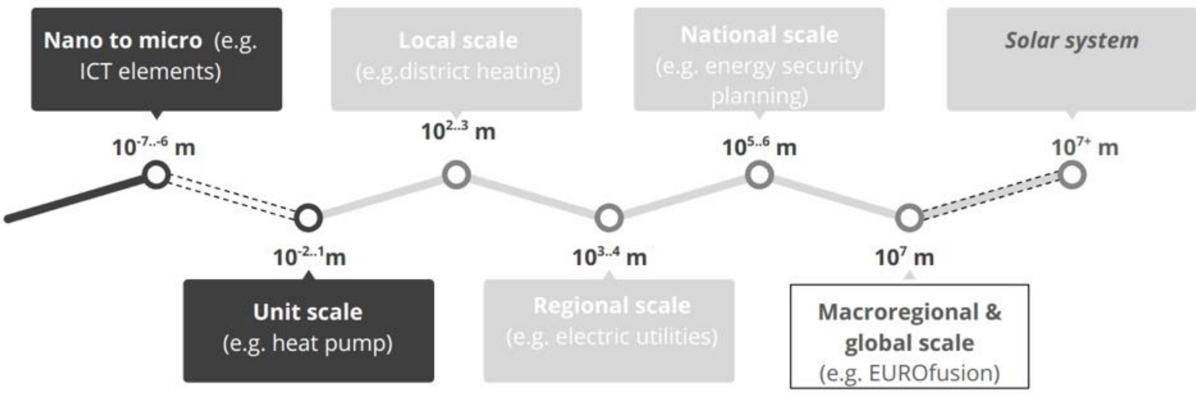
Figure 2: Relevant timescale of the energy system.
Abbreviations: Hz - Hertz, VRE (int) - variable renewable energy (integration)



Source: own figure

A yet different timescale concerns the transition of the system. For example, the transition from traditionally biomass-based energy production to a fossil-fuel-based system - as dominates the energy systems today - took centuries. However, if a region can leapfrog directly to advanced energy technologies, it could also happen much faster. Korea is an example of a country that developed within just a few decades from a country where only elites had access to energy services to one of the most modern countries in the world. Denmark owns the trophy for rapidly reducing oil-imports after the energy crisis in 1973 by more than halving oil consumption since then and transitioning to electricity production, which is strongly based on renewables.

Figure 3: Relevant timescale of the energy system.
Abbreviations: Hz - Hertz, VRE (int) - variable renewable energy (integration)



Source: own figure

Relevant **spatial scales** range from nanoscale and microscale of technical components and devices to local, regional, national scale, and beyond (see Fig. 3). Again, the scales depend on activities, for example, whether firm-level planning is concerned or the planning of energy security at the national level.

Challenges towards the Sustainable Energy Transition

Major trends in the energy system

In addition to the challenges of managing the energy system across time and space, the ongoing energy transition imposes technical, economic, social, and environmental challenges. Notably but often overlooked, it includes the built-up of energy systems in developing countries. Overall, the energy sector is undergoing a profound transformation, leading to the emergence of new energy markets, supply chains, and business concepts.

We see a shift from centralized to **decentralized energy markets and electricity grids**. We observe increasing fuel diversity and new concepts of integration (e.g., the integration of small- and large-scale energy generation, multiple storage concepts, and virtual power plants). In particular, the **integration of variable renewable energy** is sharply changing the system structure and functioning. This includes, for example, the emergence of new supply chains, e.g., to cater to the rising demand for rare earth elements and metals, which are needed for the installation of renewable energy technologies and fuel storage facilities. For example, it is estimated that with a 50% share of solar technologies in electricity production, the current yearly production would increase for silver by 3.5 times, for tellurium by 450 times, for indium by 240 times, for gallium by 400 times, and for selenium by 220 times (MIT 2015). This puts additional pressure on finding solutions that are in line with the aspiration for global sustainable development. Box 1 presents a back-of-the-envelope calculation. The example also illustrates that the challenges towards the sustainable energy system transition have to be rigorously thought through. Otherwise, a pathway deemed as sustainable will soon need to be market as an unsustainable one (and hence costly), because it is at odds with the goal of sustainable production and consumption patterns.

Box 1: Back-of-the-envelope calculation for resources needed for Advanced Metering Infrastructure at global level

Resources needed for global Advanced Metering Infrastructure (AMI). According to a market analysis in 2019 done by Wood Mackenzie Power & Renewables, the number of Advanced Metering Infrastructure is anticipated to cross 1.2 billion devices in total by 2024. Developing countries in Asia powerfully drive the demand.

What is the additional material demand? AMI - or smart meters - consist of a range of different materials. For example, the current transformer includes silicon steel, ferrites, permalloy, nanocrystalline, and amorphous materials; the power transformer requires material used for the winding (e.g., solid copper wire insulated with enamel), and LCD screens include bromine dibromine, aluminum chloride, potassium hydroxide, copper cyanide, or dimethylformamide. The complex structure of AMIs is a challenge towards recycling materials after the product's lifetime. Altogether, measured in percentage of the weight of a smart meter, plastic contributes about 20%, copper 18%, and steel 7% (Aleksic and Mujan, 2016).

Assuming a total weight of about 2.3 kg for one smart meter, the anticipated material demand for smart meters in 2024 translates into about 192000 additional tonnes of steel, 492000 additional tonnes of copper, and 540000 additional tonnes of plastic. Alternatively, the installment of AMI devices alone causes about 3.7 Mt CO2 emissions, when assuming average emissions factors for involved materials. Staying carbon neutral would thus require the saving of roughly one million flights from Paris to Tokyo for one person in the economy class. It should be noted that the simple illustrative example does not account for additional grid infrastructure, internet access, and data storage, which come on top.

Source: own calculation

Among the trends in the energy system, we also see an increase in the number and diversity of actors in the energy sector. Note, for example, the new term "prosumers." This term reflects that the clear divide between energy producers and consumers is disappearing. On the one hand, the involvement of new actors, in particular citizens, in the energy transition is very much wanted, as it is seen as a means to create acceptance for and ownership over the transition processes. On the other hand, it is also unclear how strong their influence is (and will be) in absolute terms and whether citizen-led initiatives will induce a change in the power structure of energy markets (see also Wierling et al. in this book). The key questions arising here are about the likely social change agents and the speed of the energy transition, and, hence, the support for realizing the 2030 Sustainable Development Agenda. There are currently two opposing views. The more optimistic one originates from a scaling-up of promising case studies of single or collective new social actors. In contrast, the more pessimistic view originates from the empirical analysis of past energy transitions, suggesting long-term, at least several decades of path dependencies and technological lock-ins. In sum, the systemic changes raise essential societal and political questions beyond the sole provision of energy services. The questions to be addressed include energy poverty, energy democracy, energy & resource security, as well as energy justice.

Other major global trends

All of the above trends characterizing the ongoing transition of the energy system are going hand-in-hand with other major global trends that are not only affecting the energy sector but overall societal development. One of them is the unbroken trend of the human race to be **creative**. An illustrative example is the bicycle (note: a mean of low carbon transport). Only 180 years after the invention of the "*vehicle with two wheels tandem, handlebars for steering, a saddle seat, and pedals by which it is propelled*" (Merriam Webster), we do not just have the prototype of a bicycle anymore. Instead, we also produce and use mountain bikes, hybrid bikes, comfort bikes, road bikes, triathlon bikes, time trial bikes, BMX and trick bikes, commuting bikes, cyclocross bikes, track bikes, fixed gear bikes, tandems, adult trikes, folding bikes, kid's bikes, cargo bikes, beach cruisers, and many more. Indeed, a search in the online database of patents reveals over 20000 inventions with the keyword "bicycle". A similar search for the keywords "AMI" or "smart metering" is already listing about 72300 entries for patents. The issue at stake is not to blame humanity for being creative and finding solutions to problems. The point is to stress the fact that every single new product, technology, as well as novel process, is likely to trigger new inventions, which in turn lead to new demand for materials and resources. The question is whether the demand comes as a replacement (at least partial) or on top of already existing production and consumption habits. However, the latter is the more likely case when having in mind the overall global trend of increasing product variety. Note that a supermarket in 1975 offered, on average, 9000 products, whereas an inventory undertaken in 2008 revealed an average product variety of more than 47000 items in a standard supermarket (Consumer Market Report, 2014). Concluding, creativity is a driver for increasing consumption of energy and resources.

Another essential trend concerns revolutionary **ICT advancements, along with the trend towards minimization and personalization of goods and services**. While these developments offer new opportunities (e.g., production on demand), they pose challenges for establishing the circular economy (e.g., the smaller and more complex units are, the more difficult it is to recycle them). In the energy sector, ICT is seen as an enabling technology for the low carbon energy transition (e.g., ensuring grid stability, integration of renewables). In particular, the mining and analysis of large-scale, real-time data is pivotal to control and manage energy systems, which are of growing complexity. These technologies are paving the way for real-time pricing, real-time demand-side management, or peer-to-to peer transactions. However, bear in mind the example provided in Box 1 on additional resources needed for new products and services.

The on-going global trend of **urbanization** (due to population increase and rural-urban migration) is also sharping the sustainable energy transition in different ways. Together with economic development and globalization processes, production and consumption patterns are sharply changing. Some factors offer opportunities for sustainability. Among them is the improved functioning of public transport with a higher population density. Overall, the per capita footprint of infrastructure decreases. At the same time, other factors work against sustainability. Particularly, people tend to have a higher consumption, the more income and spare time they have at their disposal. This is an irrefutable fact also for developing and emerging countries, which are (legitimately) catching up with consumption patterns of developed countries. It is worthwhile noting once more that it is not any more high-income countries that are shaping the global trends. On these grounds, it does not come as a surprise that the decoupling of global economic growth from energy and material use is not evident from empirical data. The key question is how to avoid developing and emerging countries duplicating the unsustainable pathways taken by the developed world in the past (c.f. Holden et al., 2017).

SDG 7 - Do we measure and monitor what is needed?

The measurement problem – the overlooked influence of major trends

Given the ongoing transformation of the global society in general and energy systems in particular, it is important to thoroughly analyze and monitor development pathways. The objective is to identify synergies, trade-offs, and technology lock-ins as early as possible to steer sustainable development effectively.

Current targets and indicators for SDG 7 "Clean energy for all" are presented in Box 2. While they are capturing some of the pivotal trends at national and global level (i.e., the share of population with access to electricity, reliance on clean fuels, share of renewables, financial flows to developing countries and investments into energy efficiency), many trends are not properly tracked. Broadly speaking, the gaps are:

- Monitoring of potentially unsustainable technology lock-ins from the social, environmental, and economic perspective (e.g., in connection with the built-up of energy system infrastructure, ICT support infrastructure; social participation and ownership indicators are lacking),
- Accounting of material and resource impacts of energy systems (incl. water- and land-use, non-renewable resources for renewable energy, resources for energy infrastructure and equipment),
- Accounting of interlinkages between countries (e.g., relocation of energy-intensive industries to other countries, carbon leakage),

- Accounting of interlinkages between the energy and other sectors (e.g., energy contained in infrastructure, energy for ICT, energy as a driver of increased consumption, Jevons paradox and the rebound effect).

<u>Box 2:</u> Targets and indicators for Sustainable Development Goal 7 "Ensure access to affordable, reliable, sustainable and modern energy for all"

SDG 7 "Clean energy for all" - Targets & *Indicators*
7.1: By 2030, ensure universal access to affordable, reliable and modern energy services. → *7.1.1: Proportion of population with access to electricity;* → *7.1.2 Proportion of population with primary reliance on clean fuels and technology.* 7.2: By 2030, increase substantially the share of renewable energy in the global energy mix. → *7.2.1: Renewable energy share in the total final energy consumption.* 7.3: By 2030, double the global rate of improvement in energy efficiency. → *7.3.1: Energy intensity measured in terms of primary energy and GDP.* 7.4: By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology. → *7.A.1: International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems.* 7.B: By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support. → *7.B.1: Investments in energy efficiency as % of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to SD services.*

Source: https://sustainabledevelopment.un.org/sdg7.

The analysis problem - the identification of trade-offs is taken too lightly

In 2017, the International Council for Science issued a report that "*explores the nature of interlinkages between the SDGs. It is based on the premise that a science-informed analysis of interactions across SDG domains – which is currently lacking – can support more coherent and effective decision making, and better facilitate follow-up and monitoring of progress*" (ICSU, 2017). In the following, a summary on their conclusions for SDG 7 is provided. For the energy topic, the ICSU report draws strongly from the peer-reviewed publication of McCallum et al. 2018. While the ambition of exploring the interlinkages with scientific rigor is going in the right direction, it is argued that the identification of trade-offs is taken too lightly. For the assessment of positive and negative interactions, a 7-point scale has been used, ranging from +3 for synergies to -3 for trade-offs. The strongest trade-off (-3) is labeled as a "cancelling off" of different goals, the medium category (-2) is used to signal "counter-acting" between different SDGs, and the mildest form of a trade-off (-1) is evident when one SDG sets a constraint or a condition for another SDG.

For SDG 7, only very few and in all cases just mild forms of trade-offs with other SDGs have been identified, namely with:

- SDG 1 "No poverty" (0/-1): Distributional costs of renewable energies may affect the poor stronger: "*... 7.2 and 7.3 could constrain the options for achieving 1.4.*" (i.e., equal rights to economic resources).
- SDG 2 "Zero hunger" (0/-1): Competition over land and water can result in trade-offs. Agro-fuels interact with food prices: "… *and so constrain the achievement of ending hunger for the poor*".
- SDG 3 "Good health and well-being" (0/-1): There are risks for pedestrians and cyclists: *"... Energy-saving measures related to 'active travel' (cycling and walking) can constrain efforts to reduce deaths and injuries from road traffic accidents, if the provided infrastructure is unsatisfactory and if higher air quality standards are not required …".*
- SDG 6 "Clean water and sanitation" (-1): Technologies for unconventional water (e.g., desalination) are highly energy-intensive, impacting energy intensity goals.
- SDG 8 "Decent work & economic growth" (0/-1): Two issues are brought up: People working in the fossil-fuel industry (coal, tar-sand) are in danger of losing their jobs; and "... *Decarbonising energy systems through an up-scaling of renewables and energy efficiency could constrain countries' economic growth, if only slightly. However, strong growth decoupled from environmental degradation is possible …*"
- SDG 13 "Climate action" (0): The trade-off between climate change and energy goals is insignificant: *"... The universal energy access target is fully consistent with the goal of combatting climate change, as it is likely to have only a minor effect on global carbon emissions …".*

Reflecting on the current challenges of the energy system transformation as well as the major trends influencing it, above thin and airy identification of trade-offs is very much of concern. First, the issues brought up are often minor. An example is the concern towards the loss of fossil-fuel industry jobs, which according to an estimate by IRENA amounts to as little as about 7 Million at the global level. In addition, to identify risks for pedestrians and cyclists as the only trade-off with SDG 3 does not speak for the intended "science-informed analysis."

Second, essential trade-offs arising from energy system trends are missing. For example, likely health issues in connection with the harvesting of rare earths, metals, and minerals needed for renewable energies are not accounted for. However, these are relevant for achieving target 3.9 "By 2030, substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination." Furthermore, the accounting of impacts from additional energy infrastructure, ICT, and the growing global population is missing (e.g., amount of additional cement, steel, aluminum, plastic, and land when developing access to electricity and transportation services from scratch; when ensuring a decent life for the poor). Because of this, the statements above even appear indefensible. How can the decoupling be seen as possible (see SDG 8)? How can energy access be seen as fully in line with climate change goals (see SDG 13)? The latter is even more questionable because related indicators do not specify further what "clean" energy is. Indeed, a diesel generator replacing coal-burning stoves already qualifies as "clean," and many developing countries are going for this option for practical reasons. Concluding, trade-offs have to be analyzed more rigorously, backed up by scientific evidence, and tracked through appropriate indicators. Otherwise, the trust in SDG monitoring and reporting is undermined, and a flavor of seeing an impact from lobbying groups remains (e.g., that concerns from the fossil fuel industry are taken into account while others are not, that certain technologies and new products are preferred over non-technological alternatives and others).

Summary and conclusion

The transitioning towards pathways in line with global (strong) sustainability is a complex task, for which different, interlinked dimensions have to be accounted for. In particular, the analysis of trade-offs between these different dimensions has to be carried out carefully to provide science-based recommendations to politicians, planners, and practitioners. Featuring 17 Sustainable Development Goals (SGDs), the United Nations 2030 Agenda for Sustainable Development acknowledges the complex task ahead. Among the 17 SDGs, SDG 7 "Clean energy for all" is targeting sustainable development in connection with energy. SDG 7 is one of the critical goals of the agenda, given the importance of access to energy services for human development.

This chapter has elaborated on the meaning of the sustainable energy transition, introducing the energy system and trends shaping it. The main challenges of the sustainable energy system transition arise from the need to ensure its functioning for all members of the global society across a broad range of space and time while minimizing environmental impacts. At the same time, the energy system is undergoing a deep transformation, being shaped by a variety of dynamic and accelerating trends. These include population growth at global level, the economic catching-up of countries to the developed world, the decentralization of energy markets and electricity grids, the increase in diversity and number of actors in the energy sector, the increase in fuel diversity, the enabling role of ICT for the energy transition, the unbroken trend of creativity of people, continued migration to urban areas, and the general trend towards minimization and personalization of goods and services.

For purposeful monitoring and steering of transition processes towards sustainable pathways at the global level, targets and indicators need to reflect the main challenges of the energy system and the trends shaping it. Targets and indicators have to be able to reveal potentially unsustainable technology/societal lock-ins and interlinkages between countries. Targets and indicators need to account for material- and resource impacts of providing energy services (incl. materials footprints of energy system infrastructure), and they have to account for interlinkages between energy and other dimensions of sustainable development. Current SDG 7 indicators and targets fall short in this respect, as discussed and illustrated in this chapter. In particular, the identification of trade-offs between different SDGs does not stand up to what is necessary. The observation is based on a brief review of how poorly trade-offs for SDG 7 have been investigated in the official report of the International Council of Science (ICSU, 2017). In summary, the report has only identified mild forms of negative interactions. Of concern is that issues brought up were often minor, while essential trade-offs arising from major trends are entirely missing.

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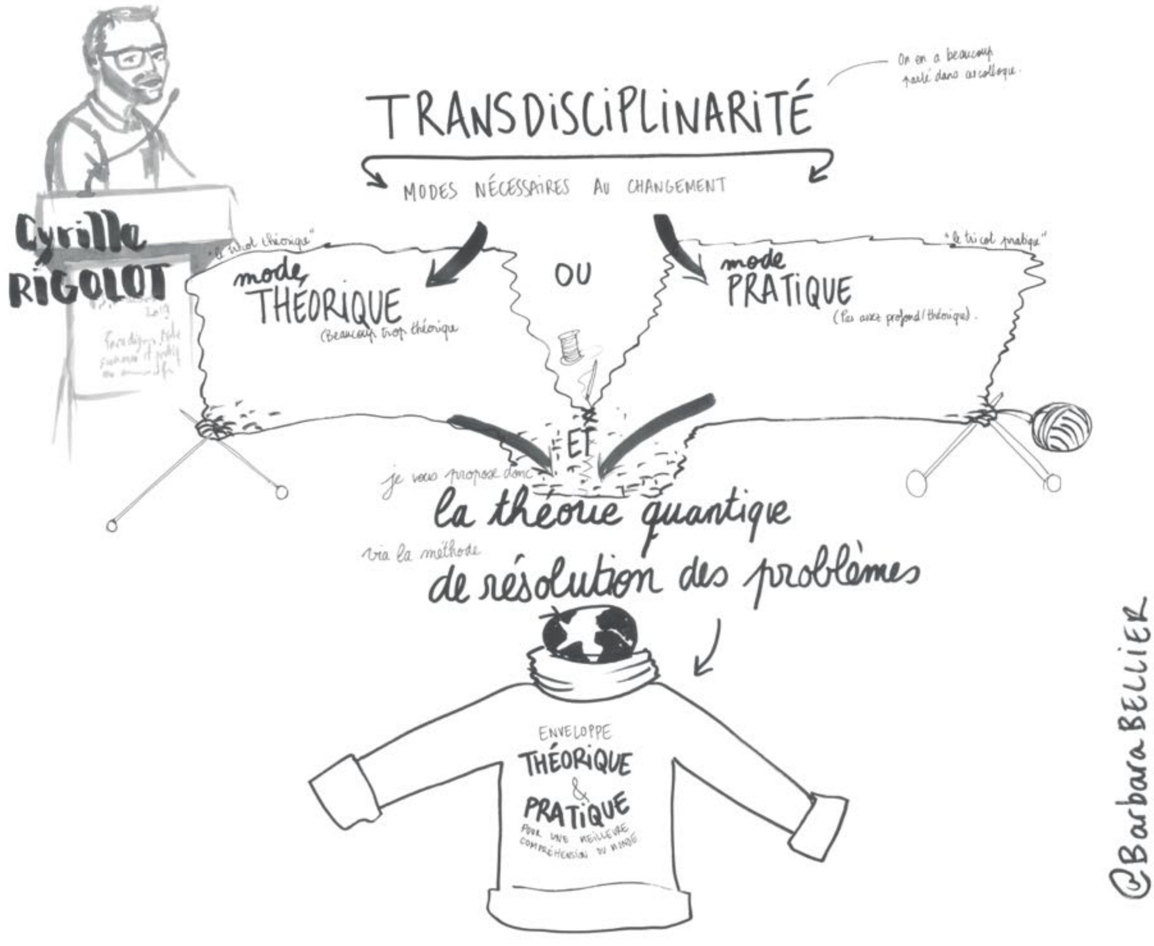
<u>PART 2</u>

PARADIGMS OF STRONG SUSTAINABILITY




Anna HORODECKA
("Horo-de'tska" is the right pronounciation)
IS IT POSSIBLE to consume SUSTAINABLE ?
BIO
ETHICAL
HM...
SO . . . LET'S TALK ABOUT NEEDS
INDIVIDUAL needs
VS
COLLECTIVE needs
THE BIG DEAL MATCH
COLLECTIVE
IF THE COLLECTIVE WINS
then we may end up with
SUSTAINABLE CONSUMPTION
BUT today we integrate "NEEDS" into an individual vision...
WHAT WE NEED IS TO WORK ON SOCIAL IDENTITY.
NO, I DON'T WANT YOUR IDEAS. I KNOW I THINK I DO THE BEST WAY.
OH! DO YOU ALSO WANT TO DO THE BEST? LET'S DO IT TOGETHER THEN...
@Barbara BELLIER

Quantum theory to foster deep transformations toward strong Sustainability

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Abstract: Transdisciplinarity is increasingly seen as a promising paradigm for strong sustainability. Following a common typology, two "Modes" of transdisciplinary can be distinguished: A theoretical "Mode 1", largely inspired by quantum theory, and a practical "Mode 2" transdisciplinarity involving multi-stakeholder's approaches. So far, Mode 1 and 2 have been developed independently. In this communication, I discuss the potential of using insights from quantum theory to foster deep transformations toward strong sustainability, by closing this gap between Mode 1 and 2. As a first example, I show how a generalization of the quantum complementarity principle to sustainability assessment can be used to better address two major issues (integration and implementation). Then, I explore how quantum insights suggest powerful sustainable pathways, by shedding light on subjectivity, the possibility of free-will and the "co-arising" of personal and systemic change. Finally, a general strategy is proposed, that combine robust quantum methodological insights with a careful exploration of ontological insights.

Keywords: Agroecology, Participatory, Complementarity principle, Subjectivity, Worldview

Introduction

Strong sustainability requires deep, large-scale and urgent transformations (Waddell et al., 2014). These transformations cannot be only technical, but they must also involve changes at the social/political level, as well as at the personal level (i.e. in the way individuals "see the world", especially as regard their relationship to nature, Niles and Tachimoto, 2018). To foster these transformations, a promising trend is the development is transdisciplinary research, which consists in integrating non-academic sources in the production of knowledge (Scholz and Steiner, 2015). Two modes of transdisciplinarity research have been identified, on the basis of the work of Helga Nowotny, Peter Scott and Michael Gibbons, in the field of the sociology of science (Nowotny et al., 2013): "Mode 1" corresponds to a theoretical approach, motivated by the search of a unity of knowledge, with the general aim to understand of the world; By contrast, "Mode 2" corresponds to a practical approach, typically consisting in participatory problem-solving projects with stakeholders. To date, both Modes 1 and 2 have been developed almost independently (Scholz and Steiner, 2015). For transdisciplinarity to be really useful for sustainability transformations, some authors have highlighted to need to better link Mode 1 and Mode 2 Transdisciplinarity (Max-Neef, 2005). Otherwise, the risk is that "Mode 1" has no sufficiently rapid and tangible impacts in the real-world, and that "Mode 2" remains too superficial, given the tremendous sustainability challenges ahead.

In this paper, I explore the potential of quantum theory as a source of insight to foster deep transformations toward strong Sustainability, by closing the gap between Mode 1 and Mode 2 transdisciplinarity. Quantum theory is at core of the theoretical foundations of Mode 1 Transdisciplinarity, as developed by quantum physicist Basarab Nicolescu (2014). It is particularly important in two fundamental axioms of transdisciplinarity: "levels of reality" and the "principle of the included middle" (see Nicolescu, 2014). By contrast, at first sight, quantum theory seems at odds with the idea of involving non-academic practitioners in very practical problem-solving projects (Mode 2 Transdisciplinarity). Indeed, quantum concepts and language often sound esoteric and mathematically abstract. The science of quantum physics itself is typically performed in the research lab, in extremely constrained experimental conditions (to maintain "quantum coherence"), by particularly skilled and trained scientists. Yet, beyond this first idea, I argue that quantum theory could in fact be a powerful source of insights in participatory problem-solving projects with stakeholders. This position has been developed in detail in a recent paper, as well as a possible strategy combing two kinds of insights: methodological and ontological (Rigolot, 2019a). In the present communication, my aim is to show how his strategy can be applied to tackle strong sustainability issues, taking illustrations from some of my own studies in the field of livestock farming sustainability transformations (Rigolot, 2018; 2019a, 2019b).

Quantum theory and sustainability assessment

According to Alrøe and Noe (2016), although many approaches and tools have been developed in the last decades for sustainability assessment, two key issues remain: i) The integration problem (the fact that different tools produce different assessments); ii) The implementation problem (i.e. the barrier between sustainability assessment and transformation). As an innovative way to deal with these two issues, these authors propose a generalization of the complementarity principle from quantum theory to sustainability assessment (Alrøe and Noe, 2016). Taken in the radical sense of Niels Bohr, the complementary principle means that "*two observations of an object, such as the determination and momentum of an elementary particle, exclude each other in such a way that prevents getting the full picture of the object, so we are left with complementary phenomena that cannot be combined*". From their long experience with assessments of food systems, Alrøe and Noe have identified two relevant forms of complementarity:

- The *observer stance complementarity* corresponds to the fundamental methodological form of complementarity, as defined by quantum mechanics: In short, "*the conditions for defining the observed system as it is (without interaction) precludes the conditions necessary for observing it (with interactions)*". Elaborating on this, the authors distinguishes two modes of sciences: detached ("*describing the world as it is and producing general knowledge*"), and involved ("*focusing on enabling action and change in concrete context*"). These two modes of sciences correspond notably to two sustainability assessment tools (complex and expert-based versus simpler and participatory). Another form of observer stance complementarity lies in the assessment position, whether it is "from within" the system or "from without".

- In *value complementarity*, "*the mutual exclusion of two observations of the same object stems from different values that determine what observations are relevant or desirable*": The focus here is on the normative conditions of observation. Alrøe and Noe give three examples of value complementarity: *Naturalness* versus *Care* to value animal welfare, authentic versus rich nature to value nature quality, and three perspectives to value growth and sustainable development (*Growth without borders*; *Growth within limits*; *Growth and ecological injustice*) (Alrøe and Noe, 2016).

As further developed by Alroe and Noe (2016), the integration problem in sustainability assessment can be seen as a complementarity issue, in a deep sense. This approach is very helpful to understand that the integration problem cannot be overcome, for example by methods of indexation (i.e. by integrating different kinds of assessments, typically into a number). However, by acknowledging this complementarity issue, the integration problem can be better handled yet (if not overcome). To this aim, it is essential to distinguish complementarity from other forms of perspectival differences in participatory projects, such as dilemmas and incommensurability, as they cannot be dealt with the same methods. By definition, incommensurability implies that it is impossible to incorporate representations of the same object from one perspective into another (because of differences in the theoretical framework, concepts...). However, incommensurable observations may still "*be performed concurrently and supplement each other to give a fuller, if multifaceted, representation of the object*", which is not the case for complementarity.

The complementarity principle also provides an explanation for the implementation problem, as assessment and transformation are based on two incompatible modes of science (*detached* and *involved* observer stance). Therefore, according to Alroe and Noe (2016), "*the implementation problem cannot be resolved by developing still more advanced and complex methods, if these approaches employ a detached observer stance that is directed by the norms of science*". Building on this analysis, I have myself proposed another explanation of the implementation problem, based on a dynamic view of complementary issues and the concept of worldview (Rigolot, 2018). Worldview has been defined as "a structuring system of meaning, informing how humans interpret and co-create reality". Many authors have argued that sustainability transformations require some shift in worldviews (Beddoe et al., 2009). In my analysis (Rigolot, 2018), I show that different ideal-typical worldviews identified in literature are associated with Alrøe and Noe's specific examples of complementarity. Considering sustainable transformations as shift in worldviews has important implications for the development of new strategies and the role of sustainability assessments. Particularly, criteria and methods used in current sustainability assessment are virtually meaningless for a same actor in a new transformed system, due to complementarity issues with emerging worldviews. In that case, trying to improve existing criteria is not necessarily a good approach for sustainability transformations, and value-based approaches that aim at communicating and mediating sustainability values should be more fruitful. However, such value-based approaches should be aimed not only at coordinated and cooperative actions, but perhaps more importantly at mutual transformations of stakeholders' own perspectives (Rigolot, 2018).

Quantum theory and sustainability pathways

Fostering mutual transformations of stakeholders' own perspectives might be more easily said than done. Again, quantum theory could be very useful in that perspective, to build sustainability pathways. As mentioned in the introduction, transformations cannot be only technical, but also require changes at the social/political level, as well as at the personal level. In other words, as framed by O'Brien and Sygna (2013), sustainability transformations require change in three "spheres" of transformations: 1) The *practical sphere*, representing behaviors and interventions; 2) The *political sphere*, representing "*systems and structures that shape change in the practical sphere*"; 3) The *personal sphere*, representing "*the subjective dimensions that influence behaviors and interventions, and how systems and structures are perceived and experienced*". James and Brown (2019) have shown how this "three spheres" framework can be used to frame organic conversions in agriculture as transformations, as they involve practical, political and personal changes. The temporal logic of these changes in the three spheres is essential in one want to foster sustainability transformations. Although James and Brown (2019) highlight "*the messy and non-linear nature of change*", their analysis implicitly suggests some kind of temporal logic in organic transformations, which is in fact quite widespread in sustainability sciences communities (Rigolot, 2019b). Schematically, it seems that going through hard and painful times is a necessary and quite central part of the transformation process. Following this implicit temporal conceptualization, the political sphere especially plays a major role to enable changes in the other spheres, whereas it seems that transformations in the personal and practical spheres cannot be scaled-out to effect transformations in the political sphere (James and Brown 2019). Moreover, the farmer may appear a bit passive in the process, waiting that a "window of opportunity" enables him to "fortuitously escape" the constrains of his conventional system (James and Brown 2019).

However, some studies have shown that other temporal logic in the three spheres evolution are possible. Particularly, Coquil et al. (2017) show that new ideas and farmers' epiphanies can play key initiating role in the transformational process, whereas these seem to happen only "in a second time" in James and Brown's (2019) analysis. Particularly, these authors show that "farmers' professional transitions were initiated by four factors (often in conjunction): (i) access to the unthinkable, (ii) practical difficulties, (iii) awareness of the gap between "doing" and "thinking" and (iv) external constraint". Particularly, "access to the unthinkable refers to the subjectivity of discovery and to access to a new realm of possibilities through a discovery". As I have developed in a response to James and Brown (2019) paper, insights provided by Coquil et al (2017) make a strong difference in the narratives that can be made around organic conversions, by shedding light on the personal sphere. In this conceptualization, the converting farmer appears rather as a curious and open individual, sometimes experiencing a remarkable subjective experience, with the possibility to become a "key individual" himself soon or later. As a consequence, contrary to James and Brown's (2019), this analysis suggests that transformations in the personal sphere can in fact powerfully scale-out to effect transformations in the political sphere, through political agency in the broad sense (O'Brien, 2015).

Generally, these differences in temporal logics when framing organic conversions reveal some kind of "chicken and egg" problems, which are typically raised by sustainability transformations (Rigolot, 2019b): It seems that changes in the "personal sphere" require changes in the "political sphere" first, but changes in the "political sphere" cannot change without prior changes in the "personal sphere" too. This raises deep theoretical questions. Particularly, an emphasis on the personal sphere as in Coquil et al., (2017) suggests that individuals are able to deliberately engage in a transformational process, in spite of unfavorable constrains in the political and practical spheres. To address this theoretical question, insights from quantum theory are particularly helpful. Indeed, a quantum ontology recognizes and legitimates the fundamental importance of subjectivity. Particularly, the International Relations scholar Alexander Wendt (2015) has recently proposed an updated version of the "quantum consciousness hypothesis", integrating the latest scientific breakthroughs in a rigorous manner, as reviewed by Rigolot and Orlando (2019). This "quantum consciousness hypothesis" could give a physical basis to explain consciousness, considered as "*collapse of a quantum wave function into a defined reality, resulting in the everyday world that we perceive and experience*" (O'Brien, 2016). Following this approach, individuals are seen as entangled and "intra-acting", rather than fully separable entities. Moreover, social structures are seen as both external and "*internal to human beings collectively*" (Wendt, 2015, p 208). In the case of organic conversions, the structures that are constraining transformations do not "come from nowhere". Instead, they reflect a particular view of the world (in this case of that legitimates high-input agriculture, a prioritization of yields…), as well as power dynamics and interests (Rigolot, 2019b). This quantum approach gives a strong meaning to the co-arising of the personal and political spheres, which can emerge through the practical sphere of transformation. This is in sharp contrast with the mainstream paradigm largely based on the assumption of classical physics, "*where agents are discret individual or self-interested states that interact through local causation, with little or no role for subjectivity, consciousness, intentionality or free will*" (O'Brien, 2016). As a perspective, we plan to explore formally this quantum conceptualization with "quantum-like models", as developed in the field of quantum cognition (Busemeyer and Bruza, 2012). In these models, farmers' preferences are not seen as "well defined", as in classical decision-making models, but rather in "superposition". As part of our on-going participatory projects with stakeholders, we expect that these quantum formalisms will be useful for decision-makers in generating powerful alternative narratives and more relevant recommendations, compared to representations based on a classic model of human beings.

Conclusion

Despite its reputation of being abstract and laboratory-based, quantum theory has the potential to facilitate fruitful collaborations between science and practice on "equal footing" (Scholz and Steiner, 2015a), as part of Mode 2 transdisciplinarity projects. Quantum insights convey a radical meaning, which could enable larger and deeper collaborations with stakeholders, where fundamental theory and practice could be deeply interconnected. However, the use of quantum theory in applied projects raises important issues, with serious potential pitfalls. Because of the real dangers of careless interpretations, scientific communities are often suspicious toward quantum approaches. As proposed in Rigolot (2019a), a strategy is to consider the previous insights as methodological tools, in a first step (other worth-mentioning examples of stimulating quantum-inspired methodologies are Q methodology and agential realism, Rigolot, 2019a). In a second step, my opinion is that we should remain open to ontological insights, i.e. the occurrence of "real" quantum phenomenon impacting the macroscale, such as in the "quantum consciousness hypothesis". This position is controversial, as these ontological claims are quite speculative. However, I believe ontological insights could be very powerful and necessary in that they convey a much-needed sense of wonder and humility. This is consistent with the claim of taking seriously different kind of knowledge and epistemologies (such as local and indigenous) in transdisciplinary research. In this way, rather than a new discipline or super-discipline, strong transdisciplinarity could mature as a "different manner of seeing the world", based on a fundamentally new relationship between the Subject and the Object (Max-Neef, 2005). This emerging worldview could be an essential part of strong sustainability.

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Wiser than the Vikings? Redefining sustainability in the Anthropocene

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Abstract: Can the concept and science of 'sustainability' offer answers to today's crises? Crucial lessons can be learned from the fates of Viking and Inuit settlers in medieval Greenland. In spite of their advanced technologies and trade systems, the Viking collapsed, whereas the Inuit kept thriving. This case reveals that sustainability can be understood as a dynamic balance of three spheres: 1. biophysical processes (controlled by thermodynamic laws and astrophysical forces) generating life and evolution; 2. human narratives on the meaning of life, death and nature; 3. economic and technological processes ('justified' by those narratives) to access nature's offerings. Sustainability depends on a civilisation's capacity to adapt its narratives and its techno-economic systems to Earth's biophysical realities. The dominant Western narrative (implicitly) defines human progress as controlling life and exploiting nature, justifying ecosystem destruction. However, today emergent practices embrace narratives (re)connecting man with nature, and pioneer in regenerative economics; yet regime institutions keep them from gaining the necessary tract. How can sustainability science help to mainstream these innovative approaches?

Keywords: sustainability science; paradigm; Anthropocene; complexity; epistemology

Introduction

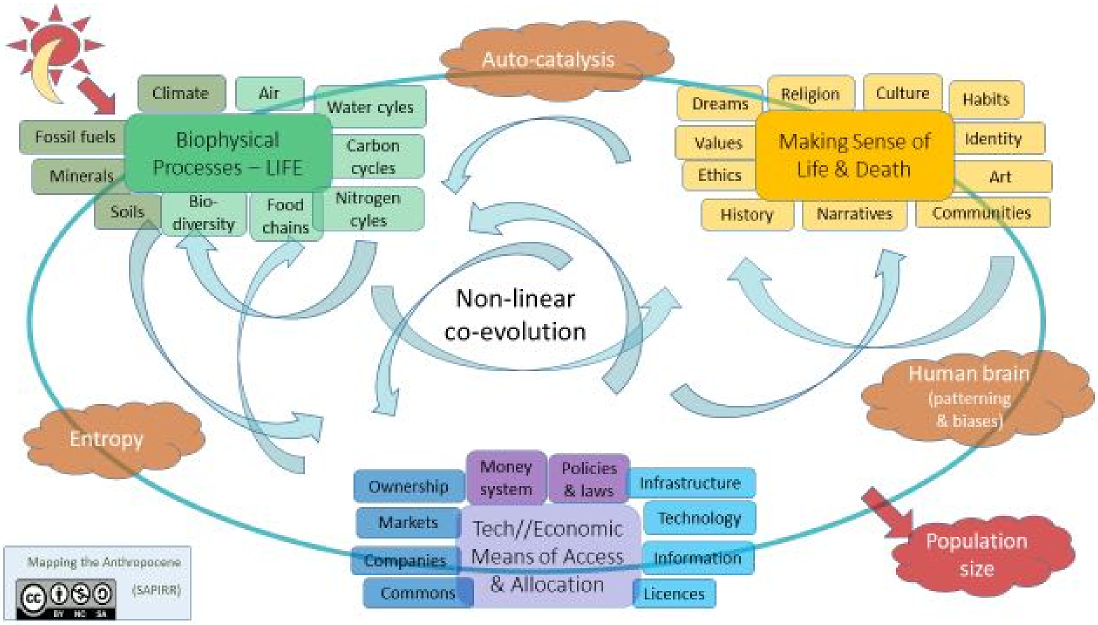
Scientists today agree humans have an impact on Earth's biophysical processes; hence they call our era the Anthropocene. There is some debate on the exact geological implications of the term and on the moral value of giving an anthropocentric name to a geological era (Crist, 2019), but here we use it to highlight the *responsibility* of humans for the state of the Earth ecosystem and the life depending on it. Human agency now takes us into a landscape unprecedented in human history: extreme levels of atmospheric CO_2, species loss at a much faster rate than natural, acidification and plastic pollution of oceans, etc. Sustainability science is conceived as a response to those challenges. The question is whether – or under what conditions – the concept and science of sustainability can help us to achieve the necessary corrections in due time.

Mapping sustainability in the Anthropocene

In his book 'Collapse' J. Diamond (2004) describes how some thousand years ago Vikings settled on Greenland, where an Inuit group also lived. After 450 years the Viking community starved to death, whereas the Inuit stayed alive and well. Their different fates teach us crucial lessons about what makes a civilization (un)able to thrive sustainably. The Viking considered their European way of life superior to the Inuit hunter-gatherer culture. With their bigger and more sophisticated ships they imported materials that were unavailable locally. They turned woods into grasslands, logged trees to build houses and churches, ate meat from the livestock they farmed, not seafood hunted at sea or traded with the Inuit. Archaeological evidence from the last phase of their life on Greenland shows no traces of any fish consumption, but reveals that the Viking ended up eating their calves and even their dogs before finally starving to death.

There is some discussion as to what explains the Viking collapse. Maybe it was caused by the fact that their economic and technological practices extracted resources from the land faster than the ecosystem could regenerate. Or the cause may have been external, such as a cooling climate. But why were the Viking unable to adapt to climate change while their Inuit neighbours did survive? And if their own practices caused their suffering, why did they prefer to hold on to them and die, rather than learn from the Inuit and survive?

Figure 1: Mapping tool for the Anthropocene



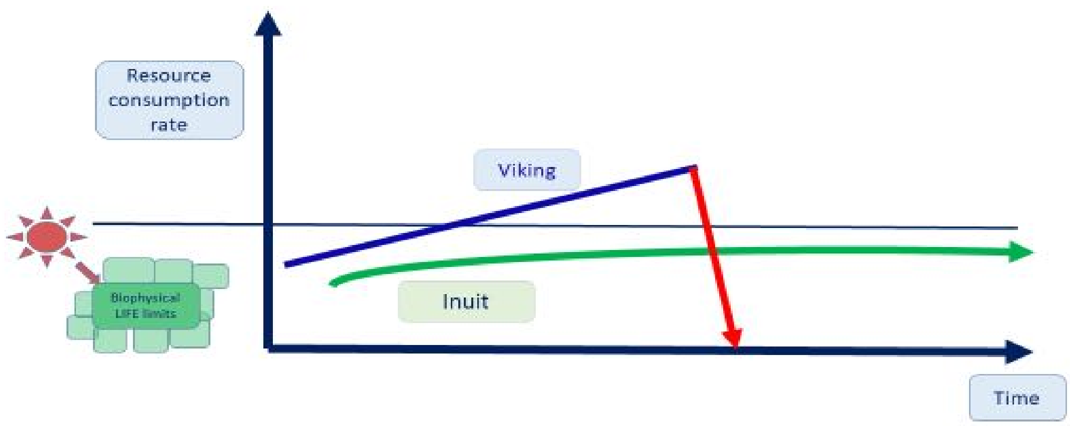
The story reveals the impact of the values and narratives a civilisation embraces. The way a culture defines its identity and its relationship to nature is at least as crucial (if not more) as the sophistication of its economic and technological means. If we map the elements allowing us to understanding the contrasting fates of Viking and Inuit, three spheres appear to be relevant (Figure 1). The first one is the **biophysical, life supporting sphere.** The energy of the sun and the gravity of the moon set in motion hydrological and climatic cycles that create(d) the conditions for life to emerge and evolve. Over millions of years, the interplay between chemical elements and life forms turning solar energy in biomass (photosynthesis) led to the **autopoiesis** (emergence) of soils, plants and animals organised as food chains, bringing about cycles of life and death continuously adapting and evolving. Humanity appeared only recently in this web, and with other species mankind has co-created a huge variety of bio-topographies (Crist, 2019).

The second sphere is the way humans **make sense** of this web of life. Since our **brain** cannot process the chaotic stream of stimuli our environment bombards us with, cultures have evolved as selection patterns, bringing order and meaning in this bewildering, awe-inspiring chaos (Lent 2017). Civilisations descending from ancient Indo-European tribes are built on the basic story that God created man in His image, as the culminating point of His creation. They see nature as God's gift to humanity, a mere resource for man to own and use as he wishes. Western culture today no longer invokes God to justify its objectification of life, but keeps enacting the credo of human supremacy as if it is beyond ethical questioning (Jasanoff 2018). It feels entitled to treat other life forms as matter, not as being worthy of respect. This narrative is so profoundly embedded in language, institutions and technologies, that it is no longer recognised as a deeply political discourse to justify the power man wields over nature; it is now considered a fact, taken for granted. The cosmologies of indigenous peoples, on the contrary, are built on respect for all beings and on restraint in exploiting nature. Their literature on human-nonhuman relations emphasizes reciprocity, kinship and gratitude. The idea that human progress is proportional to the amount of exploitation, destruction and alteration of nature is alien to them (Crist, 2019).

The third sphere concerns **economic and technological (E.T.) means** by which civilisations gain access to nature's offerings and distribute them among their members. Viking E.T.-systems were more complex and so dissipated available energy (in soils, plants…) faster than the Inuit ones, thus fuelling entropy at higher rates (Pogany, 2015). Today's global E.T.-regime dissipates (mainly fossil) energy at rates unseen in human history. It is anchored to money systems, laws, infrastructure, science, policies, etc. It reflects the credo that controlling nature is proof of our progress, lifting us above animals. In the guise of development cooperation and multilateral agreements (which all nations can join as long as they succumb to the basic credo), the West has imposed its vision worldwide, while glorifying this by calling indigenous people 'poor' and 'less developed' – early colonists tellingly called them 'animals'. This Western vision also drives the search for E.T.-systems that further extract value from and pursue mastery of nature (Harari 2015). The narrative is so embedded in systems regulating all aspects of our lives, that it is very hard to change them; many political and business leaders even call it '*unrealistic*' (Latour, 2017).

The Viking history shows that human evolution is not a linear progress (see Figure 2). For quite some time they were successful as traders, builders and farmers. This may have strengthened their sense of superiority, i.e. an escalating feedback which made it even harder for them to recognise their weaknesses and change course. This success reached a tipping point when (in a changing context) doing 'more of the same' did not bring more prosperity. Changing – e.g. by learning from nature or the Inuit – meant questioning their European identity and superiority, and this they could not do. If a civilisation is out of balance with the biophysical context, yet is unable to change its narratives, values and E.T.-means, collapse becomes a likely scenario.

Figure 2: Non-linear development of civilisations

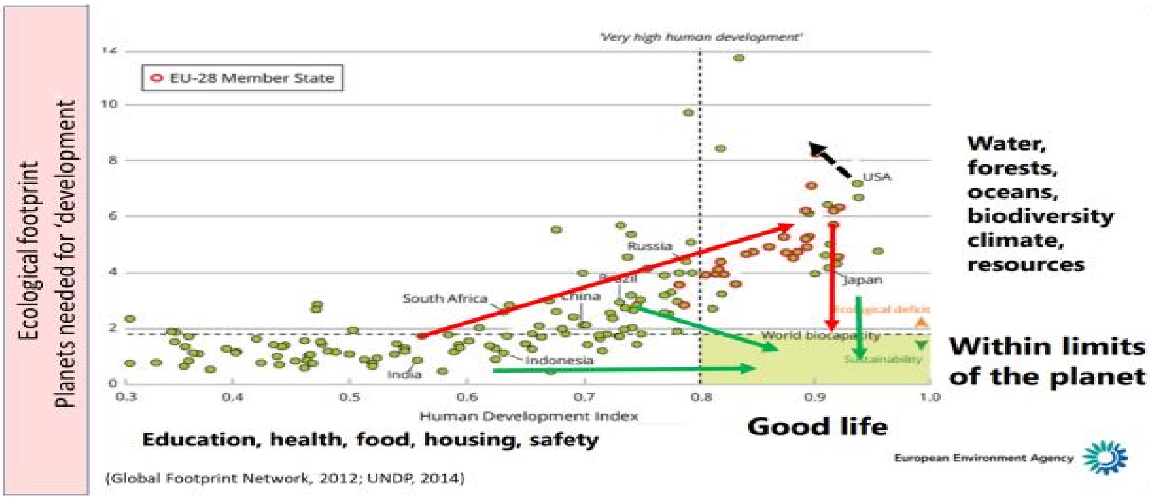


The initial success of a civilisation is also reflected in the growing size of its population. Yet the capacity of a biosphere to regenerate does not grow, as it is determined by the local availability of sunlight and materials (e.g. soils and plants) to store solar energy for human use. Once there are more mouths to feed than the landscape can support, more growth turns into a risk. Only if a civilisation keeps its population in check, it can remain in balance with nature (Crist, 2019).

Diagnosis of our time: are we wiser than the Vikings?

The European Environmental Bureau (EEB) published a graph showing the relation between the United Nations' (UN) Human Development Index (HDI) and the planetary footprint of nations (see Figure 3). The HDI combines metrics on education, life expectancy and income per capita, and is divided in ten steps. The planetary footprint shows how many times a country consumes what the Earth can provide. Not one nation ranking high on development operates within the limits of one planet Earth; most high HDI countries need more than four. To bring all nations to high levels of development *as defined by the UN*, we need at least four planets. This narrative clearly is out of touch with reality (Latour, 2017): the way development is defined does not take into account the Earth ecosystem humans depend on for their well-being, but implicitly embraces the vision of a godlike man, disconnected from Earth. Planetary overshoot is rooted in the view of nature as a divine gift that eternally provides us with resources, absorbs our waste, and flawlessly grows its regenerative capacities to keep up with our growing desires.

Figure 3: EEB graph on Human Development Index and its planetary impact



Current E.T.-systems no longer function as means for human and planetary prosperity. Instead economic growth and technological progress are now the *goal,* while people and planet are used as *resources*. One of the drivers of this means-ends reversal is the money system. Current money is created by banks (fractional reserve banking) in the form of a debt that has to be paid back *with an interest*; this means there is less money around than we collectively owe the banks, and so 'to make money' becomes the aim of all economic transactions (Pogany, 2015; Lietaer, 2011; Snick 2016b). Companies that do not make a profit, go bankrupt. And to keep up with a growing amount of debt-based money, the economy must continuously raise its productivity. Since this always involves (energy captured by) natural processes, planetary overshoot is inevitable: it is in fact designed into the system (Chang, 2011). Moreover, the social inequality between (owners of) the corporations that run the economic-technological system and the majority of mankind is increasing. What can also explain this EEB-graph, is the fact that in Western societal models, education, health care and income are organised by *redistributing* (via taxes) a percentage of economic production. In this system raising the level of development requires even steeper levels of extraction, beyond the limits of planetary and human health.

Economic growth and technological progress are interlinked. As growth exceeds the capacity of the biosphere, and resources get scarcer, research and innovation are needed to keep 'progressing', e.g. by inventing more aggressive technologies for extracting non-human life (like fishing or logging) or materials (e.g. fracking or mining). Growth can also be pursued by reducing the labour cost and making workers more productive; human resource management pursues that. Marketing uses insights in the working of the brain to nudge people towards more consumption. Planned obsolescence is a brilliant marketing strategy if you deny its impact on life. As especially technological R&I requires huge investments and money has to yield a financial return, new technologies in turn fuel economic activity. This escalating loop makes it harder for the E.T.-regime to change course and 'land on Earth' again (Latour, 2017).

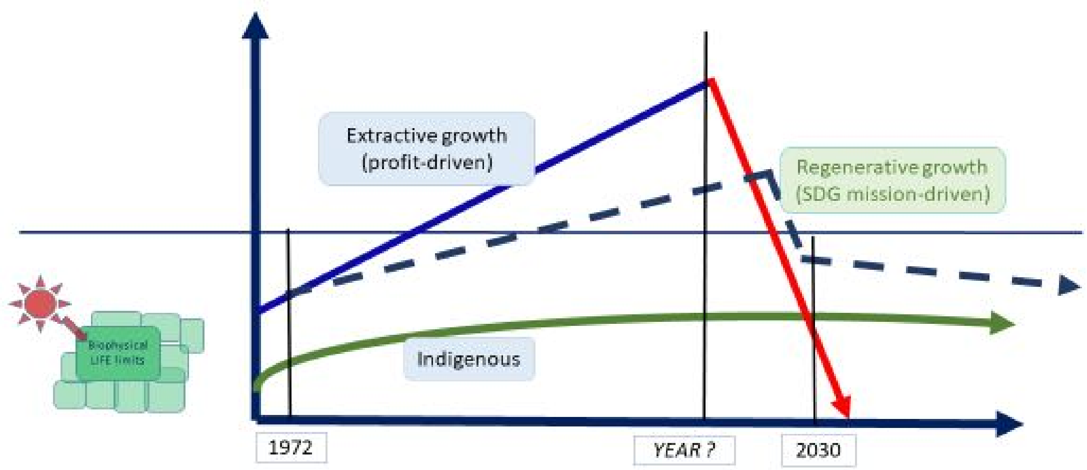
So, are we wiser than the Vikings? Our society is based on the *same* Indo-European belief system that frames man as a godlike creature and nature as a resource to exploit. Science freed itself from the censure of the Church, yet never questioned the credo that man is apart from nature; scientists are even idealised as objective observers and smart managers of the Earth. Modern science does not question the assumption that man has the right to destroy nature or engineer other life forms to pursue his aspirations in total academic freedom (Jasanoff, 2018; Crist, 2019). Our *more advanced* systems have done *more damage* to the planetary ecosystem than the Viking ever did. So, we can only claim to be wiser if we stop doing 'more of the same' before critical thresholds are reached, and if we learn from healthy ecosystems and from indigenous wisdom.

Today there are many signs that this learning is indeed taking place. Citizens and entrepreneurs no longer trust (unethical) banks or corporations to manage their affairs. New models of ownership switch from extractive (pursuing 'value' for distant shareholders) to cooperative businesses, owned by and working for the local community (Kelly, 2012). Biomimicry-based inventions (mimicking the biosphere) increase our natural intelligence and make us understand that 'it is only an investment if it leaves the world better off' (Gorissen, 2019: 2). Entrepreneurs and social innovators design companies that are mission-driven instead of profit-driven, at the service of the common good (Wahl, 2017). A growing group of researchers, political leaders, entrepreneurs and citizens look towards the commons as a sustainable system for governing shared resources (Bollier & Helfrich, 2019, Ostrom, 1990). NGO's and companies learn from the wisdom of indigenous people in the global South, and focus on strengthening their local agro-ecological knowledge and practices (Azurduy, 2019). Local monetary systems are spreading worldwide (Lietaer, 2011). Novel accounting systems no longer externalise the ecological impact of transactions, but reflect the real state of the ecosystem (Bauwens, 2019). The soundness of using GDP as an economic measure is called into question (Raworth, 2017). With (financial and other) support from a community of local users, agro-ecological farmers learn to produce and distribute food sustainably. Sharing initiatives are getting more and more widespread.

The list of initiatives that break away from the old narrative and explore new ones (inspired by nature and/or indigenous wisdom) is growing steadily. This shows our capacity to learn; we are adapting our vision of the good life, learn to find value in restriction and frugality, and diversify our pathways for achieving a quality life with healthy restraint. This desire to change course is visible in the Global Agenda 2030 the UN adopted in 2015. It lists 17 sustainable development goals (SDGs) that are not a choice menu of separate aims, but an interconnected agenda in which each goal must also foster (or at least not damage) the other goals. The agenda has been criticised because it includes economic growth (SDG8); this is seen as a sign that corporations sabotage the

Agenda by having their private goal integrated in it. Yet, what makes the SDGs a strong leverage is that they are proposed as a *global* and *interconnected* agenda, not just for the global South but also for the North. This installs a built-in self-correcting mechanism, for if growth is still defined in a way that threatens other goals (extracting profit at the detriment of justice and ecosystems), it is *not the kind of growth the UN agreed to*. The Agenda can be a leverage for reorienting the economic system; instead of increasing our extractive capacity, SDG8 can only refer to humanity's *growing capacity* to create well-being for all while restoring healthy ecosystems, and to redesign institutions, cities and technologies accordingly (Snick, 2017).

Figure 4. Diagnosis of our time



The diagnosis of our time thus reveals a mixed picture (see Figure 4). No doubt the extractive scenario (the top line) remains dominant and the regime keeps moving towards tipping points (collapsing ecosystems, loss of soils, disturbed climate patterns, mass migration, etc.). On the other hand, an abundant wellspring of niches (the dotted line) explore and learn how we can 'land on Earth' again and live sustainably in an ethical and socially just way. The question is now whether (or under what conditions) the *concept and science of sustainability* can be helpful for our civilisation to leave the extractive model and shift to the regenerative pathway in time.

Does science make us wiser than the Vikings?

Even a superficial look at the literature shows that the sustainability concept is used in often contradictory ways. In broad lines, sustainable development can refer either to efforts to sustain the dominant vision of development and growth (weak sustainability), or to efforts to adapt our vision and allow life on Earth to sustain itself (strong sustainability). The first approach leaves the basic narrative on man's supremacy and his entitlement to exploit nature and other beings unquestioned. It aims at incrementally improving the E.T.-system so as to allow for 'sustained' extraction even in a planetary and social context showing alarming signs of exhaustion and depletion. Weak sustainability 'improves' the dominant E.T.-system without looking at its deeper structural flaws, its false assumptions or questionable ethics.

Strong sustainability, on the contrary, is more like 'learning from the Inuit', for it implies questioning the values inherent in the current system. It does not just treat symptoms of crises, but addresses their root causes. Root in Latin is radix, so this is a more 'radical' approach. It invents regenerative designs, community currencies, commons, and so on., E.T.-tools outside the dominant framework. Their outlying position makes it hard for the regime to recognise or support them; they don't fit the normal narrative, and may be perceived as untrustworthy or subversive. The term 'radical' is often associated with negative connotations that overshadow the ethical concerns and deep respect for life that drive the pioneers. In this complicated, tangled linguistic and institutional field, sustainability science has to find its own position.

Before we look at the impact of the sustainability concept in science, it is useful to first describe the current R&I system in terms of the Anthropocene map (see Figure 1). Historically R&I is embedded in institutions that study (aspects of) only one sphere. Natural sciences specialise in elements and dynamics of the biophysical system. Narratives and values are considered the domain of humanities. The E.T.-sphere is split up among branches of applied sciences (e.g. economics), engineering sciences and disciplines studying specific social institutions (politics, law, etc.). Epistemology and ethics are institutionalised as subdomains of philosophy, not as the capacity and obligation of *all scientists* to reflect on the ontological and normative assumptions of their research. If courses on ethics and worldviews are part of the curriculum of natural and applied sciences, students often see them as an add-on find hardly relevant for their field, not as disciplines that help them to understand how their field can be made more relevant for society.

The current academic system was built (in the Middle Ages, i.e.) during the Holocene, and this has a profound impact on its underlying ontology and epistemology. A paradigm is a set of rules and conventions agreed upon by the scientific community; it defines valid ways to do research and sets parameters for assessing scientific progress. The medieval scientific paradigm was based upon the credo that – as stated in the Bible – God created all that exists, and that creation must reflect God's perfection. Planets were believed to move in circles, since that is the most perfect geometrical form. This premise did not allow to predict planetary movement accurately; such unpredicted phenomena are called anomalies, and they reveal flaws in a paradigm (Kuhn, 1962). Yet, for fear of being excluded from the scientific community, medieval scientists did not reject the normative model, but 'improved' it by adding more circles (epicycles), i.e. by doing 'more of the same'. Astrological maps became extremely complex compilations of epicycles upon epicycles, and so science made progress and grew successful in predicting planetary movements accurately. When Galilei (who had access to a new lens: the telescope) proposed the ellipse as a more appropriate model (eliminating anomalies), he did not *improve* the paradigm but *replaced* it; this is what distinguishes normal scientific *progress* from scientific *revolutions*. Galilei was excommunicated and only rehabilitated 350 years later; yet meanwhile the ellipse has found its way into the academic mainstream, allowing new generations of scientists to 'progress' again.

Universities were not designed in the Anthropocene, but have their roots in the previous era, the Holocene. That started about 12.000 years ago when the climate on Earth stabilised; this meant humans were no longer forced to roam the continents to find food, as in previous eras when ice ages and interglacial periods radically shifted ecosystems. It allowed them to invent agriculture, build settlements and cities, where writing and culture developed. In this stable context, modern scientists assumed reality could be studied in separate units. They studied the impact of changing parameters in one field of reality, while all others (ceteris) were believed to be unaffected (paribus). Scientific progress led to the division of reality in ever smaller sub-specialisms disconnected from the larger picture, i.e. the intertwined and complex dynamics that allow for the evolution of life on Earth. On this small, disconnected scale, it is possible to find regularities and express them in mathematical equations. The *eternal* truth of mathematics feeds the idea that science reveals *objective* truths about reality, laws of nature. Scientific progress was associated with quantitative methodologies, while qualitative aspects of life were dismissed as 'subjective', belonging to the domains of arts and religion, not science. Even in humanities the tendency towards quantitative methods to process 'data' is growing, revealing the power of the Holocene paradigm. Modern economics aims at laws that are called valid 'ceteris paribus'; all aspects that do affect other fields of reality are treated as 'externalities', not to be accounted for.

The splitting up of reality into faculties and laboratories in 'ivory towers' remains the norm today, and the stability assumption lives on. Most scientists and engineers assume that an innovation with a proven positive effect in the laboratory (where other parameters are kept stable), when rolled out at large scale (i.e. by 'bringing it to the market') will lead to a positive impact in society. Applied science and technology are deeply indebted to the specialist approach. In stable contexts causality appears to be linear (if A Then B), which allows scientists to predict and control the outcomes of their experiments (if more A then more B). Since (only) at this small scale stable correlations can be found and outcomes predicted, the current system of technological innovation is in fact a brainchild of the Holocene. The financing of research and innovation is still mostly based on the division between 'pure' science (deemed to discover objective truths about the workings of nature) and 'applied' science (using those insights and exploiting them for improving life and economic growth). The amazing inventions resulting from technological progress can be taken as proof of the (initial) success of this paradigm.

The many current man-made crises are in fact anomalies challenging the Holocene (specialist) paradigm. The debacle with antibiotics – once a great innovation in the laboratory, now one of the major health risks worldwide – was not predicted (and certainly not intended). In their laboratories researchers determined the effect and safety of this medication at the level of the individual patient, yet did not control the real impact of massive dissemination (fuelled by the profit urge of pharmaceutical companies, and affecting consumer expectations and prescription habits) in an interconnected world. It resulted in infiltration of antibiotics in the ground water, undermining the immune system and creating the conditions for mutations that brought superbugs, antibiotics-resistant bacteria. This is a wicked (non-linear) problem: yesterday's solution turns out to be today's problem. Rolling out 'more of the same' is not a solution (given bacterial antibiotic resistance), yet it appears very hard to do 'something else' given the tremendous power and strong institutionalisation of (scientific, pharmaceutical, economic, cultural…) regimes and paradigms.

Many technologies show the same flaws: they are tested in laboratory settings (with a narrow risk analysis) at a small scale (e.g. the individual consumer). The effects of their large-scale dissemination (or 'translation') on the complex co-evolution of life cannot be judged in a laboratory setting, unless the lab is taken outside the ivory tower and brought into complex real-life settings. The availability of a technology may alter people's expectations or habits in a non-predicted way, and this in turn may have a huge influence on the impact the innovation finally has. There is a growing understanding that non-academic actors should no longer be excluded from science. Foreseeing societal impact and judging acceptable levels of (systemic, large scale) risk can only be done in transdisciplinary setting using a complexity lens, i.e. anticipating as much as possible interferences with and feedbacks from other spheres. These feedbacks include not only the effects e.g. of medication on soils, water and evolution (even if mutations cannot be foreseen); they also involve values and narratives, e.g. in terms of our changing expectations concerning health and ageing, our readiness to organise types of care that foster the self-healing capacity of our bodies, our communities and our ecosystem, etc. Plastic, an 'initial success' in terms of consumer comfort, turns out to be deadly for the oceans, those crucial wellsprings of food for countless species and regulators of the climate. The same goes for electronic devices, fertilizers, nanotechnologies, pesticides, cars, etc. Wicked problems occurred not because the techno-scientific system planned them, but because it was (and still to a large extent is) blind to the systemic interdependence and complex dynamics of life. To address the current crises and contribute to Agenda 2030, science, technology, engineering and mathematics are needed, but only if they are embedded in a complexity-based (non-Holocene) paradigm and based on (or inspired by) an ethical, responsible relationship with life on Earth.

The second industrial revolution allowed for large-scale extraction of materials and for the mass production of consumer goods. Since the 1950's this model was rolled out globally (in answer to companies' need for growing markets), and led to what is called 'the great acceleration' (McNeill & Engelke, 2014). It brought world population growth and a comfortable life for many people, but at the cost of massive ecosystem depletion. This makes competition for resources more and more fierce, fuelling geopolitical tensions (Krastev & Frank, 2015). Instead of changing its narratives so as to restore peace (with nature and other humans), Western culture now simply defines human beings as competitors in pursuit of self-interest, and sees education as a leverage for this. At a recent academic congress on 'rethinking global engagement', former EU-president Van Rompuy (2019) stated that 'Europe's projected skills shortage risks being further exacerbated as the global geography of human capital shifts East, and competition to attract talent intensifies. We need popular support for accepting more skilled economic migrants'. In other words, after the grab for Africa we now proceed to the grab for Africa's and Asia's talented children, to be deployed in the economic war of Europe against their countries. This is presented as an evidence, not as a dubious social construct (Crist, 2019; Snick, 2016a).

Many of the world's outstanding academic institutions play a leading role in this 'race to the bottom'. The loss of a stable climate and of stable stocks of almost everything (biodiversity, soils, pollinators, materials…) is at the heart of current societal crises. These cannot be tackled by adding 'epicycles' to the same kind of thinking, but require a new (complexity based) paradigm. The question is now: does the concept and science of sustainability enable the research and innovation system to adapt and embrace such a new paradigm?

Does sustainability science offer new perspectives?

Current crises started reaching the front pages of newspapers only recently (with dramatic fires and school strikes), but the risks have been visible for half a century. As early as 1962 biologist Rachel Carson (1962) warned for ecological damage due to the agro-industrial use of pesticides. Since in 1972 the Limits to growth Report to the Club of Rome was published (and sold thirty million copies in thirty languages), academic, political and economic leaders were *informed* that the extractive scenario is unsustainable (Meadows et al., 1972). Clearly the crises were not unpredicted or unforeseen at all, yet this knowledge did not lead to a real questioning of the system. Often the scientists who warned for the risks were not taken seriously. The assumption that more understanding (through science) allows humans to adapt (and bring societal progress) underestimates the complexity of change, and is blind for the many interconnections that keep the system locked in. Understanding these complex and non-linear dynamics is key for humans to adapt; how to do this with a research systems that is mostly designed to *reduce* complexity?

Yet, in response to the early warnings, pioneers have started to propose adapted scientific approaches. Systems thinking was developed in order to better understand the interdependency between human and natural subsystems and to explore leverages for change (Meadows, 2008; Midgley, 2000). Ecological economics study how economic systems can take entropy into account (Georgescu-Roegen, 1971). Yet, as a whole the academic world has been very slow to accept this holistic paradigm, and remains locked-in to the specialist progress-view. Many researchers and research groups propose new (systemic, transdisciplinary) ways to tackle complex challenges, but these often remain isolated initiatives that do not affect academia as a whole. In general, the extractive economic model (and the technological regime supporting it) is still the main approach, with some 'radical' alternatives as side-branches.

The division of sciences into separate siloes and its institutionalisation in medieval structures in fact makes it very difficult for science to contribute to the co-creation of adaptive pathways for strong sustainability (Chapman, 2015; Crist, 2019). If sustainability is integrated in academia, very often it is (just like ethics) 'neutralized' by reducing it to a new discipline or specialism (often in the natural sciences). It is not taken as a paradigm for all science in the Anthropocene, one that requires it to break out of its siloes and to redefine its aim from 'increasing competitiveness' to 'reinforcing societal and natural wisdom and peace'. Most solutions proposed by the R&I system therefore can only be qualified as weak sustainability. Some examples can illustrate this.

A lot of research in (or for) sustainability focusses on 'green technologies'. Because of their enclosure in disciplines, with a lens focusing on one subsystem and blind for interactions with other subsystems, most solutions are mere improvements of the dominant paradigm, adding social and ecological corrections as epicycles, but leaving the basic model unchallenged. This system-blindness feeds e.g. the belief that replacing fossil energy by renewable energy will allow for continued (or 'sustainable') economic growth. The reasoning is that solar energy is unlimited and imposes no limits to growth. What is overlooked, however, is that to be useful for humans, solar energy has to be captured and stored by material interfaces. Solar panels, grids and batteries are needed to make solar (or any kind of renewable) energy run our machines. Most minerals needed to capture and store renewable energy are scarce and non-renewable; so for all practical purposes, solar energy is *not* abundant but just as scarce as those materials (Pogany, 2015). Switching to green energy may at best solve one problem (CO2 emissions), but at the cost of creating a range of others (mining, pollution, displacement of human and nonhuman populations, geopolitical conflicts over resources or markets, etc.). Moreover, by presenting any kind of renewable energy (including hydrogen) as clean and abundant, societal expectations and consumption patterns may well go up (a rebound effect), leading to an escalation of extraction, transport and pollution, and causing an accelerating destruction of ecosystems.

A solution often put forward to address resource depletion is to find new materials (including mining other planets) to substitute for scarce ones. There is no economist who really believes all resources (minerals, rare earths, metals, …) are renewable on a human time scale. Many of these materials were deposited during the formation stages of our planet, and geochemists have a quite accurate idea of how much of them (including soils) is available in locations where it is economically sound to extract them (i.e. where extraction does not cost more than can be gained from it) (Sverdrup & Ragnarsdottir, 2014). The tipping point for (profitable) extraction of most materials is foreseen around 2030. Those scenarios are based on current extraction rates, and do not take into account the impact of more countries aspiring Western life styles. We are creating cultural addictions that increase the global demand at a much faster rate than (even exoplanet) mining will ever be able to fulfil. So, substitution is not a solution for the problem, but an acceleration (Rosa 2013). It means we are creating expectations and infrastructures that require resources we know will be unavailable in about ten years.

Moreover, we are very busy creating a massive amount of electronic waste with chemicals leaking into the environment; processes like corrosion and osmosis cannot be stopped. This has disastrous effects on the beaches in the South where our old electronics are dumped and plastic washes up. Scientists and entrepreneurs now propose the circular economy as a way towards sustainable growth. This may be a good solution at the scale of a company or sector (extracting *more* value from *more* waste). But since it does not get rid of the growth imperative, the result is only relative decoupling (using less resources per unit of growth), not a decrease in the total use of resources (absolute decoupling). Given the laws of thermodynamics a really circular economy (without waste and dissipation of energy) is impossible on this planet. Launching our machinery in orbits away from the planet is no solution either, as gravity makes old satellites and spent rocket stages collide and disintegrate, increasing the risk for new space crafts to be destroyed by a collision with man-made orbital debris. Given gravity, space debris can only spread further.

It is remarkable that in the lab scientists use rigorous methodologies, but when it comes to judging the impacts of their innovation on society (when rolled out at large scale), their claim is that they *believe* them to be beneficial. They rarely present this as a hypothesis to be put to the test with the same methodological rigour; it is stated as a truth claim. This is complicated by the fact that complex systems may have different behaviours at different scales. Climate change, e.g., makes people suffer from heat waves, and a '*normal*' solution is to produce air-conditioners to stabilise the climate in houses. Since these devices require energy – for mining the materials, for producing, transporting, running the appliances and cleaning up the waste when discarded – they contribute to an increase of gashouse emissions and thus to even hotter summers: a vicious circle. A balanced system at small scale (house) leads to an escalating system at a larger scale (climate). To design a solution that takes into account planetary dynamics as well as human responsibility in the Anthropocene, the first question is: is it better to produce *more* (maybe 'greener') air-conditioners, or on the contrary to *avoid* the production and sales of appliances, and instead focus on ecological ways to keep the climate stable (e.g. reforestation)? Yet today no company (or for that matter research institute) can survive if its aim is to sell as little as possible. The current economic and financial system forces societal actors to conceal systemic risks or ecological solutions (such as reforestation), and to present further growth (consumption) as evidently beneficial. For science to contribute to strong sustainability, its primary focus should be on redefining its paradigm; it should join forces with pioneers in society for co-creating regenerative cultural models and adaptive economic, legal and financial tools. Only under those conditions will it be possible for scientists to make sound judgments about how beneficial new technologies can be, what risks they imply, and how to govern them responsibly and ethically.

Sustainability research hardly ever thematises the growth of the world population as a risk for our chances of survival. Population control cannot be achieved by *imposing* technical solutions, but that doesn't mean it can be neglected as a driver of planetary depletion. The size of the world population influences how much pressure man puts on nature, and for mankind to live in harmony with species that depend on extended wild landscapes, population should shrink to a more reasonable level. Evidently, until the population sets at a lower level, the demographic pyramid will be upside down, with few children at the bottom and a large proportion of older people at the top. This requires a thorough rethinking of aging policies and care systems; yet using a complexity lens reveals more pathways for rethinking policies, enables us to think outside the box of current pension systems and invent new care systems (Snick, 2019). Scientists often treat population growth as inevitable. Others see longevity it as a desirable goal, feeding man's dream of immortality, and do not ask how this impacts demographics (Harari, 2015). Some refer to it as a 'factual' justification for increased extraction, e.g. via industrialised or bio-engineered food production and a more aggressive exploitation and alteration of nature.

All these examples show that although sustainability is appearing on the research agenda, it is approached predominantly from within the Holocene paradigm (i.e. weak sustainability). Even if some universities start with more radical transdisciplinary, systemic approaches, these are not rolled out university-wide. In almost all of higher education the mainstream economic model is still taught as the normal (normative) one, while regenerative inventions are treated as marginal.

A perspective on strong sustainability

Physicist Max Planck once said science advances 'one funeral at a time', meaning that a new scientific truth does not triumph by convincing its opponents, but because these opponents eventually die, and a new generation grows up that is familiar with it. However, climate change and species loss do not wait for retirements, and academia has to step up its efforts. Radically alternative pathways for education – supporting SDGs – are slowly emerging. Since 2016 a Belgian university college (Howest) has developed an educational program for 'Network Economics', training students to set up regenerative entrepreneurial initiatives (including community currencies as a tool). The Copernicus Alliance, a European network of higher education institutions committed to transformational learning for sustainability, offers its members a platform for exchange and mutual learning. Some European research projects on Responsible R&I (RRI) have explored ways to embed strong (i.e. complexity-based, common good-oriented and co-creative) sustainability research in the R&I system (Snick, 2017). But can these initiatives have the needed impact in due time?

In the words of Planck, a new truth can only triumph if a new generation grows up that is familiar with it. So, for our civilisation to shift to a sustainable pathway, a new education is key. Sustainability should no longer be enclosed in a specific field of study, offered to students as a mere option in addition to the 'standard' package. Every young person should understand why the current course of society is like walking in the footsteps of the Viking; they should also learn that today other pathways are being explored, with a sustainable, peaceful world (SDGs) on the horizon. They have to be told that other economic systems exist, even if they are still fragile and fragmented and struggle to be accepted by the (economic, legal, cultural) regime. To keep that information from them and to present the extractive model as the only realistic one is immoral, for it robs them of their freedom to imagine more promising futures. Young people must be freed from the pressure of the extractive and competitive regime, and be allowed to co-create a future in peace and partnership (SDGs 16 and 17) with nature. They should be given the freedom to learn from indigenous wisdom, and be empowered to design regenerative practices.

Typical higher education classrooms are auditoria. Through their very architecture these spaces convey the message that the teacher in the front 'knows' while students (passively, individually) 'learn'. This design is no longer adequate. It is at best suitable for letting students master small (relatively stable) parts of reality that can contribute a part of the complex puzzle we need to solve today. But for education to bring about a radically better society the auditorium – like the laboratory – is no longer the place to learn. We know for sure the future cannot be an extrapolation from the past, as the tipping points threatening our civilisation are approaching faster than foreseen. If young people are to learn how to thrive within nature's boundaries, the best teachers are nature and the indigenous people who for centuries (until Western economies started intruding in their world) lived in harmony with their environment. The best laboratories for exploring the future are the regenerative initiatives and new economic practices that emerge in an SDG-inspired world. They can encourage students to think outside the (academic) box, acquire holistic knowledge, and shape social entrepreneurship supported by regenerative financial, technological and institutional tools. Many of those leverages are yet to be developed, so academia should have a lot to contribute. Higher education for a sustainable future has to be nurtured by four 'placentas' – allowing new life to grow without controlling it:

1. HOPE. Young people today are overwhelmed with scary news about what's wrong with society and nature; they hear that the lifestyle they cherish will no longer be possible. These negative messages lead to reactions of fear and denial. In order for them to open up to alternative futures, an inviting and nourishing environment is needed (Lipton, 2008). Field trips (to nature, to regenerative initiatives or indigenous communities) or service learning therefore are powerful learning settings: they give students hope by showing in real life that the alternative is there and that it is promising (even if still fragile). Universities should stop immediately teaching the extractive economy as the only 'realistic' one, for (in more than one respect) this is a lie, fake news. Student initiatives like Rethinking Economics are important partners in this. Also, the perspective of reducing the human population to a level in balance with the ecosystem should be presented as a hopeful one, and not as undesirable or unfeasible, as this would restrict their freedom to imagine other futures.

2. COMPLEXITY. Young people (and teachers) should be familiarised with systems thinking. This cannot be done by just reading theoretical works on complexity, as it requires skill and daily practice, not unlike learning to use a compass. This should protect them from the fallacies of linear (Holocene) thinking and help them to be more prudent as future leaders, researchers, entrepreneurs and citizens. In the Anthropocene, we have to learn to 'dance with the system' (Meadows 2008) and accept unpredictability as an opportunity to be creative. Learning to 'embrace complexity' can be practiced in playful and fun ways (Booth-Sweeney & Meadows, 2010) and by using mapping tools on various issues in many settings.

3. STORIES help young people to reflect on deep values and (blind) assumptions, and to discover other narratives. Stories do not just speak to the brain, but also to the emotions and the empathy of learners; that makes them into powerful ways to envisioning other futures; they allow learners to *feel* what it could be like, and stimulates both brain halves. Inspirational stories can be about how nature regenerates after the reintroduction of key species (Caroll, 2016), on people learning key lessons about life, or on the people and non-human beings whose history was silenced by a supremacist culture (Kingsolver, 2000 & 2012; Powers, 2018). It can help them to envision a future where the human population is again on a sustainable level and where

people express their love for children in other ways than by putting their own offspring on an already exhausted planet.

4. COCREATION. The term 'Anthropocene' should keep us aware that humans co-create life on Earth together with others species and are responsible for it. Co-creation is an ongoing, iterative and dynamic process of self-reflection and adaptation, especially in an unstable, post-Holocene context (Chapman 2015). Preparing youngsters for the future requires active (not passive) and collaborative (not competitive) learning. Involving students as co-experts in transdisciplinary research projects can be a powerful way to achieve this (FoTRRIS, 2018).

This last paragraph is not to be understood as a final conclusion of a closed set of arguments, but as a proposal (or hypothesis) for further reflection and research. What higher education and research in the future could look like, is itself a matter of co-creation, not an eternal truth.

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Social and Solidarity Economy organizations as Bio-economic Systems? Insights from the case-study of the "Association Sahel Vert"

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Abstract: Social and Solidarity Economy (SSE) organizations typically aim at societal innovation employing different values and modes of organizations. However, one of their major drawbacks is to consistently assess the sustainably of their initiatives and improve their organization accordingly. Again, since those organizations rely, more or less explicitly, on principles that cannot be reduced to the premises of the market-based rationale, a proper economic discourse should develop employing an alternative epistemology capable of moving towards a coherent logical analysis of their unique key features. Due to its systemic outlook and focus on immaterial target, the Bioeconomic epistemological proposition (Nicholas Georgescu-Roegen) seems appropriate to represent and assess SSE initiatives. Thus, is a Bio-economic informed conceptual framework a consistent epistemology to investigate SSE organizations and their sustainability? To answer, the study explores in a case-study at the Association Sahel Vert the opportunities and the limits to use a Bio-economic informed epistemology to qualitatively assess the sustainability of SSE organizations.

Keywords: Social and Solidarity Economy organization, bioeconomics, sustainability, case-study, systemic approach

Introduction

Organizations of the civil society develop a multitude of typologies that continuously evolve interpreting the instances of their epoch spontaneously providing a collective answer to the needs perceived by a group. Social and Solidarity Economy (SSE) as well as Third sector can be mentioned as fundamental conceptualizations to differently refer to similar organizations. The voluntary organizations of bodies of the civil society can be very different, highly depending on their context and on the motive behind their specific evolution as well as their aim of reproduction. Each of those organizations are searching - through voluntary collective mutual effort - a proper way to achieve their purposeful objective which is important to highlight is not the sole reproduction and distribution of monetary profits. Whether their purpose is pragmatically oriented towards the satisfaction of goals or it is radically emancipatory, all voluntary organizations of the civil society finally rely on basic principles that are alternative by definitions. (Evers & Laville, 2004; Moulaert &t Ailenei, 2005).

Problem statement

Since Social and Solidarity Economy organizations (SSEo) rely, more or less explicitly, on principles that in the end cannot be reduced to the premises of the market-based rationales, a proper economic discourse should be developed employing an alternative epistemology capable of bringing forward a coherent logical analysis of their key features. Consequently, a suitable framework would imply employing their unique principles and assets in order to sustainably achieve their specific purpose. In other words, as proposed by Dash (2014) the "*challenge is to construct a coherent theoretical framework for SSE with a strong explanatory power to capture the wide and rich diversity of the* *scattered experiments and innovations on the ground*" (p. 9). This epistemological limit is recognized as a fundamental obstacle in order to sustain these actors of societal transformation (Dash, 2014).

Hypothesis

Due to its systemic outline and immaterial target, the Bio-economic theoretical proposition, firstly developed by Nicholas Georgescu-Roegen (G-R), seems suited to represent SSE initiatives and investigate about the sustainability of their activities. In his (incomplete) attempt to carry an economic theory, the so called bioeconomics opposed to the neoclassic mainstream, G-R offered an alternative epistemology[1] and an economic rationale here referred to as the Bio-economic paradigm. Basically, the latter, placing economics under the unavoidable physical and biological constraints, considers the economic process as evolutive and made of open-systems that employ available resources within its organization to jointly strive towards the reproduction of particular (fundamentally immaterial) goals through the proper maintenance and development of its constitutive systems (Bonaiuti, 2003). However, no study ever represented an organization of SSE employing such alternative epistemology.

Research Question and Design

Therefore, the principal research questions became the following: is a Bio-economic informed conceptual framework a consistent epistemology to investigate SSE organizations and their sustainability? Consequently, which benefits are derived from the application of a Bio-economic-inspired framework representing a SSE organization as a hypothetic Bio-economic System? To develop this research, the bioeconomic thought is introduced to advise[2] the construction of a framework for the usefulness of SSE organizations. The aim of this research is therefore to explore how the interpretation of an alternative epistemology and paradigm conduce towards a frame to qualitatively study the SSE organizations sustainability. In order to do this, the case-study of the *Association Sahel Vert* in Wittenheim (France) is used, as this association practices initiatives, research and education for sustainable integrated development of disadvantaged people.

The Bio-economic[3] theoretical framework

The present work intends to experiment a qualitative analysis of an organization of the Social and Solidarity Economy informed by an alternative paradigm: the one consequent to Georgescu-Roegen's conceptualization of bioeconomics. The bioeconomic theory is the final outcome of a deep epistemological reflection conducted by G-R in order to overcome the limits of the reductionism, especially in the economic science (Giacobello, 2012; Molesti, 2006).

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[1] In this study *epistemology* is intended as the way to acquire knowledge or "*the science of knowing*" (Babbie, 2019, p. 5). The fundamental epistemological question answers the following demand: "*how can we know about reality and what is the basis of our knowledge?"* (Ritchie & Lewis, 2003, p.13).

[2] In this regard, the Bio-economic paradigm here is not reproduced orthodoxically - no attempt to conduce economic analysis to its fundamental material basis would be offered; instead, it will inform one logical framework to represent and qualitatively analyze how high-specific valued-driven organizations could proceed towards their immaterial objective deeply accounting sustainability.

[3] In this study the adjective referred to the *Bio-economics* is written in capital letter and *italics* and with a " *in order to help in the precautional distinction between the original though of G-R and the present use of an informed but different conceptualization*".

Thus, how to sustain a rigorous scientific discourse accounting for complexity? For G-R, **logic** is the only domain that have rigid and well-defined boundaries (Mayumi, 1995) Consequently, his epistemology concerns "*mainly with the problem of valid analytical representation of the relations among facts*" thus, any theory within this paradigm should be "*a logically ordered description of [a reality's] mode of functioning*" (Mayumi, 2009, p. 1244).

The science of complexity may provide us with useful concepts. For example, applying the ontology of David Lane (2006, 2011) to organizations would help in order to logically frame specific organization in a consistent manner. Accordingly, the concepts of *structure*[4], *process*[5] and *functions*[6] can be used to frame a complex understanding of organization (Bonaiuti, 2014; Lane, 2011). Finally, employing an epistemology informed by the thought of G-R, the economic analysis should be: interdisciplinary/systemic and recursive/evolutive. Again, it should account for complexity/quality of the phenomena and be represented as a logically ordered description of reality's mode of functioning.

The Bio-economic paradigm

Bioeconomics is the original theoretical proposition that G-R provided in order to overcome the (epistemological and theoretical) limitations he encountered in the mainstream (*standard,* as he was used to call it) neoclassic economic theory and its resultant paradigm. In his masterpiece "*The Entropy Law and the Economic Process"* (1971) and in the consequent issues, he delivered the conceptual cornerstones of a new economic discipline. He referred to it as bioeconomics so as to recall the fundamental natural substance of any scientific economic understanding. In fact, according to G-R, biology, as well as the physics of thermodynamics, is the ground into which the economic science finds its roots (Bonaiuti, 2013; Mayumi, 2009; Molesti, 2006).

An understanding of the economic process

The recognition of the Entropy Law as foundation of the economic process is probably both the most famous and debated contribution of the Romanian scholar, G-R claims that the **economic process**, as any other living process, is **irreversible**. Paraphrasing the eminent academic, the Law of Entropy recognizes the qualitative distinction between valuable input resources (low entropy) and output with no value (high entropy) (Georgescu-Roegen, 1973). The second Law of thermodynamic (the Entropy Law), affirms that in a thermodynamically closed-system (system that only exchange energy with his environment) there is unidirectional qualitative change towards disorder (high entropy). In a closed-system, as it is considered the planet Earth domain, living beings in order to animate takes low entropy from the environment to ensure their entropy

[4] "The *structure* of an organisation describes its parts (energetic, material and informational), the interaction modalities among its parts, and the modalities through which the organisation interacts with other organisations. In other words, it comprises the set of *rules and relationships*[4] among the parts. Generally speaking, a structure 'sustains' one or more processes. Some types of structures comprise what we define as '*representations*[4]'" (Bonaiuti, 2014, p.15).

[5] *"Processes describe the transformations (typically in structures and functions) in which the organisation may participate. The analysis of flows (of matter, energy and information) that cross the border of a process represents the way in which, for example, we can offer an analytic description of the process itself. Processes condition and modify the structures and, frequently, the functions of the organisation*" (Bonaiuti, 2014, p.16).

[6] "*By the functions (of an organisation) we mean that which provides the actions of the organisation with directedness (ends, values, etc.). In other words, functions attribute a 'weight' to the various processes and determine which process the organisation will enact (when it is in a context in which it is possible to enact more than one process)"* (Bonaiuti, 2014, p.16).

constant. Similarly, human transforms resources into mechanic labor as well as in object (Bonaiuti, 2003, 2017). However, as stated by G-R, in the Earth closed-system is valid the 4th thermodynamic Law so that the entropy of matter will eventually reach the maximum. In other words, the incoming solar energy flow will not be able to sustain labor (life activities) endlessly since "*it is impossible to recycle matter completely*" (Mayumi, 2009, p. 1243). As G-R was used to say: "matters matter too" so to point the attention to the irreversible utilization of matter (Bonaiuti, 2003; Georgescu-Roegen, 1971; Hammond & Winnett, 2009).

It is concluded that the real **output** of the economic process (as it is for life process) it is not the consequent degraded material flow, instead it is complement, the **immaterial flow**: what Georgescu-Roegen name as the **enigmatic** "**enjoyment of life**" (Bonaiuti, 2017, p.58). Here comes the central *Bio-economic* question: what is then the true outcome for which economic organizations strive dissipating their available resources? Although enigmatic[7], the true output of economic system **must be immaterial**.

The principles that rule economic systems within the said Bio-economic paradigm, from the global economy to smaller organizations, might be summarized as follows. The economic processes (as life processes) are nurtured by environmental **resources** that, eventually, are scarce in the Earth closed system: economic processes are subjected to the law of entropy. Hence, the **output** of every economic activity could be understood as two **complement flows**:

- an ***entropic* cost,** composed of: degraded resources and waste (cannot be reused due to the G-R 4th Law of the thermodynamic);
- a **valuable *immaterial* output**.

Accordingly, socioeconomical scrutiny focus on the recognition of the enigmatic "enjoyment of life", intended as the purposeful flow of ***immaterial output*** (Bonaiuti, 2017). At this stage, it is important to remember that Georgescu-Roegen never endorsed[8] for a blind literal application of the concept of entropy in economics (Mayumi, 1995). That conceptualization informs said Bio-economic approaches employing the paradigmatic vision of the human essence rooted into biological life structure and purposes. Accordingly, if the open-system framework is known as a structure to model living systems, the purposes remain subjective and highly enigmatic. Following the advanced epistemological conceptualities, approaches have been attempted in order to consider a *Bio-economic* process.

Towards a conceptualization of a Bio-economic framework for SSE qualitative research

Bioeconomics is intended as an economic theoretical framework issued by the complex understanding of bio-physical phenomena. Hence, as biologic living beings *convert* environmental resources into greater entropy to keep their entropy constant and thrive, the anthropic economic processes *convert* available resources into higher entropy targeting complex human immaterial purposes. What are these within an economic organization and how to define these complex immaterial objectives became the focus of a *Bio-economic* study. The mentioned purposes, yet

[7] The economic output is of the same order of complexity of the puzzling social life purposes.
[8] In this regard, he stated: "*While I thus insisted (as I said in the Preamble) that the economic process is entropic in all its material fibers, I hastened to add that it cannot be reduced to the degradation of low entropy*" (Georgescu-Roegen, 1986, p.8).

enigmatic, seem to be more or less explicitly targeted by the SSE organizations. The great importance of immaterial drivers appears in the attitude of voice of these organization and, even more, it seems of clear relevance considering their value driven constitution. Bearing in mind that hypothesis, in the section would be presented how the mentioned epistemology might represent an organization of the kind. Thereafter, employing the *Bio-economic* logic, possible insights might occur. In order to undertake a *Bio-economic* study, few elements should be considered.

- ✓ An economic **association** is organized as an **open-system made of complex system**: such organization can be described systemically as combination of: *structure*, *process, function.*
- ✓ Economic **process** represents the **conversion** of all available resources to target the output intended as *immaterial.*
- ✓ **Outputs** of the conversion process are of two complemental types: ***immaterial*** as its *value* and ***entropic dissipation*** as its *cost* (made of: degraded resources and waste).
- ✓ **Sustainability** might be intended as the capacity to achieve the *immaterial* purpose efficiently organizing the available resource accounting for the minimal dissipation of the resources needed: considering that Flows alone cannot target the output, instead this rely fundamentally on the quality of the agents it depends.
- ✓ ***Bio-economic*** paradigm is based on **meta-concepts** that should be interpreted **depending on the context** of their application and eventually tested against the real world.

From this standing point, it seems open the opportunity to consider socioeconomic organization as *Bio-economic* system performing *Bio-economic* processes. A *Bio-economic* inspired framework might inform the framework for a qualitatively research that study organization in its process towards the realization of its ideal undertaking.

The research design: a methodology for the qualitative research

Here it is proposed the whole research design in which to employ the mentioned epistemology to investigate the complexity of a given organization. That will conduce us to highlight elements about the sustainability of the organization subject of the study and therefore to produce insights in order to answer the research question. The appropriateness of qualitative research in order to answer the question is due its capacity to inquiry the fundamentals of an organization, to code its particularity and to employ theoretical framework in the analysis. Moreover, qualitative design is particularly suited to offer precious information about the complexity of socioeconomic phenomena as organizations (Creswell, 2009).

Case-study appears as suited research design to conduct such study. In fact, case-studies are a qualitative strategy of inquiry that allow to explore in depth activities and processes using detailed information and a variety of data collection procedures over a continued period of time (Creswell, 2009). In the present study the case is the *Association Sahel Vert*. This association has been chosen because can be easily identified as typical organization part of the Social and Solidarity Economy. Moreover, since the first contact the representatives of the organization genuinely recognized the need of a new epistemology to represent their organization differently. Sharing purpose statement enable cooperative attitudes that assured full access to precious information regarding their complex organization.

Data collection

The present qualitative research strives to gain deep understanding of one particular organization of the SSE: the *Association Sahel Vert*. The data were collected in an extensive field period in which the researcher had the opportunity to have complete access to the data of the organization. More than one year of research experience as active participant of the activity of the organization enabled the writer of this study to acquire profound knowledge about the whole organization, especially about the immaterial representation shared in the organization.

The objective of the data collection was to gather information and eventually gain knowledge about the whole function of the association so to gain rich data in order to source a systemic description and *Bio-economic* analysis. Information was collected so to generally respond to *what*, *how* and *why* questions regarding the association about to organize and sustain its activity. In order to gain the richer information, the case study is composed of a mix of data source as described in Table 1.

Table 1: Description and relevance of the data source mix. Capital X signify a greater relevance.

Data sources:	**Observations**	**Documents**	**Semi-structured Interviews**
Description	Field notes father during extensive field experience	Organization reports, internal documents and project drafts	Private talks had it with members of the organization. Those were guided by similar questions
To know:	what and how the organization actually is	what the organization is about	the intimate purpose of activities and deepening understanding by challenging the main shared complex representation
What	**X**	**X**	x
How	**X**	x	x
Why	x	x	**X**

Data analysis

How to frame qualitative data in order to be then analyzed employing a *Bio-economic* epistemology? In the following section the *Agent-Activity-Value* framework is offered as main reference to organize data to be analyzed.

The "Agent – Activity – Value" framework

The *Agent – Activity – Value* framework (A2V) is an original conceptualization proposed in order to outline the qualitative data of a socioeconomic organization according to a *Bio-economic* understanding. Inspired by the *Bio-economic* extensions elements and the complex organization ontology proposed by Lane (2011) both offered in the theoretical framework, A2V combines qualitative data from different data sources in order to represent the organization in a way to facilitate engagement with concepts and logics related to the *Bio-economic* epistemology so to be analyzed accordingly. The proposed conceptual framework searches to reproduce the complex concepts of the *Bio-economic* paradigm in the context of a particular social organization.

The A2V is constituted by an outline that allows the qualitative data of case-study about a social organization to represent and analyze the organization respectively as *Bio-economic System* (BS) reproducing *Bio-economic Process* (BP).

- ***Bio-economic System*** (**BS**).

  BS is the **static** and systemic representation of the organization. That is constructed as interrelating *Agents* kept together by the organization boundary defined as its *Value*.

  - ***Value*** is considered as the *immaterial* boundary that identifies the organization and, at the same time, its ultimate purpose. Accordingly, *Value* has a double function:
    - to define the ***identity*** of the BS. *Value* is what constitute the ideal boundary of the organization defined by its socially accepted norms;
    - to explicit the ***immaterial purpose*** to realize through the BPs. *Value* is the ultimate end toward which the BP should strive for.
  - ***Agents***: is coded as '**agent of transformation'** acknowledged both as a system, *structure*, asset, part, entity or element of the whole organization. It is possible to account for three main subcategories of *Agent*. These refers mainly to:
    - ***Material*** elements the organizations own/dispose (durable goods, economic assets, material resources the organization).
    - ***People*** and their specific role/configuration within the organization (human resource systems of the organization.
    - ***Immaterial representation***: codes representing the relevant knowledge for the function of the organization (share representations).

- ***Bio-economic Process*** (**BP**).

  BP is the representation of the organization (BS) in its qualitative **evolution**. That is described by the ***Activities*** performed by the organization.

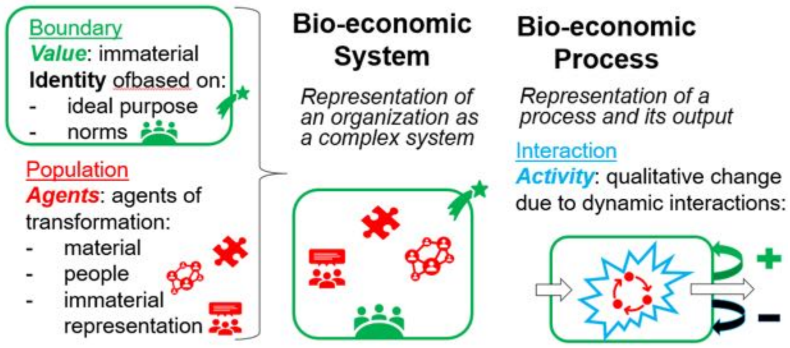
  - ***Activity*** of the organization describe the dynamic interaction occurred between *Agents* to perform a task according some purpose (*Values*). Few subcategorizations of Activity are identified:
    - ***Typical***. Those relative to processes grounded on resources owned by *Agents*. They can be of two type: *Structural* (TsA) when *Activities* mainly targets *Agents*, and *Functional* (TfA) when *Activities* mainly targets *Value*.
    - ***Environmental***. Those describing transformations of *Agents* mainly due to flows of resources (material, immaterial, people) that comes from outside the organization. They can be of two type: *Shocks* (EsA) for unexpected events, and *Organized* (EoA) if they are due to certain planification.

Analyzing the A2V representation employing the *Bio-economic* paradigm, diverse insights might be presented. According to the *Bio-economic* logic, the organization processes (*Activities*) are about dealing with transformation of its main components (*Agents*) enriching or exploiting them for the sake of the immaterial end (*Value*). In order to visualize the composition of the various concepts introduced, Figure 1 graphically depicts the main components of the organization represented according to the A2V framework. Informed by the *Bio-economic* tradition, the whole edifice of a *Bio-*

economic informed framework is an **open-system**. That it is simply to represent the continuous *Activity* of transformation of available resources used by interacting organization' *Agents* in order to enjoy the organization' *Value*.

Figure 1: Bio-economic System and Process outlined using the Agent – Activity – Value framework

The picture schematizes the *Agent* the *Activity* and the *Value* of an organization represented as performing a *Bio-economic System* with a schematic example of *Bio-economic Processes.*



Source: The author. informed by the theoretical conceptualization discussed in the previous chapter

The A2V outline represents the organization systemically (BS) as a value-driven entity composed of diverse material and immaterial systems. The outline is constructed to facilitate the use a *Bio-economic* **epistemology**. In other words, the A2V outlines the organization's data of a case study as a hypothetical *Bio-economic System* so as to enable the analysis to refer to the *Bio-economic* theoretical framework. Is then this epistemology beneficial to tell something about the sustainability of the association in question?

Bio-economic insight using the Agent – Activity – Value framework

Sustainability is here intended as the combined capacity of the BS to promote its intended purpose recognized as *Value* pondering the quality of the main *Agents* involved in the *Activity*. In other words, an organization' BP (described in the research as *Activity*) could be said sustainable if it **sustains its *Value*,** both:

- ✓ maintaining or **developing the *quality* of some *Agents*** (enriching systems, improve shared representation, increase in complexity) and,
- ✓ **with the minimal[9] degradation of other *Agents*** of the BS.

Within the *Bio-economic* paradigm, no valuable output might be attained by flow without the contribution of its structures. At the opposite, these fundamentally constitute to enjoy the immaterial of a BS. In fact, if these systems are functional, only minimal flows (*Activity*) are necessary to enjoy the *immaterial end* (generally intended as 'well-being' by Bonaiuti, 2003). Therefore, fostering the organization identity and its immaterial end (*Value*) greatly relies on the maintenance and promotion of the *quality* of its structures (*Agents*). Then, *Bio-economic* insights might be offered identifying what (*Agents*) to take care so to efficiently safeguard the quality of the structure of the organization in order to promote its most profound, yet complex and evolving, identity (*Value*). Ultimately, to account for sustainability, in the process must be identified the

[9] Informed by the *Bio-economic* paradigm, we know that the entropic cost of any activity is unavoidable. Ideally, for a process to be sustainable, the entropic dissipation should tend to its asymptote. BPs will always convert useful resources both in a part of degraded matter/energy and in a part, that is non-recyclable waste (something that is gone forever according the G-R 4th Law).

complemental unavoidable exploitation of resources (*Agents*) due to the processes (*Activities)* of the organization. That might be as a conceptual cost to minimize. In the following chapter the case study is presented so to provide more information about the context in which this qualitative research it is conduced.

Association Sahel Vert: the case-study

The *Association Sahel Vert* (ASV) is an association of French law based in Wittenheim, a commune of Alsace situated in the northern area of the *Mulhouse Alsace Agglomération*, France. However, as its name suggests[10], the organization was born from the combination of diverse projects and people engaged in socially-integrated initiatives in rural disadvantaged zone of the Malian Sahel. Benefitting the opportunity given by the commune of Wittenheim and the local communities of potassium miners, in 2002 the ASV converted the area and the buildings used for the storage of dynamite into spaces hosting the ASV Pole of Initiative, Education and Research. Since then, that place, called "*la Dynamitiere"*, has constituted the main center of activity in France offering informal education and projects of training to offer disadvantage people a chance to both discover sustainable development and their hidden capabilities. Meanwhile the activities serve to maintain and improve the center it-self. In the last years, the association consistently grew in numbers of members and turnover as well as in responsibility and complexity. In the next chapter the qualitative data gathered are organized according to the A2V framework. Findings will present and order the organization's complexity so that insights will be discussed employing a *Bio-economic* rationale.

Findings

In this chapter the results of the qualitative research are offered. Data regarding the *Association Sahel Vert* are presented employing the *Agent-Activity-Value* framework presented in the previous chapter. In the first part of this chapter the categories of *Value* and *Agent* are presented separately to finally be combined into the so-called *Bio-economic System* representing the organization in its French configuration. After the organization of data, in the second section of this chapter is showed their interpretations by presenting *Activities*. In conclusion, employing A2V category these processes are signified according to the proposed *Bio-economic* informed logic.

The *Association Sahel Vert* as Bio-economic System

Following the proposed methodology, the present research organize data according to the A2V framework so to explore the consistency and the potential of the application of a *Bio-economic* logic to a SSEo. As showed in Table 2, the exhibition of data account for the combination of subcodes of 2 main categories: *Value* and *Agent*.

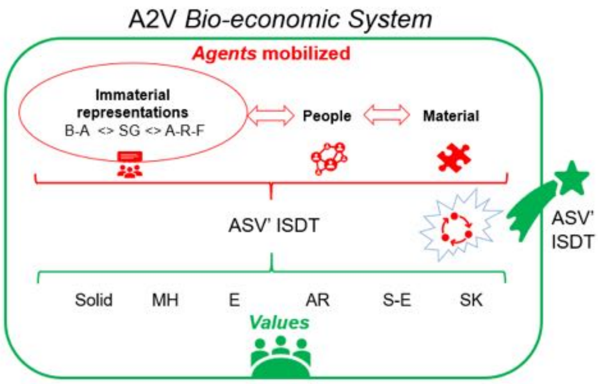
Table 2: The *Association Sahel Vert* as Bio-economic System

[10] *"Sahel Vert"*, literally Green Sahel, was created in the august of 1991 to establish solidarity cooperation with the local people of Sofara, a rural village of the commune of Fakala, in the Mopti region, Mali. From the beginning, the activities of the ASV developed as grass-root collaborative-work initiatives. The ASV advanced as a grass-root shared governed working experience in which socio-cultural differences and technical exchange combines as fundamental assets for solidarity and sustainable actions. The same dynamic of self-help, mutual recognition and solidary exchange forged the initiatives of ASV in its subsequent development in France.

BIO-ECONOMIC SYSTEM	A2V CODING FRAMEWORK	ASV SUBCODES
Value	*IMMATERIAL IDENTY (ID)*	Solidarity (Solid), Mutual Help (MH), Engagement (E), Alterity relation (AR),Self-Expression (S-E), Share of Knowledge (SK)
	IMMATERIAL END (IE)	Integrated Social Development of Territory (ISDT)
Agents	*MATERIAL*	*La Dynamitiere,* Local Environment, Vehicles, Apartments, Monetary Budget
	PEOPLE	Minors: Minor with social (DRS) or justice issues (PJJ), Minor refugee (MNA) Adults (Beneficiary-Actor): Volunteers, Employees, Eu-volunterr (ESC), Researchers Collective of Work (CdT: Minor + Adults) Workers direction (DCO) Council of Administration (CA)
	IMMATERIAL REPRESENTATIONS	Status of Beneficiary-Actor (BA), Shared Governance (SG), Action-Refection-Formalization (A-R-F), Capabilities Rituals: Daily: Briefing, Lunch; Weekly: Reunion of functions (CdT+DCO), Reunion of reflections (Adults); Reunion of management (CA-DCO), Researchers presentation to CdT Rules: Respect ASV Values, Respect of Rule & Rituals, Conflict management

Having identified the codes about categories of *Value* and *Agent*, it is possible to firstly outline the *Association Sahel Vert* as a *Bio-economic System*. The following description is represented in Figure 1. The ASV is outlined as a *Value* driven organization that struggle to reproduce a model of Integrated Social Development of the Territory in order to express its essential *Values*. The BS is the punctual outcome of the global expression of its *Values* as defined, across years of *Activities,* by the actual *quality* of its essential elements, so called *Agents*. These were identified in 3 subcategories: Material, People and Immaterial representations. Their relationship says about the structure of the ASV as a *Bio-economic System*.

Figure 2: Representation of the organization ASV as a Bio-economic System



Source: The Author

To finally understand the quality of the interdependencies within the A2V through *Bio-economic* logic, it is necessary to identify the third category: *Activities*. The findings organized in the A2V framework allow to view the main component of the organization as a *Bio-economic System*. This architecture of data is essential to provide qualitative insights about how the organization performs. In order to do this, complex *Activities* can finally be presented employing *Agents* towards the reproduction of *Value*.

The activities of the *Association Sahel Vert* as Bio-economic Processes

The findings organized in the A2V framework allow to view the main component of the organization as a *Bio-economic System*. This architecture of data is essential to provide qualitative insights about how the organization performs. In order to do this, complex Activities can finally be presented employing Agents towards the reproduction of *Value*. Mainly, data about *Activities* comes from the extensive observation of the organization. In the following section, several examples of data are provided for every subcategory of *Activities*.

Table 3: The activities of the *Association Sahel Vert*

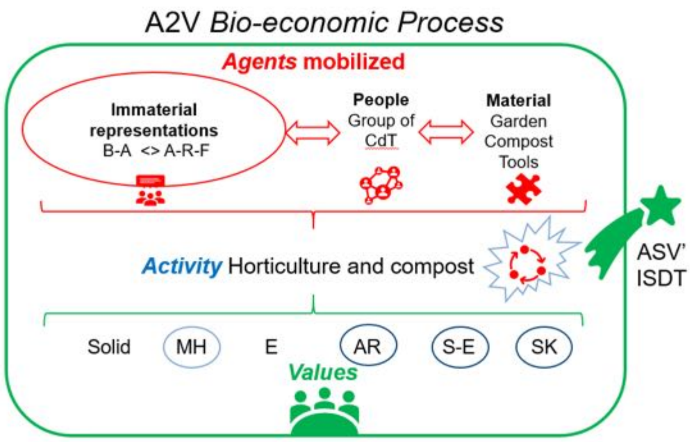
BIO-ECONOMIC PROCESSES	A2V CODING FRAMEWOKG	ASV SUBCODES Together with the relative *Values* employed & *Agents* in play
Activities	*TYPICAL STRUCTURAL* (TsA)	Horticulture & composting: Carpentry & recycling Farming Cooking Cleaning
	TYPICAL FUNCTION (TfA)	Thematic activities in school vacations Week permanence at MNA apartments Mobilities
	ENVIRONMENTAL SHOCKS (EsA)	MNA medical urgencies Donations Budget deficit due to missing payments
	ENVIRONMENTAL ORGANIZED (EoA)	Respond to Minors administrative needs Organized project in partnership

Table 4: The ASV performing as Bio-economic Systems: from observation to Bio-economic insights

BIO-ECONOMIC PROCESS	DESCRIPTION	OBSERVATION		
Activity: **Horticulture & Composting**	The *Activity* entails for: planting different variety, practicing organic agriculture techniques, irrigating, harvesting, dry out and conserve tomatoes, seeds collection, general maintenance, compost management practices.	> As a recurrent activity, garden workshop is well participated and usually is favored by the youngest. > CdT actually shares technical and agricultural competences. Share of perspective of cultivation between EU-volunteers, MNA and pensioners frequently occurs. Was observed that MNA teaches DRS and EU-volunteers too, inter-generation cross contamination of techniques happens. > It was also recorded that this is the place where visitors are firstly brought to demonstrate the qualities of ASV. Garden products are particularly appreciated. > Only in summer the production is sufficient to serve the kitchen for daily needs and B-A. Therefore, during the other months, the provisioning system greatly relies on the Food bank, moving from self-sufficiency to dependence. > A free-rider problem was noticed: products are not enough to serve every interested BA, therefore small conflicts might arise. > Maintenance and storage of instrument is an issue as SG do not clearly assign responsibility and authority to anyone specifically. Therefore, often gardeners lament lack of order, wrong usage of instruments and wasted time to search for the proper instrument. This causes episodes of frustration to daily gardeners. > Gardeners frequently work with joy and with good team spirit. In fact, they were observed more prone to express them self and learn during this workshop rather than during others.		
Agents	**Mobilized**	*Material*	*People*	*Immaterial representation*
		Garden care, maintenance	Group of Collective of Work (CdT) (usually 1 ESC, 1 BA, 1 MNA, 1 DRS)	People can participate as their BA vocation employing their relative technical Capabilities; the approach to the activities relies on A-R-F
	Modification			

	Positive	Garden care, production	People appreciation, enjoyment	Promotion of the status of BA, improves Capabilities of People
	Negative	Poor maintenance condition, disorder	People frustration due to lack of proper quality garden Materials	
Value	**Expression**			
	Positive	Share of perspective (SK); People talk and share a lot (S-E); different agricultural techniques are welcomed (AR)		
	Negative	The Poor condition of the compost suggest a collective lack of Engagement to sustain *Value* relative to environmental protection; free-rider issues demonstrate limits about the reproduction of MH.		
BIO-ECONOMIC INSIGHTS	The garden related *Activities* require lots of time and People efforts. However, those efforts are well reward in terms of *Value* outcome since People demonstrate to enjoy being engaged in these *Activities*. Moreover, People experience mutual Share Knowledge and Self-Expression. *Agents* are globally positively reward by the *Activities*: good quality production of food for CdT, Rituals and BA as well as People enjoyment were observed. Finally, garden is particularly beautiful thus, contrarily to the compost area, it positively promotes the model of the ASV to the external public. Accounting for the observed elements, one might consider garden as a fairly sustainable activity for ASV since it globally enriches its *Value* and *Agents*. To improve it, the ASV should explore more in profundity the value of environmental protection. Consequently, the organization would give more attention to activities that comprise the development of better *Agents* Capabilities that consequently would improve composting and waste management *Activities* and the relative *Agents*. Without this intervention, *Agents* Material and People would continue to be systemically exploited.			

Figure 3: Horticulture at ASV as Bio-economic Process outlined using the Agent-Activity-Value framework



Source: The author.

Discussion

Findings enabled to provide with insights about how the organization performs. One of the main contributions of such epistemology comes from the explicit representation of the typical logic of the organization. As a general conclusion, the more the organization rely on value based social infrastructure, the more the explored approach might be beneficial to represent their particular logic and structure. However, even those organizations that do not explicitly rely on immaterial characters might benefit from such research approach. In fact, since similar *Bio-economic* investigations would search for immaterial drivers and structures, any kind of organization (Third sector as well as Market and Public defined economic organization) that is studied accordingly would provide some clue of the actual, yet misinterpreted, ultimate immaterial end of their activity. According with the methodology presented in the fourth chapter, findings represent data of the case study organized in category informed by the concepts of both the *Bio-economic* and systemic paradigm. The relationship between the findings and the concepts are summarized in Table 5.

Table 5: The elements of the A2V in relation with the mentioned theoretical concepts

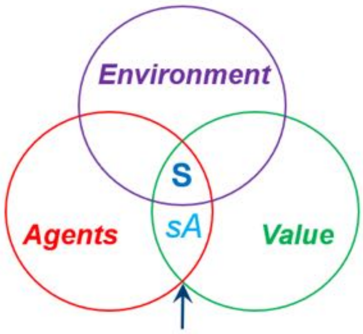
	Agents	***Activities***	***Values***	**BS**	**BP**
Findings	*Materials* *People* *Immaterial representations*	EsA EoA TsA TfA	Solid MH E AR S-E SK	Static representation of the Association Sahel Vert employing *Values* and *Agents*	Dynamic description of the of Association Sahel Vert describing *Activities* employing BS
Complex organization concepts	*Structures*	*Processes*	*Functions*	Representation of an organization as complex system	
***Bio-economic* paradigm concepts**	Agents of the process of transformation	Flows	Immaterial end		Representation of an economic process and its outputs

Firstly, the representation of the so-called *Bio-economic System* provides just for an early description of how principal systems could be logically structured according to the proposed epistemology. Thus, in order to employ a scientific analysis of the complexity of the system, the relationship between systems and subsystems (category and codes) should be further investigated to provide a consistent network eventually discovering levels of hierarchy (Lane, 2017). Secondly, the research design does not employ orthodoxically the G-R bioeconomic theory. In fact, since the research was not an orthodox analytical investigation[11], it is not possible to straightly refer it as bioeconomic contribution in line with the analytical proposition of G-R[12]. Again, in the findings there is almost no account[13] for the **environment**. Consequently, the interpretation of the concept of **sustainability** proposed in the findings should be limited accordingly. In fact, no proper global *Bio-economic* sustainability might be claimed without accounting for the actual environmental degradation due to BPs. Instead, in a qualitative research, insights about sustainability and resource efficiency within the organization are identified. Since in the presented findings there is almost no understanding of the environmental context, the claim remains incomplete. However, a qualitative research conducted accordingly helps to define a broader area defining the sustainability within the organization itself. Accordingly, a *Bio-economic* informed interpretation of the sustainability of the *Activities* of the case study (BS) broadly emerges accounting for just *Value* and *Agents* outcome of the processes (BP). In other words, sustainability is evidenced when *Value* is achieved meanwhile accounting for the maintenance of quality of its *Agents* structure. As it is displayed in Figure 4, the area evidenced by the interpretation of findings (whole *sA* and S) integrates the concept of sustainability presented in the theoretical framework (S) without clearly distinguish it. In fact, a

[11] Thus, based on material aritmomorphic concepts as the G-R Fund-Flow bioeconomic processes (Bonaiuti, 2012).
[12] That is also why the study refers to *System* and *Process* called *Bio-economic* but written with the first capital letter, space and in italic. That is to evidence how this approach, yet informed by the epistemology of G-R, advanced alternatively as defined in the study.
[13] That goes beyond the reach of a qualitative research. However, to conduce the research design closer to the original meaning, it would be possible to account for environmental impact (material as well as immaterial) employing, as precondition, Bonaiuti's Stock & Flow analysis of the regional context in which the organization performs its activities.

purely qualitative research as such goes towards the identification of sustainability (S), however it as no analytical support to define it accounting its environmental dimension In conclusion, analyses of BPs that will introduce environmental impacts would finally be able to add more accuracy to the identification of sustainability.

Figure 4: The area of sustainability identified in the study



The picture reproduced in a modified version the picture representing Venn diagrams of "The Three Pillars of Sustainability" as presented by Hammond and Winnett (2009, p. 1198). The concept of sustainability presented (here symbolized by capital "S") was situated in the interception of Social (*Value*), Economics and technology (*Agents*) and Ecology and thermodynamic (*Environment*). Since no account in the analysis was provided to the Environmental domain, the analysis of sustainability provide here account just for *Values* the *Agents*. Therefore, the offered *Bio-economic* interpretation of the *Activity* evidence its sustainability "*sA*" englobing S without clearly distinguish it.

Source: The author.

In conclusion, findings offer a qualitative interpretation of diverse theoretical concepts exploring their metaphoric meaning in the case study eventually providing for some meaningful insights. As presented ultimately in the findings, proper insights emerge from the continuous exploration of relationship between the elements of the Bio-economic System.

Conclusion

In the case-study, the explored epistemology succeeds to evidence the basic characters for which the different kinds of voluntary organization are identified in the literature, demonstrating in particular the consistency of a Bio-economic epistemology to study SSE organizations. On the other side, the investigation of sustainability consistently offers valuable insights about the quality of the initiatives of the organization; however, a qualitative research is considered insufficient to properly relate with the Bio-economic theoretical contribution. Therefore, a development of this epistemology is endorsed combining quantitative and qualitative approaches in order to give more accuracy in the statements accounting also for the environmental impact of SSE initiatives. In conclusion, the explored Bio-economic approach can be judged appropriate in order to guarantee the sustainability within the organization itself, while a more complete approach, both qualitative and quantitative, must be considered to properly recall the Bio-economic theoretical framework achieving strong sustainability.

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The degradation of sustainability of food systems by excess ultra-processed and animal foods: the 3V rule to counteract it

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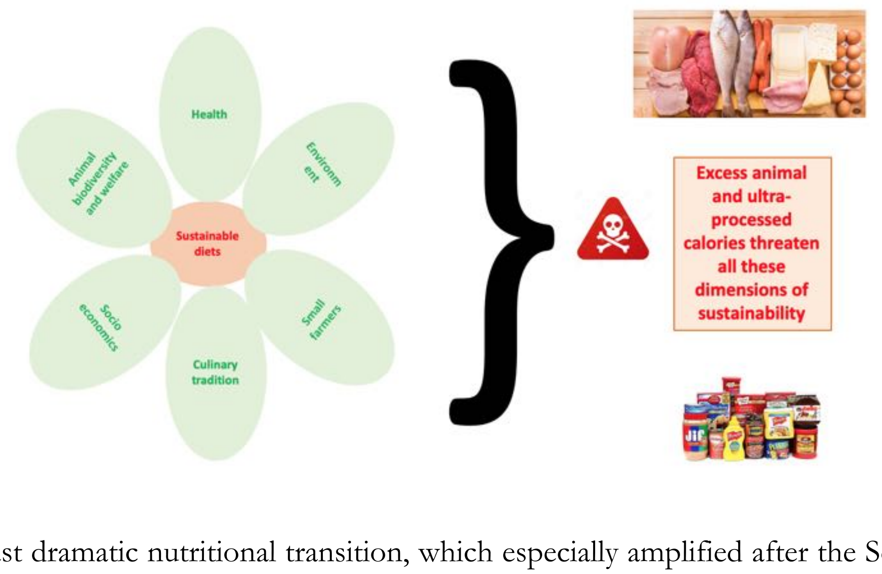
Abstract: Ultra-processed foods are the result of an extreme food artificialization to reach easy and immediate sensory pleasures. Their excessive consumption has been linked with increased risks of several chronic diseases, notably total cancers and mortality. Besides, excess animal and ultra-processed calories threaten food system sustainability. To counteract this, we propose a very simple and efficient lever: the three golden rules for healthy, ethical and sustainable food systems. They have both scientific and holistic bases. Indeed, scientific-based evidence show that the protective diet for human health, animal biodiversity and well-being, and environment follows the rule of the 3V for "Végétal, Vrai, Varié": Végétal (Plant-based foods): maximum 15% daily animal calories; Vrai (Real food): maximum 15% daily ultra-processed calories; Varié (Varied foods): among real foods eat diversified, if possible organic, local and seasonal. Thus, decreasing ultra-processed food consumption has an immediate positive impact on global food system sustainability, notably protecting small farmers, culinary tradition, socioeconomics, environment, biodiversity

Keywords: Ultra-processed foods, animal calories, food systems, sustainability, human health

Introduction

In theory, sustainable food systems should protect the three dimensions of life on earth, that are human health, animal biodiversity and welfare, and environment. Yet, today, food system sustainability is threatened by excess animal and ultra-processed food calories (Figure 1), especially in Western countries, and more and more in emerging economies, where animal and ultra-processed foods are external signs of wealth (Fardet & Rock, 2018).

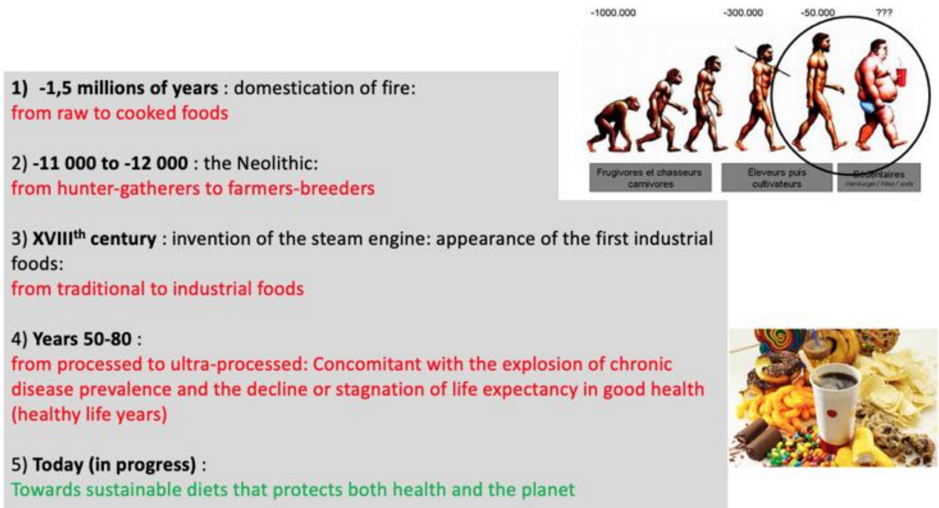
Figure 1: The different dimensions of food systems as threatened by excess animal and ultra-processed calories



Before this last dramatic nutritional transition, which especially amplified after the Second World War, humanity faced three main other nutritional transitions (Figure 2) : 1) from raw to cooked foods with the domestication of fire (more than 1,500 000 years ago), 2) from Paleolithic to

Neolithic with the replacement of hunter-gatherer by farmer-breeder and the consumption of cereals, dairy products and farmed meat, and 3) from traditional to industrial foods with the invention of the steam engine, and the first industrial food, *i.e.*, tinned goods in 1795 by means of the canning process. The last transition occurred in the 50's after the Second World War and culminated in the 80's with the advent of marketing, big agro-food multinationals and the hyper-technology applied to our foods. This last transition has been largely ignored while it is crucial because it marks the passage from real to fake foods, from normally- to ultra-processed foods; this trend is concomitant with the worldwide explosions of the prevalence of chronic diseases that progressively substituted to infectious and deficiency diseases.

Figure 2: The five nutritional transitions that faced humanity



In this article, the link between excessive ultra-processed food consumption and food system sustainability will be explored, investigating beyond the excess animal-based food consumption. We will then propose a simple, qualitative, scientific and holistic rule to counteract the degradation of food system sustainability. This rule for protecting both human health and planet is based on the observation - in scientific literature - that complex human diets own three main important dimensions: the plant/animal-based food ratio, the degree of processing, and the diversity (Fardet & Rock, 2018).

Ultra-processed foods and food system sustainability

Definition: how to identify them?

Ultra-processed foods have been first defined around the year 2010 by a Brazilian epidemiologist *via* the NOVA classification (Monteiro, 2010; Monteiro, 2009), then in 2014 in the Brazilian Dietary Guidelines (Ministry of Health of Brazil, 2014) and through comparison with other classifications (Moubarac et al., 2014). To summarize, ultra-processed foods are characterized in their formulation by the addition of cosmetic ingredients and/or additives for primarily industrial use - and having undergone an excessive processing - to mimic, exacerbate, mask or restore sensory properties, such as aroma, texture, taste and color. It can also involve denaturing technological processes directly applied to original foods, such as pre-frying, extrusion-cooking, puffing or extreme refining. As stated by Monteiro et al. (2019): "*Generally, the practical way to identify if a product is ultra-processed is to* *check to see if its list of ingredients contains at least one item characteristic of the ultra-processed food group, which is to say, either food substances never or rarely used in kitchens, or classes of additives whose function is to make the final product palatable or more appealing (i.e.'cosmetic additives').*" (Monteiro et al., 2019). The authors added: "*Food substances not used in kitchens appear in the beginning or in the middle of the lists of ingredients of ultra-processed foods. These include hydrolyzed proteins, soya protein isolate, gluten, casein, whey protein, 'mechanically separated meat', fructose, high-fructose corn syrup, 'fruit juice concentrate', invert sugar, maltodextrin, dextrose, lactose, soluble or insoluble fiber, hydrogenated or interesterified oil; and also, other sources of protein, carbohydrate or fat which are neither foods from NOVA group 1 or group 3, nor culinary ingredients from NOVA group 2. The presence in the list of ingredients of one or more of these food substances identifies a product as ultra-processed [*…*] Cosmetic additives include flavors, flavor enhancers, colors, emulsifiers, emulsifying salts, sweeteners, thickeners, and anti-foaming, bulking, carbonating, foaming, gelling and glazing agents*." (Monteiro et al., 2019).

In others words , ultra-processed foods are the symbol of the artificialisation of our foods through cosmetic ingredients and/or additives, with the purpose of exacerbating organoleptic food properties that are color, aroma, taste and texture (Fardet, 2019; Fardet & Rock, 2019). This is very profitable for three reasons: 1) one can continue to eat the food because pleasure overcomes satiety; 2) one redeems the product; and 3) children are targeted from a very young age, they can become customers for life, with the dramatic consequence of keeping them away from organoleptic properties of real/homemade traditional foods.

More generally, ultra-processed foods developed worldwide for three main reasons: 1) hyper standardized and easy-to-access sensory attributes; 2) their low cost due to the replacement of real foods by artifices such as aromas; and 3) being very practical and having an increased shelf life. Finally, agro-food industry has taken over from mothers who, in the old days, cooked at home. Foods at very low cost and time saving have also greatly contributed to increase the offer of ultra-processed foods.

Worldwide consumption and sale growth rates

Consumption of ultra-processed foods is high in Western countries, especially Anglo-Saxon nations, with 307 kg/year per capita in USA, followed by Canada (230 kg), Germany (219 kg), Mexico (214 kg), Belgium (210 kg), Australia, Norway and UK (> 200 kg/year) (Pan American Health Organization, 2015). Conversely, it is still low in India (7 kg), and some African, South-America and Asian countries (< 100 kg) (Pan American Health Organization, 2015). However, the growth rate of sales is very high in emerging countries, with an 115% increase in sales between 2000 and 2013 for the Asia-Pacific region, 71% in Middle East and Africa, and 73% in Eastern Europe (Pan American Health Organization, 2015). Overall, the world growth was 44% during this period. Finally, the market share of ultra-processed foods is the highest in Asian and Pacific countries, with 29.2%.

In France, the consumption of daily ultra-processed calories is almost of 40% of the total calorie intake (Julia et al., 2018), with 71% of packaged foods in large and medium-sized stores (Frank et al., 2018), and around 26% in organic stores (Desquilbet et al., 2018).

In emerging countries, such as India, China, and some South-American countries, these foods progressively substitute real foods, causing an increasing prevalence of overweight occurrence, obesity, type 2 diabetes and hepatic steatosis (called the "disease of sodas").

Ultra-processed foods and human health

The issue of ultra-processed food consumption and human health has been recently reviewed (FAO et al., 2019; Fardet & Rock, 2019). Today, more than 35 epidemiological studies have been carried out since the year 2010. These studies showed a significant increase in the risk of overweight, obesity, adiposity, metabolic syndrome, type 2 diabetes, hypertension, hypercholesterolemia, total and breast cancers, cardiovascular diseases, irritable bowel syndrome and functional dyspepsia, asthma and wheezing, frailty, depression and mortality. To establish a causal relationship established by the latest epidemiological studies, current research focuses on additives (alone or as a cocktail) featuring ultra-processed products. Another explanation behind this negative health impact can consider first the artificialization of food matrices as primary cause, leading people to consume more calories, salt, sugars, saturated fats and additives than necessary, then affecting the physiology (overweight), before resulting in more severe diseases. Indeed, hyper-attractive and hyper-addictive foods prompt consumers to consume beyond their real nutritional needs (Hall et al., 2019). Moreover, four characteristics of these foods have been identified as being deleterious to health (Figure 3) (Fardet & Rock, 2019):

1) "empty" calories, devoid of protective micronutrients for preventing chronic diseases, *i.e.*, fiber, vitamins, minerals, and antioxidants;

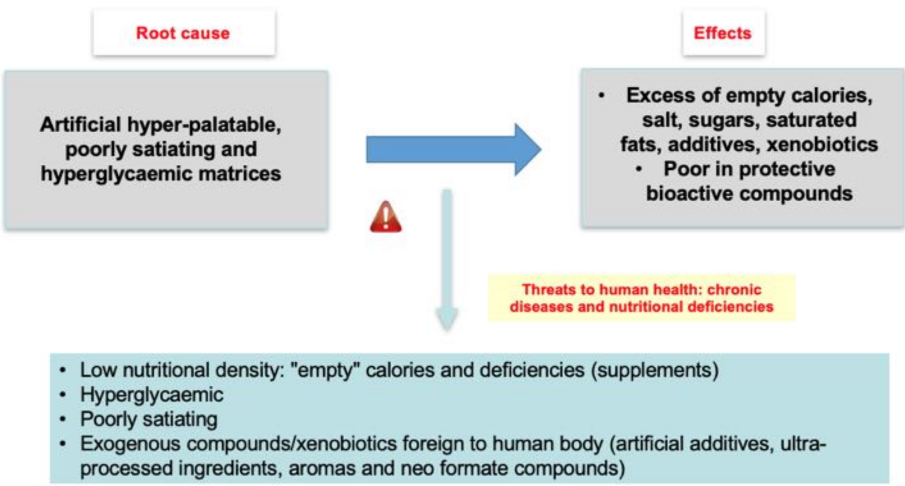
2) hyperglycemic foods;

3) Poorly satiating foods;

4) the presence of numerous xenobiotics such as neoformed compounds, synthetic additives, ultra-processed ingredients (*e.g.*, invert sugars, glucose-fructose syrup, hydrolyzed protein, hydrogenated oils, etc.), and potential migrating compounds from packaging.

This cocktail, when regularly and highly consumed, makes the bed of metabolic deregulations (weight gain, insulin-resistance, metabolic syndrome and hepatic steatosis), leading to more serious and/or fatal chronic diseases such as non-alcoholic steatohepatitis (NASH), type 2 diabetes, cardiovascular diseases and some cancers.

Figure 3: Ultra-processed food characteristics that are deleterious to human health



Ultra-processed foods and animal well-being and biodiversity

Due to interrelated low cost and massive consumption through the economy of scale, animal calories from ultra-processed foods can only come from intensive livestock. In such a system, animals are raised in extreme conditions, not always respectful of their fundamental needs and wellbeing, leading to animal suffering.

In France, 82% of animals are raised intensively, notably chickens, rabbits and pigs (more than 90%), while cattle are only 15% (Friends of the Earth Europe, 2015).

In the 1960s to 1970s, people began to pay attention to animal welfare in intensive breeding, after livestock and poultry husbandry changed from extensive range to intensive animal husbandry (Weary & Fraser, 1999). According to Li et al. (2015) "*animals' living environment, quality of life and behavior need are far from satisfied, and animal welfare has not been improved fundamentally*" (Li et al., 2015, p.284). In intensive livestock and poultry breeding, animal welfare is not guaranteed, affecting the quality of the animal products (Li et al., 2015). For example, sows in intensive pig farms are often confined in cages (sow stalls) that are a little bigger than their body (Caulfield & Cambridge, 2008).

he idea of refusing to sanction change unless supported by scientific evidence maintains this situation (Caulfield & Cambridge, 2008). Yet, "*the criteria for assessing welfare should not be restricted to consideration of scientific evidence alone, but should be widened to encompass moral and ethical considerations*" (page 446) (Caulfield & Cambridge, 2008). As stated by the AVMA (American Veterinary Medical Association) Task Force, more science is not going to resolve the issue (Caulfield & Cambridge, 2008). Since the management of farm animals must take into account their physiological, social and behavioral needs, organic systems are probably a relevant solution for optimal welfare (Gade, 2002).

For example, by 1999 onwards, literature shows some description of the potential causes of suffering for turkey broilers in intensive conditions, including several main trends: 1) genetic selection of fast growing strains has increased locomotory problems, and made natural mating impossible; 2) high stocking densities have several drawbacks such as poor air quality, cannibalism and impairment of the gait of the birds; 3) A range of different photoperiods are used in practice, and have many consequences for welfare; 4) transport and slaughter are further causes of poor animal welfare (Martrenchar, 1999).

More science has been developed to improve animal farming in these intensive conditions. However, one can also consider that animal welfare is more an ethical issue than a scientific one: it is easy to know whether animals are suffering or not. The idea behind more science may well be to always move back the time for the adoption of more restrictive measures for breeders.

Ultra-processed foods and environment: pollution, deforestation, greenhouse gas emissions

Excess ultra-processed food consumption is threatening the environment, through mainly pollution, deforestation and greenhouse gas emissions. These are overpackaged foods, especially sodas, leading to plastic pollution in oceans, or the deforestation for providing more soy for animal feeding and cheapest animal calories, notably in Western Europe. As stated in the 2014 Brazilian Dietary Guidelines: "*The need for cheap oils, sugar and other raw materials for ultra-processed foods creates monocultures and farms producing for export and not for local consumption. Intensive farming of raw materials is* *dependent on pesticides and intensive use of fertilizers and water. The manufacture and distribution of most ultra-processed foods involves long transport routes, and thus excess use of non-renewable energy and water, and emission of pollutants. This all results in environmental degradation and pollution, loss of biodiversity, and draining and loss of water, energy and other natural resources. Production and consumption also cause creation of vast amounts of waste and garbage, dumped in disgusting and dangerous landfill sites. Overall, ultra-processed foods are a serious threat to the sustained survival of the planet*" (Ministry of Health of Brazil, 2014).

Today, it is also more profitable to sell the isolated ingredients of foods than the original complex raw food. A few foods, cultivated in intensive conditions, are then cracked in many isolated ingredients and nutrients, and are recombined worldwide into the form of ultra-processed foods. They are mainly soy, pea, wheat, maize, rice, potatoes, milk, eggs and meats. It is easy to guess that this is largely more energy-consuming than the original raw food locally produced and consumed.

Ultra-processed foods and socioeconomics

In theory, sustainable socio-economics corresponds to food systems that allow all the actors of the agro-food value chain to decently live from their work; but also, to supply to everyone foods of high quality regardless one's income or education, and to preserve social life. With ultra-processed foods, these dimensions of sustainability are not achieved. The poorest and less educated are the highest consumers of ultra-processed foods, which are the cheapest types of available calories. In USA, ultra-processed foods are almost 62% less expensive than un/minimally-processed fresh foods (Gupta et al., 2019).

Concerning the agri-food value chain, in a country like France, for every 100 euros worth of food, the farmer only gets 6%, while mass retail and the food industry take the rest. This disproportion does not allow farmers to make a decent living, resulting in a continuous decrease of the number of farmers and increased suicide levels.

Due to their very low price and high attractiveness, it is assumed that ultra-processed foods may substitute to local and traditional foods, especially in emerging and developing countries. This approach is threatening small farmers, who are then obliged 'to put the key under the door' and to move to urban areas, adding to the ever-increasing slums. For example, in Africa, it has been observed that the import of chicken wings destroys local companies (Friends of the Earth Europe 2015). Indeed, the processing of slaughtering by-products into animal feed is prohibited for European poultry companies, but allowed to cheaply export them to developing countries. This is only one example among others - *e.g.*, excess milk in Europe first dried and then exported to Africa where it is sold cheaper than local milk.

As reported by Johnston *et al.* the reason lies in the fact that "*current government subsidies to farmers in the United States and parts of Europe enable developed countries to produce large quantities of cheap staple and ultra-processed foods at 40–60% below the cost of local production of similar goods in developing markets (Action Aid, 2002). In turn, these less healthy foods as imports are considerably less expensive than the locally produced foods, distorting local markets and depressing demand for the more expensive, locally produced, and oftentimes healthier food options (Affairs, 2011)* " (Johnston et al., 2014).

As written by an unknown author in 2005 in the journal Revue Tiers Monde: "*How many countries have paid a heavy price for having sacrificed, if not more, their peasants on the pretext of providing sufficient basis for industrial development by imposing leonine terms of exchange on peasants without impelling the modernization of their agriculture? How many countries are experiencing stagnation, a social regression, even a break in their social* *cohesion, for having simultaneously precipitated this modernization of their agriculture, expelled the poorest and least protected peasants, finally surrounded the cities of shantytowns where they are crammed together, forced to sell their labor power for misery income in informal activities of strict survival?*" (Unknown, 2005).

Finally, as stated in the Brazilian Dietary Guidelines: "*Ultra-processed foods are formulated and packaged to be ready-to-consume without any preparation. This makes meals and sharing of food at table unnecessary. Ultra-processed foods can be consumed anytime, anywhere, often when being entertained or when working, walking in the street, driving, or talking on a phone. These are mostly isolated situations, which are disguised by advertisements suggesting that such products promote social interaction, which they do not*" (Ministry of Health of Brazil, 2014).

Ultra-processed foods, culture and culinary traditions

As stated in the Brazilian Dietary Guidelines: "*Brands, packages, labels, and the contents of ultra-processed foods tend to be identical throughout the world. A type of soft drink made by one giant manufacturer is essentially the same the world over. Types of burger made by various manufacturers are much the same everywhere. Leading brands are promoted often using the same entertainers, models, music and slogans everywhere, including on television, the internet and social media. They are disseminated by means of intensive and aggressive advertising campaigns, including the launching of hundreds of new products every year, which leads to a false sense of diversity. Because of these campaigns, genuine food cultures come to be regarded as uninteresting. All this pushes a sense especially to children and young people that the culture and identity of their own country, region, ethnicity and tradition including food culture and patterns, are boring. Young people especially are being induced by major manufacturers, in effect acting in concert, to have a false sense of belonging in a superior, modern, high cost and expense consumer culture*" (Ministry of Health of Brazil, 2014).

If food standardization obviously allows a strict and efficient toxicological and hygienic control, conversely, such standardized foods are mainly ultra-processed and unhealthy foods: food safety has somewhat replaced food diversity, and substitutes to more healthy foods. In Western and emerging economies, the populations no longer die from food toxins but from chronic diseases, and they suffer from deficiencies, because empty calories from ultra-processed foods do not supply enough protective micronutrients (Cornwell et al., 2018; Fardet et al., 2017; Gupta et al., 2019; Louzada et al., 2015; Luiten et al., 2016; PAHO & WHO, 2019; Rauber et al., 2018).

Food standardization is also accompanied by standardized tastes worldwide (Alpha, 2007; Fumey, 2007). Consequently, vacationers and travelers may well prefer to buy ultra-processed foods abroad with no risk to dislike the product than testing a local dish with the risk of not liking it while paying for it. The same is true for children, in contact with standardized taste when very young, and who later reject real foods with subtler tastes. One can also observe that in most countries the increase of living standards often translates into a decline in the consumption of traditional food is a shift towards a certain homogenization of the way of eating, towards the offer of agro-food industries of more animal and ultra-processed food calories, often considered by national policies as a demand, and by populations as outward sign of wealth.

The 3Vs rule for protecting food system sustainability

Too many animal calories

Beyond excess ultra-processed calories (see above), excess animal calories has been consistently associated with increased risks of some leading chronic diseases such as colon cancer/adenoma

(Aune et al., 2013) and cardiovascular diseases (Chen et al., 2013; Micha, Wallace & Mozaffarian, 2010). This led French authorities to propose limiting animal-based foods in national recommendations (ANSES, 2019; Nutractiv & Ligeriaa Pays de la Loire, 2018). The process is also associated with increased greenhouse gas emissions (Tilman & Clark, 2014; Willett et al., 2019), potentially leading to global warming as regularly pointed out and published by the Intergovernmental Panel on Climate Change (IPCC). Presently, there is no need to demonstrate that meat-rich diet is no more sustainable (Wageningen University, 2019).

On the contrary, high consumption of plant-based foods (*i.e.*, fruits and vegetables, wholegrain cereals, nuts and seeds, legumes, and tubers) have been consistently associated with reduced risks of chronic diseases and metabolic deregulations (Fardet & Boirie, 2014; Qian et al., 2019; Yokoyama et al., 2017).

For the future, the plant/animal ratio therefore appears as an important dimension for defining sustainable diet for health and environment.

The 3V rule basis

15% maximum animal calories

Several institutions have defined a sustainable diet for the future, taking into consideration human health and the environment (Stolze et al., 2019; Karlsson et al., 2017; Le Mouël et al., 2018; Solagro, 2019; Willett et al., 2019; WWF France, 2019). The recommended servings or grams of animal products reach an average of 15.5% of daily animal calories. Then, when considering traditional protective diets worldwide, such as Okinawan (Willcox et al., 2014), Mediterranean (Martinez-Lacoba et al., 2018), and Nordic/Baltic (Meltzer et al., 2019) diets, and also *a posteriori* scientific protective diets such as DASH (Mohsenpour et al., 2019), prudent (Enas et al., 2003), anti-inflammatory (Tolkien et al., 2019), and vegetarian (Parker & Vadiveloo, 2019), , our calculation also resulted in 15.5% calories for daily animal products intake. Both foresight and actual protective diets therefore converge towards ⊕15% daily animal calories.

In comparison, the average nationally recommended animal calories from 37 countries is 21.9% (Scherer et al., 2019), with the French Programme National Nutrition Santé (PNNS) corresponding to ⊕30% animal calories.

15% maximum ultra-processed calories

For defining the maximum daily ultra-processed calories, we selected epidemiological studies investigating the association between overweight/obesity risk and the consumption of ultra-processed foods (Canella et al., 2014; Canhada et al., 2019; Juul et al., 2018; Louzada et al., 2015; Mendonca et al., 2016; Nardocci et al., 2019). This method was used for two main reasons: 1) it is the most studied health outcome with ultra-processed foods, and 2) overweight/obesity is the first step to more serious - even fatal - diseases, such as some cancers and cardiovascular diseases (Fardet & Boirie, 2013). On average, the maximum ultra-processed food caloric threshold for which obesity risk begins to increase is 24.5%, and the precautionary ultra-processed food caloric threshold is 14.1%, from which a +⊕29% increased risk of overweight/obesity was observed in two studies (Canhada et al., 2019; Louzada et al., 2015).

Varied, if possible organic, local and seasonal

In addition to the plant/animal ratio and the degree of food processing, a third and basic dimension can be added to a diet. Indeed, in order to meet all nutritional needs, it is important to eat "varied": both plant- and animal-based foods, and include different food groups, *i.e.*, fruits and vegetables, whole grain cereals, legumes, tubers, nuts and seeds, algae, white and red meats, insects, seafood, dairy products, egg-based products, and offal.

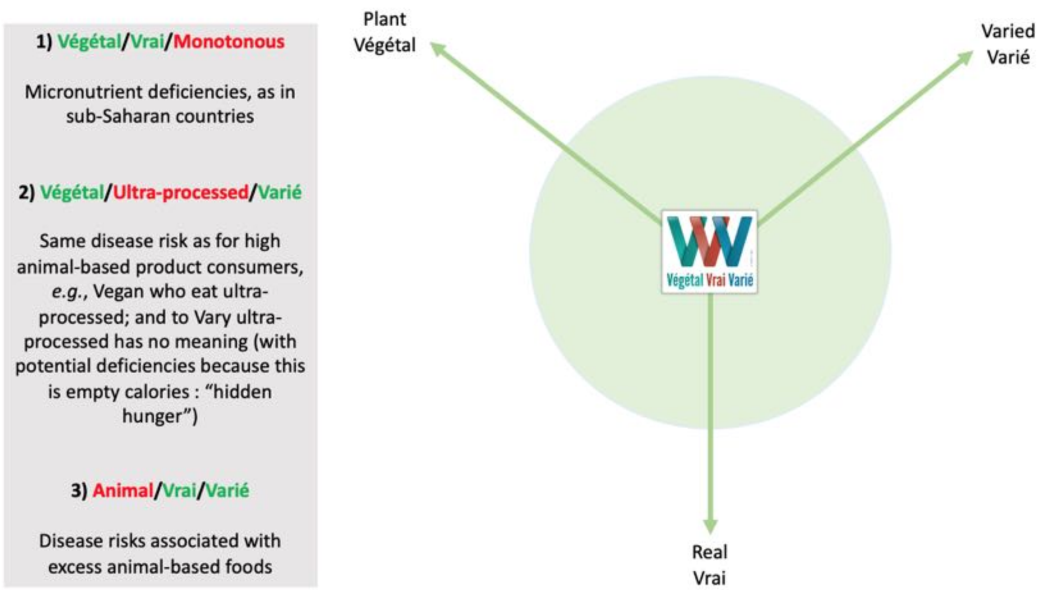
This is not only important for human organism metabolism but also for the environment, because eating "varied" stimulates planetary biodiversity, polyculture, genetic biodiversity, and food system resilience, especially towards forthcoming climatic changes.

Further environmental impacts (*e.g.*, greenhouse gas emissions and pesticides) and xenobiotic consumption may be also reduced when trying to consume organic, local and/or seasonal.

The 3 rules are interconnected

The above-mentioned 3V rule is therefore based on three interconnected fundamental dimensions of a sustainable diet (**Figure 4**). They are qualitative, and easy to appropriate for the general public without high level of knowledge in nutritional and food sciences. However, if one dimension is lacking as developed below, the diet is no more protective against human health and planet as a whole.

Figure 4: The interconnectedness of the 3V rule



Animal/Vrai/Varié

Although we eat real and varied foods, if our main daily calorie basis is animal products rather than vegetal ones, then deleterious impacts can be seen for our health and the environment.

This is yet the case for the Inuits diet, mainly based on animal products. However, this is a niche population that has specifically evolved for thousands of years with its particular environment.

Compared to the whole Canadian population, their life expectancy is around 10 years less. It is therefore important to point out that a 3V rule-based diet is for the general worldwide population that has reached today over 7.7 billion people. Extrapolating Inuits' diet to world population is not possible today.

Végétal/Ultra-Processed/Varié

Following only rules 1 and 3, *i.e.*, Plant food-based & Varied, but not the second rule for "Real" foods, *i.e.*, limiting ultra-processed foods, can also be problematic. For example, some vegetarians and vegans may consume many ultra-processed plant-based products offered by agro-food industry. In this case, as shown in a longitudinal study, the risk of coronary heart diseases is quite similar to those consuming high level of animal calories (Satija et al., 2017). Besides, when consuming many ultra-processed foods, the third dimension "Varied" has less interest because ultra-processed foods are "empty" calories that can lead to nutritional deficiencies, called "hidden hunger".

Végétal/Vrai/Monotonous

Finally, as observed in Sub-Saharian African and South-Asian countries, it is not sufficient to eat many plant-based and minimally processed foods, but also "Varied" ones. Indeed, often, their diet tend to be monotonous, mainly based on the same cereal and/or legumes, leading to potential nutritional deficiencies. For example, in Laos, white refined glutinous rice is more than 50% of daily calories, with potential deficiencies in vitamin A.

The regionalization of healthy diets: declining the 3V rule according to local specificity

The last concept we want to develop is that of the « regionalization of the healthy 3V rule-based diet ». These rules are very generic, allowing their declination according to the specificities of regions worldwide, depending on pedo-climatic, agronomic, urbanization, social, and/or culinary tradition related factors. The 15% maximum animal calories may vary according to culinary traditions, with insects in Asia, dairy products in Western countries, fish and seafood in coastal regions, cheese and red meat in mountain regions, etc. The same is true for the main plant sources: fruit, vegetables, grains and nuts may be adapted to local climate, and culinary traditions. Such regionalization is necessary in order to avoid dogmatic protective diets, and to vary food sources.

The case of France

The case of France is interesting because the French population is used to a daily consumption of up to 40% of animal calories, (ANSES, 2017), and up to 40% of ultra-processed calories (Julia et al., 2018). A question arises: "by what to replace the +25% animal excess and ultra-processed calories?" Probably the most sustainable solution is the increase in product offer, and then a replacement by wholegrain cereals, legumes, and nuts and seeds, being all under-consumed below 14 g/day (Fardet & Rock, 2018). In addition, they are sustainable crops, especially legumes, and are rich in complex carbohydrates, proteins, and lipids, respectively. They concentrate both a high energy and nutritional density, and a high level of fiber.

The challenge here is to tend towards this flexitarian diet in which animal calories accompany plant calories, not the contrary. This is a revolutionary dietary transition!

Conclusions & Perspectives

This holistic integrated and scientifically-sound 3V rule is well adapted to the large public because the science-society interface is holistic and qualitative. These rules also avoid the single-nutrient approach with no mention of nutrients. Adopting these rules allows, without having to worry about them, to meet all DRI (Dietary Recommended Intakes), and other nutritional needs, with low levels of salt (< 5 g/day), saturated fats (< 10% daily calories), added sugars (≤ 10% daily calories), and a low omega 6/omega 3 ratio (< 5).

The 3V rule can be compared to Russian dolls: the more global and holistic the target for public recommendation, the more sustainable it is, encompassing in the long term numerous dimensions of food system sustainability. Thus, the 3V rule is the biggest Russian doll, acting as an umbrella guideline for the food system. However, if your public target is a small Russian doll, only a few dimensions will be considered. For example, if we recommend "less sugars", animal wellbeing is not taken into consideration, nor the degree of processing, etc.

By tending towards the 3V rule, one can act locally through one's own consuming style, and have a global impact. Another issue is also the international/local food ratio. Which percentages to reach? Probably the international food share is today too high, and it is no more adapted to ensure environment protection. We suggest that increasing consumption of local foods can be safe, even for ensuring food security.

As perspectives, an interesting interventional study could be to select a population of people very far from the 3V rule (high in animal and ultra-processed calories), and asking them on several years to tend towards the 3V rule. The aim of such study would then be to measure physiological parameters, chronic disease prevalence, and others.

Other foresight studies could be to calculate, for several countries worldwide, the adequacy to the 3V rule, in order to identify relevant levers to improve food system sustainability.

Finally, behind the 3V rule there is a considerable amount of scientific data converging towards this protective generic diet. We therefore propose that such a diet could be a relevant basis for future recommendations, but also to communication to large public, together with emphasis on school education.

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Sustainable consumption on the crossroad between individual and collective needs. Chances of the concept of social identity

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Abstract: Sustainable consumption is one of current challenges of the global world in front of the climate change causing many economists and other social and political researchers to explain this phenomenon and find instruments to encourage it. Among them we can find heterodox economics which is based on anthropological assumptions that differ from those in neoclassical economics (homo oeconomicus). For instance, institutional, ecological or humanistic economics embed their concept of human nature in social and to some extent in natural environment. The focus on the social dimension awakes interest in the relation between individual and social (collective) needs. The goal of the paper is to outline the possibilities to conceptualize sustainable consumption not only as an individual need but as a collective one. Doing so, the paper indicates on the limitations of standard economic theories that are focused on individual preferences. The article considers behavioral, institutional, ecological and humanistic approaches in economics. It shows how these approaches solve the dilemma between individual and collective needs in the context of sustainable consumption. Although some of them, such as institutionalism, ecological economics or the humanistic economics, open to us other than market opportunities - pointing to the role of rules and norms shaping economic activity, they do not explain how collective needs may be perceived as a part of individual choices and not something external. The concept of social identity explains this problem. It clarifies the identification processes in individual groups - which can contribute positively or negatively to sustainable consumption. These multiple identities are created in interacting systems (economic, political, social, cultural). For this reason, when looking at sustainable consumption, we should search for an integrating approach – allowing to capture the complex nature of the sustainable consumption. The latter as a collective need may be considered as individual one via multiple identities shaped by various systems.

Keywords: social identity, sustainable consumption, preferences, individual and collective needs

Introduction

Sustainable consumption is the challenge of current sustainability policy. What kind of problem is it? How we as economists may explain it? How can we extend the perspective of economics to its new, non-mainstream directions to explain this phenomenon?

Sustainable consumption is seen by politicians as one of important goals towards achieving of **sustainable development**. It is one of the goals of Europe 2020 strategy, of climate summits, and especially of the SDG (Sustainable Development Goals) – *Global Goals for Sustainable Development* – where the 12th goal is *Responsible Consumption and Production*. These programs are dealing with the already existing *unsustainability* which denotes the lack of long-term environmental sustainability. *The latter is characterized by falling stocks of natural resources, increasing concentrations of pollution in environmental media, or loss of nature and biodiversity* (van den Bergh, 2010, p. 2048). These are legitimate motivations, but how we may approach this challenge by economics?

There is a big gap between sociological, psychological and economic literature studying the phenomenon of consumption. Can we, however, include some of the psychological and sociological reflections we have in the expansion of the economic perspective so that we can better understand the causes of unsustainable consumption, the factors explaining it, or the factors that would favor sustainable consumption.

Within psychology and sociology, as well as slowly and economics, there is a reflection that identity can be helpful in explaining many human decisions, including consumption. Economics is there no exception. Some economists are even talking about the *identity economics* (Akerlof et al., 2017; Akerlof & Kranton, 2000; J. B. Davis, 2019; Fine, 2009; Horst et al., 2007).

The main challenge in **sustainable consumption** is not only to increase the emission efficiency in current production (which is characteristic for weak sustainability), but rather to change the structure of resources used – and limit it to the renewable resources (strong sustainability). Moreover, it means a reduction of consumed goods and services to these limits but on the same time to meet our needs in the best way, and not reducing these needs for future generations. Nevertheless, even reducing the production level to renewable recourse usage level won't permit for absolute longevity. This is because of rising entropy of the our global system (Georgescu-Roegen, 1987).

Sustainable consumption is therefore not only to meet the economic criterion, i.e. production at the lowest cost, or even the production of goods at the maximal energy efficiency. Rather, it should satisfy people's needs with smaller number of products, in order to minimize the negative impact on the environment, by using (absolutely and not only in terms of efficiency) less energy, and less raw materials. Staying before the necessity to reduce the usage of natural resources we have to affront a question what our needs are. And further weather it is still reasonable to speak about individualist preferences which base on assumption of unsatiated needs. Maybe we should refer to such theories of needs which let us distinguish between more fundamental or less important needs. We must answer these questions before we proceed with further considerations.

Sustainable consumption in the light of individual and collective needs

Let's start with the colloquial statement that preferences not necessary respond to our needs. Needs have their own structure (individual and collective), and we will show them in the context of sustainable consumption and the problem of identity. This topology of key concepts will allow you to look at the possibilities of embedding this problem in various economic theories.

Preferences are an economic concept, referring to whether we prefer one thing over another, or rather how much we are ready to buy at given prices. It is assumed that a person knows what s/he wants and knows his/her preferences. Therefore, it would be more reasonable to refer to individual needs, assuming that when buying humans satisfies their wrong or well identified needs (and sometimes the needs of others), not necessarily realizing what exactly they are. Of course, we may and maybe should ask whether what we prefer (preference) actually meets our real needs? This question was discussed among others by Max-Neef (1991), who introduces differentiated matrix of needs and satisfiers. To the latter counts among other violators – goods consumed (and so – preferred according to the revealed preferences concept of Samuelson (1938)), which don't satisfy our needs. Why are their consumed at all? Max-Neef is referring here among others to the misleading information of advertisement. Summarizing, when speaking about individual approach to sustainable consumption, assuming that natural resources are limited, and consumption should be limited, the focus on satisfaction of needs and not of preferences seems more rational.

However, we may perceive the sustainable consumption as a collective need, and more precisely – the **need of the collective**. Where is the difference? If we think about **individual needs** (like food, sleeping, clothing), we usually refer to something what we need for ourselves, and can consume to great extent through the market. But we have some individual needs, which we can't buy on the market. We can count here for instance a clean the presence of various species, water availability, a climate that does not threaten the lives of our children. These needs are our still individual needs but with a 'collective' character (let's call them *'collective' needs*) – in the sense 'collective', that I can achieve them under the circumstance that other individuals will as well achieve them. These needs bring us closer to the concept of **needs of the collective** – needs of the whole society. This time in the sense, that if not met, they may lead in worst case to the collapse of the society – in sense that the society won't be able to survive and to live (sustain). In less drastic case, they may cause the society less stabile – socially unsustainable. This process is manifested by social exclusion, growing division between rich and poor, missing safety, diminishing presence of public space. Eizenberg and Jabareen 2017 discussed this issue referring to social components of sustainability. On the contrary, sustainability enhances the durability of the society – giving the future generations the possibility to exist, improving quality of community life (e.g. by stopping the climate crisis in our lifetime, improving air quality, preserving the diversity of species). Of course, the consequences of meeting such collective needs may be positive for the individual and may answer to his/her 'collective' needs.

Unfortunately, these needs may be impacted negatively by our excessive private consumption. Even if meeting them is in our interest, we don't have the control over their achievement, and so their value for us in the everyday consumer choices is underestimated (using the language of neo-institutionalists we have here the case of wrongly ascribed property rights). Moreover, in some cases the environment especially its state in the future may not have the same value for each individual and so won't appear on their preferences curves. We can imagine people who won't live any longer, and don't have children or from other reasons aren't interested in the durability of our civilization. But, even if they counted, it is not the effect of my choice counts, but a cumulative effect of many people's actions over time.

Although, sustainable development is in the interest of society today perceived as the whole (*collective need*), we may ask if this is the **collective preference**? When we assume the concept of revealed preferences, the answer will be 'no'. This is because we are expanding and not limiting our consumption level when it comes to food consumptions, the flat dimensions and one-way products, or products of short living. Similarly, even if sustainable development is interest of the society as whole, many of it may oppose certain political instruments – attempting to reduce the consumption. For instance, actions like rising fuel prizes or limits for car usage evoke still many protests (in France for instance). It's not only because people may value negatively such movements calculating its consequences for them in terms of the rise in costs, but that they may fear the negative effects on economic growth, their workplace etc. For the long time, the society was consciously and unconsciously fed with the idea dissipated by economic policy makers and media, that the rise in demand is necessary for the prosperity. Perhaps that is why there may be no collective preference for imposing restrictions on consumption.

So, sustainable consumption - enabling the continuation of society and its further development (for future generations), allows to meet not only some of the vital basic needs (such as health) but it constitutes the basis for a more sustainable fulfillment of private needs, is considered a need of a collective, much more than an individual need.

Why is the **change of terminology** (both speaking on the individual and collective level) so important - from preference to needs? Needs can be discussed, generalized, presented for debate. We are referring not to an unique individual whose preferences can't be compared to another individual but we try to find interpersonal similarities, which may be the basis of constructing the social or political order. This is a starting point for a creation of a list of basic needs (in sense of Nussbaum, 2003) which can be put for the debate and allow to take political decisions in situations where the market fails. Relying on the majority assimilates market mechanisms and does not provoke the discussion about the needs which may then foster the communication within the society. Arguments and reasoning are more legalistic way of thinking, where one provides *ratios* and criteria which should be observed if taking a decision (for instance public discourse, based on an approach developed by Habermas, 1991). Staying with the terminology of preferences we give the last voice to the market, which is then the only instance able to harmonize the preferences not transferable to the common denominator. In case of the decisions beyond market, it will give the last voice to the principles on which it is based (utilitarianism).

The example of cigarette consumption can allow us to understand the complexity of the problem of sustainable consumption and look at this issue in the context of individual and collective needs. A person who smokes not only pollutes the atmosphere but exposes other people's health to so-called passive smoking. The smoker is likely to get ill (for instance cancer) - and hence he/she will require society to partially cover his/her treatment costs. At the same time, if actions were to be taken to reduce smoking, smokers may notice that smoking is their preference and even a need. Smokers, if there were more of them, could vote that freedom to smoke everywhere is a collective preference. And yet, in politics, solutions have been introduced that pose multiple restrictions on such consumption, limiting consumer freedom and not allowing him/her to decide everything. The question, of course, was how to implement this policy direction basing on economics? Is the price incentive alone sufficient? The addicted person is able to pay even more and rather limit the consumption of other products important for his/her health. The example shows how unbalanced is individual consumption in the sense that it does not meet the needs or impedes human development, at the same time limits common resources, depleting the possibility of satisfying collective needs. It consumes raw materials that could be used differently, contributes to pollution in the production process (emissions), leads to health loss in the utilization phase and to pollution in a disposal phase (slowly decomposing waste).

Discussing this issue, we refer not only to 'what is' to what is considered 'desirable' - which sets the course of action for us. After all, a person who smokes often values health, and a person who uses an airplane actually loves nature. However, there is still something which prevents these persons or whole societies to achieve their goals or values. A person struggling with his/her addiction, although s/he still prefers' cigarettes, is able to buy them, although these products are not good for them, and don't actually count to needs but to wants.

The smoker doesn't change his/her preferences easily, but he/she may seek a therapy or help, limiting the availability of cigarettes. In other words, the smoker shapes his/her surroundings to cope. An important step, however, is for him/her to become aware of this problem and yet to distinguish that preference cannot be equaled to needs. Preference is a **real state** (i.e. not necessarily what we want to consume, and we consume), **need is a desirable state**.

Similarly, the society which copes with unsustainability, has to change its legal environment and does not leave it purely to current political decisions, but it creates appropriate institutions, introduces legal norms and spends funds for various campaigns. Doing so, it makes itself committed to a certain strategy of action. The society may as well look for the empowerment in certain values enabling communication of it actions to their member- e.g. protection of the highest good - health.

Concluding, the problem of sustainable consumption is very complex, often requires normative judgments and state interference in the market, creation of institutions and changes in the set of values. Not only the ecological values have to be stressed but also for instance 'health' value which has a very high rank in the list of values. For example, the treatment of diseases caused by excessive consumption and related pollution, depletes the stock of jointly used collective goods - access to medical service, fresh air. This issue is addressed by the concept of **suspended identity** between the *present* I and the *desired* I and the *ideal* I (Higgins, 1987), which, if transferred to society, would look like this: **actual state of society - perfect (vision of society) and desired** (what expectations in relation to society has the world, other countries).

Sustainable consumption as a collective need? Possibilities of conceptualization under various economic approaches.

The sustainable consumption as an economic problem founds its place in various economic **theories.** A person guided by his/her own interests has a difficulty to consider in his/her choice **collective needs**. The latter relate to the common good or common resources, i.e. all that is in the possession or use of society as a whole. Collective needs are understood in a different way within various economic theories. In every context of an evolving and changing economic theory or economic approach, it can have different connotations, distinctive meanings and lead to diverse political and economic reflections.

It is important therefore to find out how the theories conceptualize **collective needs**. It may be important for answering the question, how the collective need may be approached through the economic policy, in sense of direct impact on individual behavior via price system (tax incentives), or impact on preferences by information, or indirect impact through institutions impacting on the collective and through the collective on individual behavior. Last but not least, the level of individual consumption can be as well variated by the level of spending on 'public goods' (macroeconomic equation).

In the next section we will ask about the possibility to explain the possible ways to explain the relation between needs of collective (or groups) and individual consumption, which probably provide another instrument to impact on the individual choices via identity.

Mainstream approaches (neoclassical economics)

The neoclassical economics is focused primarily on the efficiency and is looking for most efficient solutions for dealing with limited resources under the assumption of unlimited needs and rational decisions of agents. Such a situation is granted by the market, where the products which are sold are mostly private - rival and excludable, other products like club goods may circulate by the market as well but less efficiently, due to the non-rival character.

It is acknowledged that there are some goods which can't be distributed by market efficiently due to their non-excludability. There are two kind of groups which we may count there – public goods (which additionally have the characteristics of non-rivalry character) and commons, which have a rival character – in sense that that if somebody is using them, the utility of such consumption is diminishing for other users. Both kinds of goods cannot be provided by the individual. In case of *public goods*, it is the government which is providing them. In case of *commons*, it is a community. The neoclassical economics acknowledge the importance of public goods for various reasons, however their provisions brings a risk of inefficiency, so there is an exchange between inefficiency and other reasons for which public goods are provided (Ramazzotti, 2018). The manner in which *public goods* are consumed is individual in nature, and often leads to their over-consumption or insufficient consumption. So, it may be concluded that the best way to distribute rare resources is to privatize them, which allows them to be used effectively.

Neoclassical theory is aware of some market inefficiencies - i.e. situations where *external effects* occur - i.e. when an individual or a company does not bear the costs of its activity (e.g. in the event of pollution) but shift these costs on the whole society, what limit the society in its attempt to meet the 'collective' needs. The theory of externalities within mainstream economics shows us that negative externalities should be neutralized by the state via market who imposes Pigou taxes and so in theory impact on the limitations of the production and so on emission. However, this may not solve the problem. People used to consume some products (like cars, big houses) – won't necessary lower the demand for some products due to high opportunity costs or because of the expectations formed by peer groups. They may be as well locked-in in the habits and accept higher price without lowering significantly the demand. The company consuming all available water and paying the highest price for it, still may cause the lack of water for ordinary people living in one region, who need it for the everyday usage. Pigou taxes is as well 'blind' for the scope of such production. It makes only difference between products which are highly emissive and low emissive. However, there are products moderately emissive, which are not very crucial for meeting basic needs, and there are high-emission goods- such as heating, which are necessary for survival (at least in cold countries). Already after presenting such a simple example, it turns out that limiting oneself to price mechanisms can harm prosperity as well as the basic principle of social justice.

Behavioral Economics

Behavioral economics analyzes limits of neoclassical theory in order to make its prognoses and models (after necessary corrections) more valid. It perceives the reason of the lacking sufficiency of price signals (like Pigou taxes), in the fact that people don't react necessary neither to price signal nor to information (which could affect the preferences) because their decisions aren't really rationally. This means that people not really maximize their utility but act according to some heuristics, which allow them to take decision faster (Kahneman, 2011). Moreover, they are sometimes locked-in in existing habits. The role of habits was already explained by Durkheim (1893), in the sociological work of Bourdieu (1990) and cognitive psychology (Aarts et al., 1998; Bargh, 1994). Counter-intentional habits (Verplanken & Faes, 1999) interferes substantially with the ability of the individual to make decisions in his or her own best interests.

So, there must be other ways to impact on people's choice in order to make them more considering the needs of 'collective' - like sustainability. This can happen if we understand the rules of people's behaviors (described by heuristics, nudges, theory of perspectives). By applying these rules, we can influence people to choose these products, or such consumption behavior (for instance – refusing to buy) which will meet the collective needs in a more satisfactory way. However, not because they are assumed to be more rational, but on the contrary - that they use limited rationality, which means that they do not always choose according to their preferences. For example, Venkatachalam (2008) analyzes the implications of using limited models of rationality in environmental research in general, and in particular in policy making. Here, he uses numerous psychological studies that have made it possible to formulate some heuristics governing human choices. They are extensively described by Kahneman (2003, 2011); Thaler (1980); Thaler & Sunstein (2009). The mechanisms that are used are e.g. the famous 'nudge', framing etc. Some of them are already widely used in promoting sustainable consumption, reducing food waste (Visschers et al., 2016), and learning new strategies for behavior.

One of these strategies for sustainability is **choice architecture or nudges** (Thaler & Sunstein, 2009) which may be applied in the policy. Basing on decision-making paradigms, like for instance **status quo bias or anchoring effects**, one may encourage the green consumption. In many cases, like for instance in **electricity**, a default option as a reference point may be set (biased towards more 'green' solution) which may increase green consumption (Momsen & Stoerk, 2014). Similarly, information feedback and framing of information work – informing households how much more or less than other neighbor energy they have used (Costa & Kahn, 2013). Similarly, changing framing in presenting damages and gains of green choices alters the conceptualization of green consumption (J. J. Davis, 1995; Hardisty et al., 2010).

But behavioral theory focusing on individualizing basic laws, may omit the aspect which for institutional economics is discussed explicitly – that the habits of mind depend on social and cultural context and developed within it: '*Habits of mind and behavior develop in a social and cultural context*' (Zey, 1992, p. 14). So, what we consider as 'individual' decisions is in fact the result of our relation to others and happens beyond our conscious control. Expectation of others, and interactions together with social norms, are building our identity and influence our consumer choices.

Moreover, behavioral economics can be blamed of the problem already stressed by Skinner, (1976) in *Walden Two* or in a literary way by Huxley (1932) in *Brave New World* and thus enslaving man, manipulating the individual even for his/her good. Although, when accompanied by extensive education, information campaigns, this allegation of manipulation is weakened. Sustainable consumption in **behavioral economics** is a technical problem, it focuses more on how to achieve a given set of behaviors, or for people to choose certain products. But who will choose them and how? Behavioral economics does not give an answer for this question.

Summarizing, unorthodox approaches which take a broader perspective on human needs, are far more interdisciplinary, taking as a basis the considerations of philosophers, theologians and psychologists - who recognize that a human has a social nature and is unable to exist and flourish without society. These approaches restore an important role to collective needs - also called **social** or **relational** (e.g. feminist economics, humanities). Some even refer to spiritual needs (humanistic and ecological economics).

Old and New Institutional Economics

Institutions are products of social life, which regulate, select and direct our activities in a durable way helping to make choices and ensure greater range of predictability of peoples' behavior (Wilkin, 2016, p. 98). Their place is in people's minds - are *dominant ways of thinking* which consider particular social conditions, particular functions of the individual and the society – as Veblen (1899) the father of (old) institutionalism maintained. For new institutionalists as Ostrom (2008) and

North (1991) institutions refer to accepted rules, norms and behavior strategies (Ostrom, 2008, p. 824). They may be considered as the product of the culture and in this sense - are software of the mind (Hofstede, 2000). People are learning these *institutions* due to process which may be called *social programming* – through education by parents and schools, where they learn how to behave in certain situations – so they learn indirectly how to consider needs of the *collective* – the societal harmony.

What is their role in consumer choices in respect of the *collective's needs*? On one side their existence is something what the community needs to function. They harmonize the interaction between people, they make the interaction possible and so they permit the society to function and to achieve progress and flourishment. In this sense they make the exchange process between people possible. This is because they reduce the uncertainty which is a part of exchange processes. On the other side they impact directly on some specific norms, and values which people endorse, which can be considered as positive or negative. Institutions shape peoples' expectations – what they consider as valuable and what not and impact on their behavior. Sztompka (2002, p. 417) put it in following words: *if people's expectations are institutionalized, they can have an feedback on human's action like limiting frames, and on social resources, which people use to take their ideas about 'proper goals', which are worth to achieve (values) and proper ways to achieve them (norms).* In some periods of the history some institutions encouraged the limitation of consumption (like in the protestant culture described by Weber (2005)), and in other – as nowadays – existing institutions encourage to consume more and more.

Institutional economics by shifting the focus from the individual to society, reflects on how society regulates itself through informal and formal institutions. The institutional system bases on rules designed by the collective and should permit the society to achieve the needs of the collective, which in turn are a precondition of satisfying needs of individuals. New institutionalism introduces the category of *property rights* which enhance the value of goods. Full property rights over an object make it more valuable than limited ones. The assignment of property rights may reduce the excessive use of some rare resources – as ecological services for instance. On the other side, limiting of property rights may be helpful to reach some society's goals. So, for instance supermarkets may be limited in their property rights when it comes to the utilization of sold products. They may be enforced to give them away (for social needs) before the expiration date. In this case, indirectly the property rights of natural resources (like earth, seeds – products permitting food production) is limited, and can be administered only under condition of proper use. Organizations which don't respect them (misusing the resources in order to maintain higher price) are punished. So, within institutional economics, consumption is not only an effect of preferences, but as well a result of formal and informal institutions and the government, who can co-shape institutions. Government by rising investments for public services as transport, and introducing limits on private transport may lower demand for cars and lead to changes of life styles of citizens.

The problem of unsustainable consumption is similar to that of common pastures tragedy described by Hardin (1968). Ostrom investigates rules which may be helpful to avoid such a tragedy. Users of shared resources (commons) design and obey some rules limiting their usage of the common good, because only in that way they can in long period meet their individual needs (using these commons to achieve their own goals) and collective needs (related to the existence of this common resource).

Environmental and Ecological economics

Similarly, as old institutionalism was considered as heterodox and new institutionalism as part of mainstream – the ecological and environmental economics belong to separated camps – heterodox and orthodox respectively. Whereas the environmental economics bases on neoclassical paradigm, the ecological economics has more old institutional traits. Both approaches acknowledge the necessity of sustainability, but they understand it differently.

The **environmental** economics starts with a weak sustainability assumption, assuming that humans' consumption is flexible in sense of its substitutability (van den Bergh, 2010, p. 2049). Moreover, it bases on the new institutional approach believing much in the proper assignment of property rights, and payments for ecological services (price systems). One of crucial concepts of environmental economics is negative environmental externality and focus on efficiency.

On the other side – **ecological economics** as a heterodox movement is skeptical towards the market and its efficiency, which tells us only about means, but gives no answer which goals are really worth achieving. The focus lies on a strong sustainability (van den Bergh, 2010, p. 2047) and reducing of the scale of the economy. Daly (1992) has repeatedly argued that traditional economics addresses allocation problems but has neglected the issue of optimal physical scale of the economy. Well defined property rights and the price systems which require commodification of ecological services, aren't sufficient instruments. It may be also visualized on the example of payments for ecosystem services. The latter may be understood as: the benefits humans derive from ecosystem functioning. *Ecosystem services, and the natural capital assets that produce them, represent a significant contribution to sustainable human well- being — larger than the contribution of marketed goods and services* (Farley & Costanza, 2010, p. 2061). Farley and Costanza (2010) maintain here '*Payments however do not require commodification'* and '*Only rarely will market payment mechanisms be appropriate*'. The reason for such a caution is that ecosystem services are essential, non-substitutable and poorly understood, and there are real costs to their provision and protection (Farley & Costanza, 2010). Although for Costanza environmental services have public good character, Kosoy and Corbera (2010, p. 1235) validate such an approach as too radical. However, both acknowledge the role of a collective to take the decisions, and such a platform is a political one. This corresponds with the concept of human nature of ecological economics which is basing on 3 parallel concepts – homo *oeconomicus, homo politicus* and homo *ecologicus* (Horodecka, 2018). The efficiency is good for choosing best means, but it fails when it comes about the goals. Ecological economy treats sustainable consumption as a collective need. It is a necessary condition of sustainable development and so a precondition of the existence of economic and social system. Furthermore, it is an integral part of wellbeing, which can't be limited to material aspects, but has social and ecological components. Sustainable consumption rules cannot be perceived any more as choice of a company, a region or even a state, but are the concern of entire planet and all people. One has to have also in mind that ecological, social and economic systems influence each other and so instruments and chosen to stabilize each of them can limit or enforce instruments used in another. Which of the system has a precedence? According to ecological economics, social systems are limited by ecological system. Moreover, the role of economic system is instrumental one towards the well-being understood as quality of life encompassing collective and individual needs. There is some attempt to measure these collective needs. SDG creates a good framework, and **Sustainable Development Index** (SWI) can be perceived as an efficient tool helpful in social transformation towards a new economy based on resource renewable energy (Costanza et al., 2016). Achieving this goal is a matter not only of changing the policy, but also of the institution, as well as norms and values.

Humanistic economics

Humanistic economics which was inspired by the humanistic psychologists (Maslow, 1943; Rogers, 1995) as well as the so-called Buddhist economics (Schumacher, 1973) bases generally on the assumption that the individual is not self-made, but that society (*collective*) play an important role in the formation of the individual, offering him/her a supporting environment. People are continuously surrounded by a dense web of interpersonal relationships, of which they themselves are part, acting an reacting (Lutz & Lux, 1979). Although the society is supposed to support the development of the individual, the individual cannot be developed on the costs of the society. Moreover, the development of individual needs has its limits, because only *wants* are unlimited the *needs* are limited. The flourishing is possible if we manage to differentiate between *wants* and *needs*. Otherwise one remains on the low level of development and cannot proceed in a hierarchy of needs toward satisfaction of one's *collective* needs, depicted on the pyramid of needs (Maslow, 1943, 1962). The subsequent stages of pyramid allow us to go beyond the successive levels of reference of the individual from objects allowing to meet material needs, passing to people surrounding the individual (need to be accepted, recognized), and to act on them thing (self-realization) towards self-transcendence. The possibility to satisfy them is doable if the individual finds a social support, in other words social trust, interaction or common good. The denser are the relations and networks between people, more probable that the society will provide this opportunity and impact positively on the obsolesce of *wants*.

In Buddhist economics (Daniels, 2003; Leonard, 2019) and humanistic economics (Lutz & Lux, 1979, 1988), a distinction has been made between needs which support the flourishing of the person and wants, which hinder it. *Wants* are rather goods that we do not necessarily need to meet basic needs and which serve implementation of selfish, egocentric motives that do not allow us to go higher in the ladder of development. Such an explanation does not allow us to understand why some people do not want to grow and instead consume more than they need. Maybe, the inability to meet higher needs (for instance: relationships with others, self-realization or the need for love) lead to their replacement with other needs. Such an explanation at the individual level is not sufficient for an economist who searches for causes in phenomena that can be shaped, changed, and studied not only at the individual level.

Humanistic approach to economics is similar in many points to some other approaches to reflection on economics conducted from a religious perspective - such as Catholic Social Teaching, Protestant reflections upon economy (Protestant ethics), or Islamic economics (Horodecka, 2014, 2015, 2018). So, for example in Catholic Social Teaching, *common good* is a collective need and a necessary condition for human development (individual need) and on the same time a result of human relations. Sustainable development and consumption are important part of common good (Christie et al., 2019). The care for it is the moral duty of every human being, regardless of religious affiliation. However, nowadays many societies suffer to great part on loneliness, exclusion, isolation. *[L]oneliness is seen to involve the manner in which a person experiences and evaluates his or her isolation and lack of communication with other people* (De Jong, 1987). Depression is already killing many of people and it is considered as one of major mortal diseases. People lacking contacts to other people may replace the higher – relational needs with lower ones what creates a place for induced needs.

These needs are created artificially by companies wanting to sell their products. Buying them allows people to acquire certain values and needs not only by possessing them alone, but also by the value that they 'buy' thanks to them – being young, being attractive, being important for others.

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The presented approaches offer some alternative understanding of *collective needs* or *needs of the collective* which within standard economics are considered as a cost on efficiency. **Institutional economics** (especially old one) perceives the *needs of the collective* as institutions – norms, ways of thinking and behaving which are developed within the collective and which may be adapted to current trends and challenges (like climate change for instance) if there is a net of interactions in the society permitting it. If the society manage to develop norms which are sustainable – it may be helpful for achieve the sustainable consumption. Institutions are developed within groups – therefore the challenge of the society is their existence and participation in political process. **Ecological economics** is offering another understanding of collective needs – it is exact the ability of the society to survive by being sustainable. The society and markets need the nature to exist, and so the forms of society and markets have to adapt to the challenges made by the climate and not in other directions. Whereas environmental economics is more oriented on price systems and property rights in managing the problem of 'commons' the ecological economics is offering more complex solutions and treat the sustainability and sustainable consumption as a kind of 'public good'. Eventually, the humanistic economics is perceiving the sustainability and sustainable consumption (as counterpart of consumerism) as part of common good and as a necessary condition to achieve the individual flourishing.

These approaches teach us that an economic agent is to perceive as a social being limited by the ecological system, and that the rules arising within the social system are immanent and not external to it, they cannot be reduced to market laws or psychological processes. They require conscious shaping of rules of operation through the creation of institutions, as well as cultural change in terms of norms and values, and a 'conversion' of society (Foxon et al., 2013) or in other words social transformation towards greater respect for common and collective goods, like sustainable consumption. However, how can these collective needs become the basis of our choices, or how do these existing institutions, norms, and values shaped in relationships create the structure of our "I" and translate into our choices? Individual and social identity gives us the answer to this question.

Social identity as a link between collective and individual identity

Social identity permits as to connect the *needs of the collective* expressed by groups and societies with *individual needs*. It helps us to understand why the individual making his/her consumption choice does not really respond to own preferences but on the expectations of some groups with which he/she voluntary or not voluntary identifies. The reflections developed here base to great extent on social psychological theories of self and identity (Mead, 1967), social identity theory (Tajfel 1973) and self-discrepancy theory (Higgins, 1987). The theory of social identity as described by Tajfel et al. (1971); Tajfel and Turner (1986) explains to us that a person in search of recognition or gaining additional resources builds an identity by belonging to groups, identifying with them (Akerlof & Kranton, 2010, 2000). Individuals, trying to transform their current individual features into the features of their own image, join social groups and adopt the typical features of these groups. So, social identity can be understood in terms of individual needs, which by its nature (adopting to the group and its needs) has to consider needs of the collective.

Identity may impact on consumer choices in various ways, and by very different mechanisms. Firstly it may be considered **as a factor of human motivation** - a motivational construct (Eccles, 2009). Furthermore, our consumption choices are often perceived as an instrument to extend our **sense of self** and **identity (socially constructed),** what is used by marketing strategies (Higgins, 1987). People buying certain products are in particular sensitive buying not only because of their intrinsic value, but because possessing these objects is confirming one's identity, or it is enhancing it, or it is filling in the place of some affirmed identity, which people actually don't have.

The consumption is as well a **way to communicate other who we are, and to what social category we belong** (consciously or unconsciously) – our social identity. People, in order to communicate their social identity to others, and in order to be distinguished by similar people, are choosing especially these products which are visible. Horst et al. (2007) explain our behavior and choices as a result of the group we belong to. People who want to identify with a particular group and gain the status that it offers compared to other groups adapt to the way of consumption, e.g. within this group, ensuring its homogeneity. It is a useful modifier of individual behavior only if the identity of the person was ecological or if the group to which he belongs and with which s/he identifies actually favors ecological consumption. The group identity is often signaled to others by certain consumption goods (like clothes, cars, destinations of holidays), which of course may be more or less sustainable. There are some 'marking services' whose scope is to embed people in their social group, which is more than invidious 'display consumption' as suggested Veblen (conspicuous consumption), but something which help to maintain the in-group identification and so to make the functioning of the group possible. This is especially of importance when cultural shifts and social shocks arrive. In such cases the group may due to the 'common identity' show social resilience. The group is so able to maintain its social identity and to negotiate inter-group relationships. Consumer goods may facilitate social conversations which may be in favor of sustainability. Even an ecological identity needs some goods which characterize it and permit social conversation about it, as using public traffic, wearing self-made clothes, or using a thermos instead of one-way mugs. These consumer goods play a symbolic role and facilitate a *social conversations* about individual and social identity, group cohesiveness and cultural meaning (Jackson, 2005).

Personal and social identity aren't unchangeable, but their flexibility depends on the time. Whereas in the short run, for instance, people adapt to existing norms and social categories which are defining their identities, in the medium run people may choose their identity and do something to change the social categories and norms. The long run offers most possibilities – people may change norms and categories by their actions. In this long-time perspective social norms are endogenous to their identities and adapt to them (Kranton, 2016, p. 406). So even if changing habits seems to be a great challenge and some people may think that it happen step by step, there are as well possibilities that people break with some style form on the basis of decision or change in their life (birth of child, moving to another country), where maintenance of past consuming habits seems not possible to be continued. Finally, there are culture-dependent identities of localities which make people buying certain types of products for instance – having a garden even if the person is disliking it for other reasons, or having spare-room bed in a house, or a living-space.

Last but not least, there are **collective identities** which may be of importance when we speak about the influence of certain **trends**. A **collective identity** is referring to one's identity as part of a specific social group (Brewer and Gardner, 1996), which has its source in the need to belong (Baumeister & Leary, 1995). Impacting on them (like identification with one's working place, university or local) may help us to develop a new aspect of self-identity – and so to change one's consumption behavior (Mallett & Melchiori, 2016). |Collective identity is as well expression of some actual trends. Nowadays consumerism is such a trend, which is accompanied by 'dilemmas of the self' which develop as result of enlarging choice of consumer goods. For Baumann (1998) people are reconstructing their identity permanently, facing the impermanent, transient nature of modern consumer goods. As result they aggregate identities *loosely arranged of the purchasable, not-too-lasting, easily detachable and utterly replaceable tokens currently available in the shops.* Consumerism may be responsible for 'empty self' (Cushman, 1990), which cause that consumer feeling prompted to 'fill it up'. Such a 'social logic' of consumption may be described as a 'luxurious and spectacular penury' (Baudrillard, 1998).

However, we usually have many different identities not specifically related to the groups to which we belong consciously but resulting rather from the social role we have and the place in which we are. These multiply-identities may be shaped by different systems and may lead to contradictory behaviors. For instance the so-called affluent identity may be stronger than the ecological and result in sustainable consumption for show (Tiefenbeck i in. 2013), or lead to the replacement of the original internal ecological motivation by external motivation (e.g. financial incentives for ecological consumption), described in social psychology (Deci i in. 1985), and economics (Frey 1994). These different identities may be outcome of various interacting systems (Foxon et al., 2013; Horodecka, 2008): economic, political, social and cultural. In order to understand the problem of sustainable consumption we should consider the interaction of all these systems and their respective and cumulative influence on identity shaping. Cumulative, as soon as there are spillovers which may be interpreted as the effects or externalities incurred on system processes from interactions with or to other systems (Liu et al., 2015).

The **economic** system sets certain impulses on the identity – in the developing countries people are constrained by economic conditions to economize, whereas in rich countries – they have not only the opportunity but are also encouraged to spend even more to rise the demand. So just being a part of the rich or poor country can make us sustainable (like poor countries by necessity) or not (in rich countries people consume and emit several times more than in poor). Similarly, the **political** system and existing political marketing create different identities. For a long time in developed countries, consuming was encouraged, thanks among all to the ideas of Keynes, even if Keynes wished that this state will end when the needs of the society get satisfied (Keynes, 1930). Similarly, neoliberalism created another challenge, when the global pressure to make profits led to an explosion of consumption on an unprecedented scale, and the widespread availability of cheap products, led to the formation of the said affluent identity. The **social** system and its structure, general characteristic (mass society, consumer society, traditional), and the dominant divisions lines in the society (due to wealth or education or gender, age), may be helpful to understand the identities responsible for sustainable consuming behavior. Moreover it gives as the insight into the dynamics of groups representing new ideas and their impact on joint activities and political actions (Klandermans, 2014), e.g. through lifestyles (Fernandez-Jesus et al., 2018). In the **cultural** system, we are focusing on identity with certain values, existing inside or outside this group. People want to radiate something more than status and wealth through their consumption behaviors - to show something of their personality (Chen & Funke, 2008). Bronner and de Hoog (2019), researching on consumer trends, discover that although traditionally durable material goods play a role in consumer behavior, they are also increasingly intangible, which mainly relate to experience. Therefore, interest in intangible preferences in relation to material products is growing (Trentmann, 2017; Van Boven & Gilovich, 2003; Yang & Mattila, 2017). Nowadays, vegetarianism and veganism connect people (identity) who have no other common features apart from e.g. empathy for animals, which is becoming increasingly popular. Identities are also created based on such cultural trends - as a healthy lifestyle, sport, being young, living close to nature. Certain values become the basis for creating specific groups discussed in the previous section.

Identity analyzed in the context of these four interacting and overlapping systems can give us the opportunity to deepen the problem and discover in the phenomenon of sustainable consumption various identities formed within these different systems. However, partial identities may sometimes hinder this process. For example, the identity of developed and developing countries is an identity that leads to disputes and tensions. Developed countries consume much more than developed countries and are responsible for much more emissions. However, they are often shifting the attention from the global consumption and global emissions to the question of efficiency (which is higher than energy efficiency in poor countries) and they justify their richness and prosperity with the help offered to the poor countries. Poor countries may want the same collective consumption rights as the rich in the past (e.g. when it comes to reducing emissions) bringing the arguments about their standard of living which is much lower. Therefore, in order to limit the contradictory identities that inhibit this process, one should obviously act in the direction of reducing social inequalities, reducing social barriers, prejudices, stereotypes and access to education, which may help in process of enforcing identities that exceed the boundaries between identities, such as wealth, skin color, and gender, like 'being human' (Sen, 2014).

Conclusion

The paper is an attempt to outline a map of the problem of sustainable consumption as a collective need. It indicates to a limitation of standard economic theories that are focused on preferences or individual needs. The insufficient meeting of collective needs is associated with their increasing restitution with individual needs, which ends disastrously for the environment. The article shows how newer economic approaches (behavioral, institutional, ecological and humanistic economics) solve the dilemma between individual and collective needs in the context of sustainable consumption. Although some of them open other possibilities than market ones - pointing to the role of rules and norms shaping economic activity, they do not explain how collective needs may be perceived as a part of individual needs. The concept of social identity can be perceived as a solution to this problem. However, one has to have in mind that multiple identities are created in interacting systems (economic, political, social, cultural). For this reason, when analyzing sustainable consumption, we should possibly use the complexity approach considering the overlapping impact of various systems on the creation of social which in turn impact on the consumer and his/her choices.

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Economic behavior to the environmental equilibrium: analysis from game theory

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Abstract: This research aims to show how models from neoclassical economics theory points on environmental problematic. since environmental crisis reflects directly on the operation of the economics, socials, and ecological systems. By using the game theory methodology, we proposed a concrete analysis about the individual economic behavior within the environmental action as a part of their utility function. We observe that once the relations between society and nature, among two (or more) agents in relation to a natural element become conflicts of interest, this ceases to be an economic problem to become an ethical problem. Therefore, it can clearly be argued that it is not a failure in economic theory, since it even generates possible solutions from a well-established institutional framework, answering what different authors have questioned regarding neoclassical theory as responsible for a problem that is out of it. In conclusion, we consider that environmental crisis is not a neoclassical theory problem but an ethic problem, and it requires effective incentives to achieve strong sustainability.

Keywords: Economic behavior, game theory, ethical problem, moral philosophy

Introduction

It has been pointed out that economic science (under the guidelines of the neoclassical theory paradigm) and particularly the capitalist economic system is primarily responsible for the environmental crisis that societies are currently experiencing (Martínez, 2004; Fazio, 2012), which includes the overexploitation of natural resources for commercial purposes, unequal distribution of resources, excessive urban growth, pollution among others (Delgado, Espina, & Sejenovich, 2013).

On these statements arise relevant questions from the philosophy of science such as the following: economic science, as a scientific discipline, is in crisis?; Is the neoclassical economy responsible for environmental anomalies ?; Are there sufficient anomalies to refute the neoclassical paradigm ?; Can the dominant (neoclassical) paradigm solve the anomalies attributed to it?, It is necessary to solve these types of questions before arguing that a scientific theory, in this case the neoclassical economic theory, is obsolete given its inability to solve problems. The objective in this paper is precisely to analyze the application of neoclassical theory from the behavior of the economic agent against a situation of environmentally friendly behavior, through the methodology of game theory; in order to indicate if the theory is effectively incapable of solving the type of economic phenomena that are currently affecting societies, or if these problems are generated by other circumstances that escape the actions of the neoclassical theory.

Economic behavior and application of economic science

It is called economic behavior, any behavior directed by economic laws (García de la Sienra A., 1998) This dynamic is under the concept of maximization of preferences, where, each individual seeks to improve their utility (or welfare) from the decision making offered by the conceptual framework of the economy. Economic problems, then, become decision problems, which are seen from the perspective of game theory:

An individual decision problem is a game in which one of the players is the individual and the other is nature. The "pure strategies" of nature are called states of nature, and these are represented from the neoclassical theory by the market. Since the market has no preferences, only the utility of pure strategy profiles for the personal player is considered: where $uij = u(s_i, sj)$ is the utility for the individual, resulting from the state of nature being s_j and the choice of agent is s_i. The pair (s_i, s_j) represents the result that occurs if the prevailing state of nature is sj and the agent chooses the action s_i (García de la Sienra A., Theory of choice).

When the individual (decision maker) is forced to choose an action from a set of possible (known) courses of action, the decision problem is composed of the following elements: The objectives of the decision maker; the states of nature he faces; feasible courses of action, also called actions, choices or decisions; the consequences or results that come from the conjunction of each action with each state of nature; and the degree of uncertainty of the consequences of each possible action (García de la Sienra A., Theory of choice) The central stage of the research is the market, which is given from the institutional point of view by individuals, who participate either as consumers or producers; The explanation of their behavior is based on the assumption that individuals try to maximize their own satisfactions by behaving rationally (Dopfer K., 1978).

> "*The economic problem that the individual typically faces is to make a better choice between several given alternatives. The basic conditions under which individual maximization operates are exogenously determined and do not change in the model; production and utility functions are stable, and the same applies to the distribution of income and wealth*" (Dopfer K., 1978, p. 16).

The problem of utility maximization is a set of personal agents that depend on their individual choice. However, the object on which the various branches of the economy deal, which address economic problems, are phenomena that occur at precise levels or levels of social formations (Barcelo, 1992). Which leads to the idea of forming a mechanism that leads to social welfare; Therefore, since its inception, economic theory has been considered as a source of recommendations for the elaboration of public policies (Beker, 2002).

The recommendations arising from the neoclassical theory are about the concept of equilibrium. Hence, one of the models of application of the theory is through welfare economics; This application extends the estimates of individual utility to a welfare state for all members of the economy. When economists consider environmental issues, they point to the results of economic well-being. For this reason, an attempt is made to demonstrate an economic equilibrium with respect to environmental conditions (which concern all human beings), so it is necessary to resort to such approaches.

Game theory and environmental decisions

With the objective of modeling an economic-environmental equilibrium, this could only be achieved by resorting to the analysis of the decision-making of economic agents, which is adequately exposed from game theory.

The notion of environmental sustainability emphasizes the vital support of environmental systems, without which neither (economic) production nor humanity could exist. This life support includes the atmosphere, water and soil; All of these require being healthy so that the capacity of their environmental services is maintained. Therefore, environmental sustainability can be represented by a set of regulatory restrictions on the main activities that regulate the scale of the economic-human subsystem with respect to the physical-ecological system (Cafri & Schiliro, 2012).

Properly, game theory is a tool for the analysis of the interaction between rational agents, the formulation of hypotheses about their behavior and the prediction of the results of each interaction. From this point, it is very convenient for the analysis of environmental problems and for the application (enforcing) of environmental agreements that are based on cooperation (Cioni, 2006). In this framework, the possibility of two types of games is presented: cooperative and non-cooperative, given that economic anomalies with respect to environmental terms that generate market failures[1] are mainly presented in the form of external effects and as the problem of the free rider, this form is attached to the modeling of non-cooperative games, so that this tool is used for economic-environmental analysis.

Non-cooperative games

The fundamental law of game theory is that each player acts rationally, in the sense that he maximizes his expected utility by reacting to any profile of the other players; To explain it, the concepts of expected utility, strategies and equilibrium are used.

Every non-zero finite sum of a non-cooperative game normally has at least an equilibrium of n-tuple (orderly sequence) of pure or mixed strategies, which correspond to the decision to perform some action, taken with the sole in order to maximize the expected utility through a single shot in the game, that is, a single decision making. Once the dynamics of the theory are defined, Nash's theorem can be introduced: Every game strategically has an equilibrium in mixed strategies (Nash, 1950). This equilibrium is reached when all players have made use of their strategies and reached a level of utility in which no one can worsen or improve their situation.

The form of non-cooperative games allows describing interdependent strategies among n players, each being characterized by at least: a set of pure strategies Yes; and an expected utility function (Cioni, 2006).

$$ui \rightarrow R$$

with

$$S = \times^{n} S_i$$

Examples of non-cooperative games are given under the following simplified assumptions:

1. There are only two players;

2. Each player has a finite, real and limited set of strategies;

3. Players choose their strategies simultaneously;

4. Unless stated otherwise, the games are one-shot.

[1] Market failures are situations in which real circumstances deviate from the ideal and become inefficient outlets, so it is necessary to recommend corrective economic policies. Much of the content of the environmental economy is focused on identifying and correcting market failures in relation to the services that the environment provides to the economy.

Thus, the most basic example of a non-cooperative game would be in the form of the prisoner's dilemma, which owes its name to the following scenario:

Given for two people, with strategies (S_1, S_2) one cooperative and one non-cooperative respectively. Two prisoners are assumed, who are in fact guilty of a felony, both are protected in separate cells. Contemplating their future, each of them perceives two strategies: (S_1), not admitting crime; and (S_2), confess everything. The prosecutor finds an opportunity to make them confess, implementing the following incentives: first, if neither prisoner confesses, the punishment will be 10 years in jail for both of them; second, with a single confession, and if only one prisoner shows evidence, then you have 8 years in jail for the cooperating prisoner and 20 years in jail for the non-cooperator; Finally, if both confess, then both receive a 15-year prison sentence (Ordeshook, 2003).

The result is that both prisoners choose the non-cooperative strategy among them (S_2), which is the most severe equilibrium sentence that both can receive equally; since they prefer not to cooperate with each other, so as not to risk having a greater punishment, because only one of them confesses and obtains the worst punishment.

Table 1: Prisoner's dilemma for two people (Ordeshook, 2003).

P1/P2	**P2.(S1)**	**P2.(S2)**
P,1(S1)	(−10, −10)	(−20, −8)
P,1(S2)	(−8, −20)	(−15, −15)

Game features can be added as follows:
1. Each player has a dominant strategy;
2. If each person uses their dominant strategy, then the final exit will be a Pareto inferior optimum, in which both can find a better, unanimously preferable exit;
3. That their strategies are dominant means that even if players can communicate with each other beforehand and agree to avoid the lower Pareto outcome, if they cannot somehow make a binding agreement, then, each person will ultimately be affected by it. .

The operation of the game, where both prisoners have a dominant S_2 strategy. Regardless of what the other prisoner does, in which the performance is an exit that both prisoners prefer to achieve, it is the least favorable, it can be formally explained:
1. Each player can cooperate for a better exit of both (strategy c), or not cooperate (strategy nc);
2. Each player earns a *B = 3* benefit by cooperating;
3. The cost to cooperate is equal in *C = 4* for both players

The benefit enjoyed is equal in *(2) (B) = 6* and is greater than the cost to cooperate, and therefore, its implementation is socially efficient. If each player decides to cooperate alone, that may incur an equal loss for *B-C = -1*. If both players cooperate, both reach an equal gain for *B-C / 2 = 1* where if neither cooperates, then neither gets a profit or a loss (Cioni, 2006).

The result can be seen having the following preference structure:
1. $(nc, c) \succ A(nc, nc) \succ A(c, nc)$;
2. $(c, nc) \succ B(nc, nc) \succ B(nc, c)$.

From this structure, it stands out that the only equilibrium is the strategy offered in (nc, nc) where the payments are (0, 0), which is also less than where both can obtain a benefit if the two players cooperate (1, 1). By inspecting the prisoner's dilemma table, it is easy to see that if one player can implement the project by himself, the other can only benefit at no cost, incurring free-rider behavior. The same is always true if both players can agree to cooperate before starting the game (c, c); in this way both players would obtain a high common benefit. If, after signing a cooperative agreement, A is sure that B will comply with it, A will have strong incentives to divert his actions to (nc) and win 3 instead of just 1. The same holds for B. in this case, a free-rider behavior (to play (nc)) of one of the players can be provided as the best incentive for a non-cooperative movement identical to the other (Cioni, 2006).

Table 2: Prisoner's dilemma general form (Cioni 2006)

A/B	**B(c)**	**B(nc)**
A(c)	$(B-C/2, B-C/2)$	$(B-C, B)$
A(nc)	$(B, B-C)$	$(0,0)$

In this situation, from the game of a single movement, there is no way for the two players to cooperate and reach the socially optimal solution (that is, the one offered (c, c)). The lack of incentives, or the uncertainty to a greater loss make the players prefer a lower Pareto exit, the same situation happens with the friendly behavior with the environment.

Non-cooperative environmental game with analysis of externalities and public goods

It is considered a reinterpretation of the prisoner's game that, as an example, an environmental game case is modeled on air pollution control in: (Ordeshook, 2003). From the affectation in the functions of utility of the individuals, according to the form of the externalities; where the strategies are now reinterpreted as (S_1) cooperative strategy: the payment of a fee that would be reflected in the regeneration of forests, where precisely the partiality of regenerated forest would be the public good Y[2]; and a non-cooperative strategy (S_2): not paying the fee. Two individuals A, B are assumed; with utility functions given with respect to the consumption of two goods X, Y, where the air available in the current pollution conditions would be good X (considering that, with a greater number of forests, one of the environmental services that it offers is the possibility of having cleaner air), which in turn is also a public good[3].

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[2] On the consumption of this type of goods, such as fresh air, forests, beaches, etc., environmental services have been identified, such as recreational or contemplative amenities, the health benefits they represent, and even their aesthetic value; same services for which although it is not easy to assess a price for their enjoyment, they are recognized as a consumer good.

[3] Public goods are consumer goods that do not express rivalry or exclusivity; open access resources have rivalry, but not exclusivity; congestible resources, present exclusivity, but not rivalry (space limit, quota) Invalid specified source .. The fact that public goods are not rivals, that is, what at any level of use for production, the marginal rate to supply it is zero; nor excluding, that it is not possible to exclude anyone from their consumption. It generates that the use of these goods is excluded from economic estimates, allowing the existence of market failures, particularly of free-rider; where one or more individuals consume a good or service without paying for it, generating inefficiency

Table 3 : Prisoner's dilemma, air pollution with consumer-consumer externalities.

A/B	$B(S_1)$	$B(S_2)$
$A(S_1)$	$[U^A (X^A, Y^A, Y^B), U^B (X^B, Y^B, Y^A)]$	$[U^A (X^A, Y^A), (X^B, Y^A)]$
$A(S_2)$	$[U^A (X^A, Y^B), U^B (X^B, Y^B)]$	$[U^A(X^A,0), U^B(X^B,0)]$

The different outputs show that the fact of resorting to the non-cooperative strategy indirectly affects the utility of the other: the failure to pay their respective forest regeneration fee by one player reduces the total amount of forest Y that the other could consume, conditioning it to consume a necessarily smaller portion of Y than it could consume if both paid, only the portion regenerated for their own payment, considering that $Y^A + Y^B = Y$ *, and therefore, Y *> (Y^A) , (Y^B). where the utility of the consumer is greater when it is a function of (Y^A, Y^B):

$U^A (X^A, Y^A, Y^B) > U^A (X^A, Y^A) > U^A (X^A, 0)$

$U^B (X^B, Y^A, Y^B) > U^B (X^B, Y^B) > U^B (X^B, 0)$

On the other hand, choosing the cooperative strategy clearly represents a positive externality, directly affecting the utility of the other by increasing their consumption of the public good AND, specifically generating a free-rider problem, since the strategy (S_1) always means increasing, although be a small portion of the good Y available for the consumption of both individuals - as a public good - each one retaining its consumption of good X constant. Finally, that both individuals take the non-cooperative strategy (S_2), leads to a payment exit in which both players do not have access to the consumption of the public good Y, which could be seen as exhausted for the society of two individuals. The preference structure seen previously for non-cooperative games (Cioni, 2006), would suggest that, since there is talk of a positive externality over public goods, both players would be encouraged not to pay, hoping that the other player would do it for they, allowing a free consumption of the forest portion regenerated by the payment of the other player, evidencing a free-rider problem.

It is possible to take the analysis to instances of n-players, maintaining the same circumstances that lead to the form of the problem of the free-rider on all the individuals of a society except an individual i. In the case, an S company is assumed, with n number of people; Therefore, everyone is represented except the individual i as Sn − i, where we seek to maximize the social welfare function BS (X, Y):

Table 4: Prisoner's dilemma n players: free-rider externalities.

i/S_{n-i}	$S_{n-i}(S1)$	$S_{n-i}(S2)$
$i(S1)$	$[U_i(X_i, Y^*), BS(X_{n-i}, Y^*)]$	$[U_i(X_i, Y_i), BS(X_{n-i}, Y_i)]$
$i(S2)$	$[U_i(X_i, Y_{n-i}), BS(X_{n-i}, Y_{n-i})]$	$[U_i(X_i, 0), BS(X_{n-i}, 0)]$

Comparing the payments of each column, when presented (S_1, S_2) is the social optimum, where all members of the economy cooperate by adding a social welfare function, in this case, with environmental purposes; on the other hand, when i adopts (S_2) and society (S_1), it is the classic free-rider problem, where the total of the Y pay available to all, is being assumed by society, while i continues to maximize its utility depending on the consumption of both X_i and Y_{n-i}.

The game reveals that regardless of the strategy that anyone chooses, (S_2) is the dominant strategy for i. Since the game is symmetrical, this argument holds that (S_2) is the dominant strategy for all people. Despite knowing that if someone chooses (S_2) and receives payment 0, and therefore, everyone will be in a worse situation than if they all take a cooperative attitude (Ordeshook, 2003), in this case friendly to the environment. In addition, with everyone paying their fees, each person would maximize their utility based on consuming Xi, Y *, which is considerably better than receiving Y = 0, as when everyone chooses (S_2), remembering what: $Y * = \Sigma Y_n > Y_i$.

It could be thought that knowing the above, and in this particular case, that the consequences are to lose the total number of forests in a society, would lead individuals to act cooperatively to achieve the optimum of social welfare. However, if n is very large, thinking about cooperative strategies can be especially difficult, since the task would be to coordinate the voluntary actions of all people, and to achieve this type of coordination requires leadership and some minimal form of organization, which is out of this model (Ordeshook, 2003).

Limits and possible solutions

Since the game points out that different environmental problems can be approached from the analysis of externalities, the possible solutions evoke the same instances as the internalization of external effects: the estimation of taxes or subsidies, and the regulation of property rights (Mass - Collel, Whinston, & Green, 1995). Although this solution is not presented as a simple task; as one of the main limitations is that unless society or its leaders can apply sanctions of some kind, it will not be achieved, as it is common that each member who initially contributes to some voluntary agreement, at the same time, shares an incentive to desert unilaterally (Ordeshook, 2003). The difficulty in solving this problem comes from the number of people who must reach an agreement in society, where everyone should be incentivized by a benefit when performing this or that action. Already Hume, I noticed the difficulty of this purpose in the treaty of human nature: "*It is very difficult, and indeed impossible, for a thousand people to reach an agreement on some kind of action: it is difficult for them to design so complicated, and even more difficult to execute; while each one seeks a pretext to rid himself of the problem and of the expense, to put all the burden on the others*" (Hume, 2001, p. 382).

Finally, although it is pointed out that agreements for large groups of people are not reached, there is doubt about the possibility of whether an agreement could be reached between games of few participants, for example, the case of a game that models the strategies of choice to reach a bilateral international agreement between two countries; remembering that the competitive game between two players under the analysis of externalities, although it is not resolved by the lack of incentives, the solution for these externalities from the microeconomic theory is to resort to the establishment of property rights and in more general to government intervention as a regulatory body with the power to enforce its authority, as with the establishment of mandatory fees, taxes or subsidies (Mass-Collel, Whinston, & Green, 1995). In the case of international agreements, the main limitation is summed up by the lack of an authority body with sufficient capacity to force both countries to assume cooperative strategies (Cioni, 2006). Specifying this problem, in many cases the players, seen as countries linked to some international agreement, cannot sign binding contracts and the reasons can be the following:

1. The strategies of the players are unobservable to the mediator or the legal executor of the contracts (if it exists);

2. There are no effective ways to punish players who infringe a contract either because the available punishments are inadequate or because it is very difficult to detect any violation, as is the case of common goods offered by environmental services;
3. The strategies of some actors involve the violation of inalienable rights (such as sovereignty, food security and the like) (Mayerson, 1991).

Collective action to resolve the prisoner's dilemma, then, requires more than cooperation and agreements in good faith. This dilemma can find its solution only if there is a means to reach and properly apply the agreements at all levels. The philosophers of the social contract like Hobbes and Locke, already saw a similar condition in which the lack of any authority would deprive society of order, which would result in a state of war, in which man in his natural state would act by its own means promoting violence, insecurity, theft and death to become the basic means of subsistence, excluding arts, industry, study and other desirable situations that ensures a state of order, where the government allows to safeguard the integrity of individuals (Ordeshook, 2003).

Conclusions

With the analysis presented on the possible economic-environmental equilibrium from the application of the neoclassical economic theory, it can be concluded that said equilibrium, although not unattainable, since formally there is a verifiable point where under the order imposed by some authority could direct the course of actions; in practical terms, this equilibrium is only in the best approximate case, since it depends on the individual decision-making of the economic agents, as shown, they lack the necessary incentive to direct them towards cooperative decision-making regarding to the environment. Under this argument, environmental economics assumes as its own the concepts and principles established by neoclassical theory (Martínez de la Torre, 2008); that is, despite openly promoting a friendly management of natural resources, the analysis is still done in a framework of choice, based on increasing or maintaining the utility that is obtained directly from nature; where it has been seen that some tools of the neoclassical models can be extended to evaluate the relations between economy and the natural world (Brown & Timmerman, 2015); with the limitation that once the relations between society and nature, between two (or more) agents with respect to a natural element become conflicts of interest, it ceases to be an economic problem to become an ethical problem and, therefore, therefore, it can clearly be argued that it is not a failure in economic theory, since it even generates the possible solutions from a well-established institutional framework, answering what different authors have questioned regarding neoclassical theory as responsible for a problem that It is out of it. So, being a problem of interest rather than an economic problem, arguing, for example, for an intrinsic value in plants, animals and in general in ecosystems, is a philosophically problematic position: then assume that a species or an ecosystem as a whole, is aware, is unsustainable (Singer, 1984); but it does not prevent seeking rational solutions within the moral philosophy that studies and influences social behavior.

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Industrial symbiosis, a circular bioeconomy strategy. The sugar beet case study at the Bazancourt-Pomacle Platform

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Abstract: Industrial symbiosis (IS) is presented as an inter-firm innovation with the aim of biophysical flows optimization but also structural sustainability. In this paper, we introduce geographical system dynamics as the methodology used to analyse the Biorefinery using Stock and Flow Diagrams (SFD) to identify the actors/institutions and networks that represent the bottleneck of the technological and innovation change in the local Bioeconomy ecosystem. The institutional adaptive theory, the complex systems theory and the spatial economy encompass the theoretical framework that conceptualizes industrial symbiosis in the ground of circular bioeconomy, where the territorial system dynamics methodology helps to identify the innovation drivers. This methodology draws up three scenarios (baseline, change in the sugar-beet outcome mix and decrease in sugar-beet productive efficiency) to illustrate the by-products allocation (sugar green juice, low quality syrup, CO_2 and stillage) encompassing sustainable strategies that looks forward the enhancement of the agro-industrial ecosystem performance. We assume that Bazancourt-Pomacle platform holds the conditions to be considered an industrial symbiosis, in the sought of providing a better understanding of the stakeholder's causal effects and the complexity of their influence in the local industry regarding the sugar-beet valorisation alternatives.

Keywords: Bio-refinery, System dynamics, Proximity, Industrial ecology, Institutional change

Introduction

Richard Register (Roseland, 1997) has introduced the "sustainable city" concept in 1975, through the non-profit organization "Urban ecology". The sustainable city concept emerges looking to increase the wellbeing for citizens through a comprehensive approach of urban planning, waste management and air emissions (Register, 1987). Thus, from a systemic point of view, a sustainable city can be described as the set of complex subsystems that are associated or connected in order to undertake a sustainable transition (Diemer & Morales, 2016). Urban areas and agro-industrial systems represent two subsystems of a sustainable city, which take part in the municipal solid waste (MSW) production faster than any other pollutant in the city, greenhouse gases included (Hoornweg, Bhada-Tata, & Kennedy, 2015). Therefore, the sustainable and circular management of resources became a key driver to fight against global issues such as the resources depletion and/or the waste overproduction.

The current global recycling circuits are not able tackle this challenge, so one solution is to stop thinking waste as the undesirable residues from the production process, but as the worthy by-products that could be reintegrated as resources in other production processes. The narrowing strategy for by-product loops (Baldassarre et al., 2019; Blomsma, 2018), define the operationalisation of circular economy, sharing this assumption with the Industrial Ecology (Baas & Boons, 2004; Chertow, 2007; Taddeo, Simboli, Morgante, & Erkman, 2017) and institutional (Roggero, Bisaro, & Villamayor-Tomas, 2018) theoretical foundations.

Bioeconomy share most assumptions coming from Industrial Ecology and Institutional Analysis, unfolding an alternative that encourage the transition to renewable bio-based resources in order to produce food, energy, biomaterials and other bio-based products (Fuentes-Saguar, Mainar-

Causapé, & Ferrari, 2017; Sylvain Germont, 2019). A circular bioeconomy is therefore a bioeconomy in which organic by-products from agriculture, the food industry, wood, or waste treatment are absorbed and reintegrated in the system loops. The circular bioeconomy evolves from a straight-line logic to a systemic and circular approach where the sustainable management of resources is settled down (Germont, S., 2019), indeed, this transition entails structural changes in the production and consumption patterns.

We propose a sugar beet simulation model in the Bazancourt-Pomacle platform (BPP), to outstand the operational specificities of circular bioeconomy. The sugar beet system dynamic model fulfills the 3 conditions of an industrial symbiosis (IS): 1) The waste from one actor becomes the raw material for another; 2) economic and / or environmental benefits result from those synergies; 3) the collaboration between actors builds up the industrial ecosystem (Diemer, 2016). Industrial symbiosis is a subfield of industrial ecology, defined herein as the process of cooperation between several stakeholders who seek to strengthen circularity in a territory, according to the principles of efficiency and resilience (Diemer & Morales, 2016).

Industrial symbiosis is one of the most successful examples of circular bioeconomy, considering that it analyzes the links between actors aiming to strengthen circularity in a territory by closing, narrowing or slowing down the resources loops. Circularity could be improved throughout eco-efficiency (i.e. zero waste, cleaner production, carbon footprint), shift on distribution technologies, development of bio-based products and by-products (i.e. biofuels, bioplastics, biomolecules, etc.) and resilience to shocks (i.e. climate, political, economic, etc.). Industrial symbiosis can improve the systems understanding when including the scope and behavior of the actors influencing the value chain, the network collaboration styles and the system pathways.

The aim of this article is to improve our understanding on circular bioeconomy application in the BPP, by identifying the structure of sugar beet value chain and analyzing the allocation effects (crystallization, distillation etc.) in the ecosystem through the institutional lenses of complex proximity. The research question addressed herein is how the territory, institutions and actors' behavior influence the IS evolution pathways of bioeconomy? To better answer this question, we call on a methodology like system dynamics, able to link biophysical flows and socioeconomic variables, thus, providing a decision making tool able to address collective action problems, that could not be solved individually by any single member of the network (Geissdoerfer, Savaget, Bocken, & Hultink, 2017 ; Saavedra, Iritani, Pavan, & Ometto, 2018 ; Roggero, Bisaro, & Villamayor-Tomas, 2018).

Territorial system dynamics' is developed from the assumption that *path dependencies* rely on the historical context and are determined by *behavioral patterns*, incorporated into an institutional framework of adaptive change. Path dependencies and behavioral patterns concepts come from theories that rarely communicate, but herein they close the gap between geographic economy and the system dynamics, with the aim of identifying trajectories according to current behaviors, in the sugar beet agro-industrial platform, in La Marne department, submitted to the French institutional rules. The systemic model is built around Cristal Union sugar cooperative which plays the role of anchor tenant (Chertow, 2007; Onita, et al., 2006 ; Befort et Nieddu, 2017) and three ancillary players who contribute to the IS success: Cristanol, the distillery part of Cristal Union consortium, the starch and sugar lab ADM (ex. CHAMTOR), as well as Air Liquide, the industrial gases specialist, in charge of transforming carbon dioxide as input for soft drink industry.

Framework of resources and by-products in the industrial symbiosis

Scholars and practitioners insist on the use of "by-products" as concept rather than “waste”. This semantic change triggers an alternative approach for dealing with upstream impacts of residues, criticizing the zero-burden assumption of wastes as a comprehensive element of the productive system. Indeed, this definition offers a more precise understanding than the economic one where waste is simply an output that does not provide economic value to the process from which it must be eliminated, throughout the implementation of efficient processes. The by-product concept relies on the input concept, where residue is understood as a resource that could be looped through any production process in order to increase profitability. From a theoretical point of view, by-products should not be submitted to the zero burden assumption (Olofsson & Börjesson, 2018), standing as outcome of the production process from which it is extracted to go into the market, and then into the consumption sphere (Callon, 2016).

Wastes are not defined by physical properties or chemical compositions but rather by the economic process, trade, markets, or even perceptions, defining by-products over time and across space, a product can be both a by-product and waste in different places. When by-products are developed through a technological adaptive change in the production unit, like in the 30’s when the oil refinery period took place (Galambos, Hikino , & Zamagni, 2007) (Benninga, 1990), the residues are just used as inputs for the same production process, ensuring the profitability of firm or supply chain. On the other hand, when the by-product approach is organized at the meso-scale, like in the BPP example (Thénot & Honorine FFE, 2017) in France, the Fluminense biorefinery of the North region in Brazil (Santos & Magrini, 2018), or the Wanze biorefinery in Belgium.

The main source of inputs for Biorefineries is biomass (food and feed products or residues) and other by-products like CO_2, which is used by surrounding firms due to the availability of local resources. The Bazancourt-Pomacle case is a successful example where the development of an Industrial symbiosis is based on the biomass availability, coming from the upstream process (agricultural cooperatives) and embedded within the system’s boundaries (Bouteiller, Thenot, & Lescieux-Katir, 2018; Domenech, Bleischwitz, Doranova, Panayotopoulos, & Roman, 2019; Thénot, Bouteiller, & Lescieux-Katir, 2018.; Thénot & Honorine FFE, 2017).

Assumptions from the industrial symbiosis in the bioeconomy system

The theoretical framework used to explain the industrial ecology implementation in the context of bioeconomy includes the analysis of institutions (Baas & Boons, 2004; Decouzon, Maillefert, Petit, & Sarran, 2015; Ostrom & Basurto, 2011) and systems theory. Both theories, seek to highlight the structural dimension of the market, resulting from the conceptual shift from waste to resource. Territorial system dynamics is an analytical tool that allow the causal loops identification, balancing or reinforcing the impacts over the system (stocks – flows logic).

Bio-refinery: an institution of coordination

Bioeconomy entails a functional and institutional change in the value chain coming from stakeholders’ cooperation (Vivien, 2019) in the collective action arena (Ostrom & Basurto, 2011; Callon, 2016 ; Roggero et al., 2018) of Industrial symbiosis. Indeed, in sought of coordination, the IS actors will set up the collective decision-making procedures and allocations rules for resources, etc.

The three conditions defining BPP pathway dependence are: 1) the role of actors within the IS; 2) the regulatory and institutional framework in IS structure; 3) the actors submitted to the uncertainty of external shocks. According to the first condition, the most powerful actors are those who have the capacity to impose their interests and rules in the resource allocation and management. Then, the second condition unfolds the IS actors' struggling between their behaviour resistance/adaptation towards a new institutional framework entailing a more stringent normative. For example, biorefineries in France have suffered from the reduction rates of bioethanol in fuels. Finally, synergies among actors are conditioned by external shocks linked to the fluctuation of raw materials' price, the climate change effects on agriculture, the reallocation of agricultural land or even the reduction in the quantity of available by-products following the waste reduction policies.

The Bazancourt-Pomacle Platform entails the most remarkable example of a successful industrial symbiosis in the Bioeconomy field. It is composed by 10 actors including Vivescia / Bletanol, Cristal Union, Cristanol, Chamtor, Givaudan Active Beauty, Wheatoleo, Air Liquide, European of biomass, the Industrial research center (ARD) and an academic research center (CEBB). Within the sugar beet value chain, we can identify the following products and by-products:

- Within the commodities we can find the green sugar juice and syrups which, as a result of crystallization or distillation, will result in products such as sugar, alcohol and bioethanol.
- Within the by-products we can identify the stillage, low quality syrup from crystallization, and the CO_2 resulting from distillation and crystallization.

In general, by products are reused within the boundaries of the platform: low-purity syrup to be distilled into alcohol or bioethanol, CO_2 to gasify drinking beverages, pressed pulps for animal feed, and finally, the scum from syrup production as well as the stillage are reused as fertilizers.

Feedback effects, a causal systemic analysis

The existing literature about systems analysis identifies three theories as the main framework to explain causal relationships: 1) connections, 2) rebound effects and 3) commitments. This paper uses the previous framework to explain causal relationships, followed by the analysis of complex relationships: the theory of proximity, the theory of complex adaptive systems and the ecosystem theory.

Geographic economy outstands as a discipline in the quest of territorial resources optimization, essential in the understanding of IS. In the current state of the art, territory appears as the scenario where the actors in the agro-industrial ecosystem plays their synergic role. The proximity approach performed in the territory encompasses two comprehensive dimensions: 1) geographic and relational proximity defined by the Cartesian distance and; 2) organizational / institutional proximity which refers to the network of relationships beyond physical space (Beaurain & Brullot, 2011).

The theory of complex adaptive systems seeks to articulate disciplines that were previously disconnected, not because it wants to gather all the knowledge but because complexity implies the recognition of uncertainty (Miller & Miller, 2007). In the complex adaptive framework, complex thinking (Patrucco, 2011) highlights two basic characteristics: 1) the whole cannot be reduced to the sum of parts, 2) complexity introduces the notion of balance / instability dualism, suggesting that sustainable trade-offs could cause an imbalance in environmental flows and an organizational disruption triggering the systems collapse or change. The idea of an open, out of equilibrium system that evolves towards a stabilizing dynamism could encourage the consensus needed to integrate complexity throughout the ecosystems theory.

Finally, the ecosystems theory has certain momentum in the academic community (E. M. Morales, Diemer, Cervantes, & Carrillo-González, 2019; Tsujimoto et al., 2017; Nielsen, 2007) outstanding the following five assumptions: 1) the organic analysis of networks, also including the characteristics of competition, depredation, parasitism and destruction added to cooperation in the ecosystem; 2) recognition of the actors' diversity with their own attributes, motivations and objectives that define the rationality of decisions; 3) ecosystem boundaries based on product / service value chains; 4) the dynamic transformation of the ecosystem over time and 5) the behavioral and functional structure has an influence on the sustainability or decline of the ecosystem itself.

The territorial system dynamics as a prospective modeling method

Systems dynamics is a method developed for the study of complex nonlinear problems resulting from behavioral systems, as shown by J.J. Forrester in the books *Industrial Dynamics* (1961) and *Urban Dynamics* (1969) – or even the famous work published by the Club of Rome - *Limits to growth* (Meadows, Meadow, Randers, & Behrens, 1972). System dynamics has recently gain the attention of the scientific community, because its ability to define the system's boundaries, analyse the modes of behaviour composing the structure of the system, identify the actors and the feedback loops (reinforcing or balancing) in a stock and flow logic. The behavioural patterns are dynamic because it is always changing as consequence of the causal relationships which reinforce or balance the tangible and intangible (Hein et al., 2017) flows and delays, it cannot be captured by an optimization process based on a linear economic allocation model where the equilibrium is fixed.

At this case study, we have used data from secondary sources, including: 1) institutional reports and action plans, 2) official communications from stakeholders, local counties and regions, 3) academic literature in English and French regarding the Bazancourt-Pomacle platform. Secondary data was then validated by consultants with strong expertise in the platform, such as the director of European of Biomass and ARD, during semi-structured interviews. Within the institutional reports and action plans we can find the Cristal Union Executive Board Report 2017/2018 (Cristal Union, 2018) and the national French guidelines of circular economy (Ministère de la transition écologique et solidaire, 2018) as well as the Methodological Guide to the development of regional circular economy strategies in France (ADEME, 2014) ; the guidelines of industrial and territorial ecology; how to manage territories (Ministère de l'Ecologie, du Développement durable et de l'Énergie, 2014) ; the Bioeconomy strategic plan for France. 2018-2020 action plan (Ministère de l'Agriculture et l'Alimentation, 2018) and; the Memento Local economy, circular economy and industrial and territorial ecology (France Custer, 2018).

The territorial system dynamics methodology encompasses institutional theory and systems theory, previously developed in the theoretical framework. It is important to define the theoretical basis of this methodology which, according to our literature review, has been barely used to analyze IS, with few exceptions like the studies published by and Cui, Liu, Côté, & Liu (2018). The territorial system dynamics seeks to represent territorial models of sugar beet value chain in the case of the BPP agro-industrial ecosystem.

Industrial symbiosis' dynamic modeling in a bio-economic ecosystem

In this paper, we identify the biorefinery (Santos & Magrini, 2018) as an ecosystem located in the hinterlands of urban and rural areas with strong sustainability potential (Prendeville, Cherim, & Bocken, 2018). To support the previous assumption, our starting point is the association of circular bioeconomy and IS concepts, figuring out how the sugar beet flows and stocks circulating in the agro-industrial ecosystem can improve the systemic by-products integration in the value chain. One of the main contributions of the territorial system dynamics is the improvement in the analysis of meso-scale case studies, like the BPP, where the European, national and local institutional drivers are identified and their impacts disentangled, unfolding the small changes able to trigger multiplier effects.

By-products circularity in the upstream or downstream stages could be measured by the socio-economic cyclical rate (ISCr) = share of by-products / processed raw materials is 9.6% in Europe (UE28) in 2014 (Mayer et al., 2018). To articulate institutional change and geographic proximity in territorial system dynamics, we define the role of IS actors in the bioeconomy, regarding how local actors are embedded in the agro-industrial territory. Assuming territorial system dynamics as the best way to integrate the stakeholder's role and behavioral patterns in a model, we aim to unfold the cause-effects relationships resulting from the allocation decisions. Three stock and flows scenarios were simulated from a systemic agro-industrial model presented in this paper, looking for the integration of quantitative and qualitative aspects to better understand the expected impacts and benefits. The named scenarios are: 1) the baseline scenario; 2) the sugar beet's outcome mix scenario; and 3) the reduced sugar beet production scenario resulting from climatic risks, political and economic decisions.

Model starting conditions

Sugar beet represented 67% of agricultural production in *La Marne* region in 2017 (Ministère de l'Agriculture et l'Alimentation, 2019). Agricultural production at Bazancourt-Pomacle area reached 3 million tons in 2014 (Ministère de l'Ecologie, du Développement durable et de l'Énergie, 2014). Given this figure, we estimate total production for 2017 (period t) at 3.36 million tons, and therefore 2.25 million tons (s1 shown in Table 1) of sugar beet processed on the site. The area used for growing sugar beet in the Marne increased annually by 3% between 2007 and 2017, and varied between -3% and +8%. Currently BPP can store 672,000 tons of sugar beet (s3), or approximately 30% of annual production. We assume model simulations based on equations subject to the model's hypotheses (see Table 1 below) linking the theoretical framework with the model's initial conditions.

In the model, the production of low quality syrup is calculated at 54,600 tons (s4) and the stock of by-products from distillation fixed at 101,929 tons (s5) (including available sugar beet biomass delivered for distillation). The CO_2 emission rate for sugar is 45% (kc1) of the overall sugar, the CO_2 emissions rate from low quality syrup projected for distillation is 25% (kc2) of the overall volume, the stillage production rate for sugar is 6.5% (kssu) and the stillage production rate for low quality syrup is 5% (kssy).

Build-up of model hypotheses

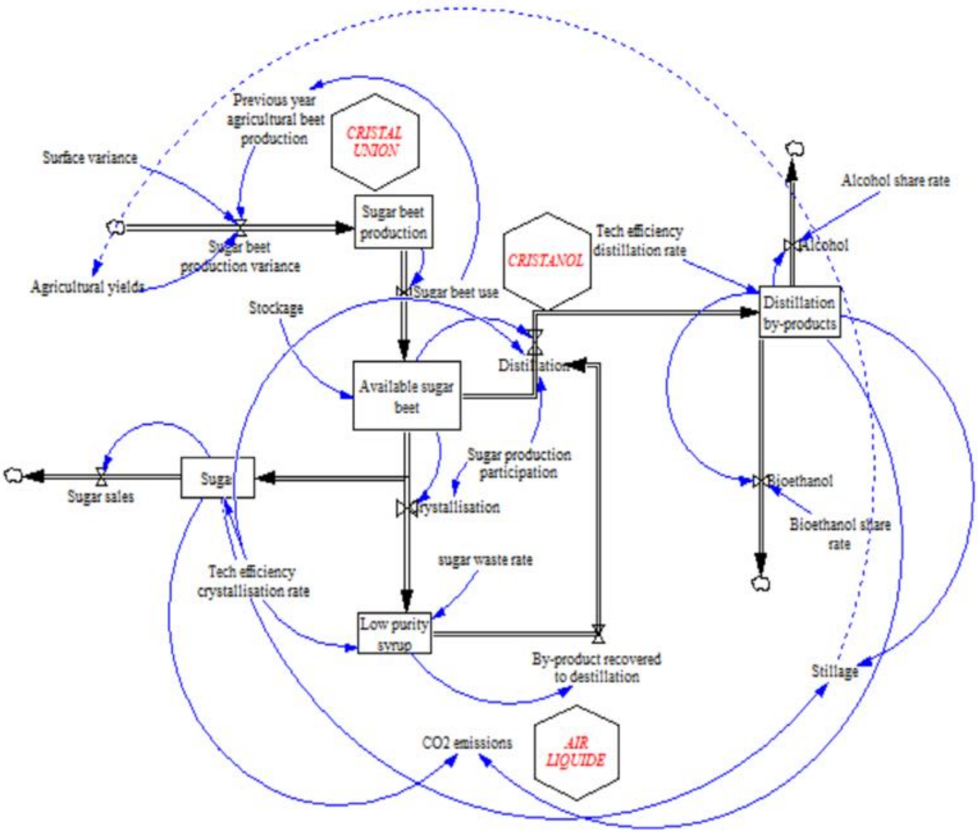
We set up in four groups the hypotheses used to build up the model: 1) production hypotheses, 2) products and by-products use hypotheses, 3) feedback loops hypotheses and 3) gap between decisions and their effects hypotheses.

1. The sugar beet production hypotheses are:
   - The sugar beet production assumption state that agricultural yields of beet on PBP increased by 1% per year over period t, with variability from -26% to + 18%,
2. The sugar beet products and by-products use hypotheses are:
   - Half the sugar beet available at BPP are used to produce sugar, and the other half to produce alcohol and bioethanol,
   - The tech efficiency crystallisation rate is 13%, which represents the volume of sugar beet liable to be transformed into raw juice,
   - The quality of 19% of the raw juice is too low to be used for human consumption
   - The tech efficiency distillation rate is 6%, which represents the volume of sugar beet transformed into alcohol,
3. Hypotheses concerning feedback loops (also known as reinforcing or balancing loops)
   - Low quality syrup resulting from crystallisation is a byproduct reused as an input for distillation,
   - CO_2 recovered from crystallisation and distillation is reused by Air Liquide,
4. Hypotheses concerning time gap between decisions and their effects
   - The planting surface is decided well before the harvest, based on information from the previous year,
   - There are no sugar stocks in the model, as sales equals production,

Dynamic modelling of the Industrial Symbiosis at the BBP

In the Figure 1, the stocks are represented by square boxes, for example the stocks of sugar beet available. The double black arrows represent processes (production, use, sales) that determine the stocks of products and by-products, i.e. the sugar stocks will be influenced by stocks from previous year and production in current year. The current year's production will depend on the tech efficiency crystallisation rate. The available technologies and their efficiency are symbolised by rates, and are represented by the double black arrows connected to the symbol ( ). We assume these rates can change over time. Finally, the variables influencing the rates are illustrated by curved blue arrows. The stock is the accumulation of materials over a certain period (one year in this case) and the rate refers to the changes in flows over time, i.e. the by-products reused for distillation. The dotted arrow represents causal relations identified in the field, but which have not been modelled due to the lack of data, i.e. we observe that stillage improves agricultural yields, but we don't have data about it. If data is available, this model can be extended in terms of actors, relationships and rules regarding biomass, products and by-products.

Figure 1. Sugar beet flow and stock diagram of the BPP



The model depends on previous years conditions (stocks), those in the current year (flows), and allocation decisions made by different players (rates) in the industrial symbiosis. Thus, after the assumptions definition, it is necessary to define the model equations that will structure the system in 2017 (period t) and its trajectories until 2027. All the double black arrows have been modeled and integrate causality (actions and effects) into the simulations using the following equations:

The land change coefficient calculates how the land change coefficient influence the sugar beet production flow, expressed in equation 1:

$$L = \frac{L_t - L_{t-10}}{L_{t-10}} \Big/ N \qquad (1)$$

Where L is the land dedicated to sugar beet production in the Bazancourt-Pomacle platform; 2017(t) and 2007 (t-10), expressing this ratio in terms of *t-10*, then the data is subsequently annualized when divided by the number of observed periods (N). Constitutive equations represent the coefficient on which yield changes influence the sugar beet production flow (equation 2). Where Y is the yield change coefficient of sugar beet production in the BPP, maintaining the same periods of analysis and ratio calculated by year.

$$Y = \frac{y_t - y_{t-10}}{y_{t-10}} \Big/ N \qquad (2)$$

Moreover, to calculate the flows originated in the platform and recognize them from the available external sources of inputs, some equations modeling the structural relationship within the system components are required. For example, the sugar beet flow can be expressed as shown in the equation 3.

$$Sb_{f(t)} = \mathrm{L} \times \mathrm{Y} \times Sb_{P(t-1)} \qquad (3)$$

Where Sugar beet production (Sb_p) in *t* period, outstands as a result of land change coefficient (*S*), the yield change coefficient and the sugar beet production of previous period $Sb_{p(t-1)}$. These equations may be simplified later according to specific assumptions and analysis of influence at different rates. Three initial values are included in the equations 4, 5 and 6: the sugar beet production (s1), the sugar beet storage (s2) and the sugar beet availability (s3).

$$\mathrm{Sb}_p = s1 + Sb_f - Sb_u \qquad (4)$$

$$s3 = \mathrm{s1} + \mathrm{s2} \qquad (5)$$

$$Sb_a = \mathrm{s2} + \mathrm{s3} + \mathrm{Sb}_{u(t)} - C_t - D_t \quad (6)$$

Table 1. Nomenclature

Symbol	Description
L	Land change coefficient
N	Number of periods
Y	Yield change coefficient
Sb_p	Sugar beet production
Sb_f	Sugar beet flow
Sb_u	Sugar beet use
Sb_a	Sugar beet availability
s1	Initial value of sugar beet production
s2	Sugar beet storage
s3	Initial value of sugar beet availability
s4	Low quality syrup initial value
s5	Initial value of distillation by-products
D	Distillation
a_{coef}	Sugar production allocation coefficient
B_{recov}	By-product recovered to distillation
Lsyr	Low quality syrup
S_p	Sugar production
S_s	Sugar sales
D_{byp}	Distilled by-products
A	Alcohol production
B	Bioethanol production
C	Crystallization
E	CO_2 emission
F	Stillage production
k_w	Sugar waste rate
k_{ec}	Tech efficiency crystallization rate
k_{ed}	Tech efficiency distillation rate
k_{c1}	Sugar CO_2 emission rate
k_{c2}	Low quality syrup CO_2 emission rate
k_{ssu}	Stillage production rate from sugar
k_{ssy}	Stillage production rate from low quality syrup
t	Current time period, 2017

The behavioral modeling includes the allocation equations, thereby considering the available technological possibilities for every choice (distillation and crystallization in this case). Regarding the distillation equation, t is the time, the storage (s2) is deducted from the total available volume of sugar beet ($Sb_{a)}$ and multiplied by the difference between the unit and the sugar production allocation coefficient (a_{coef}), without disregarding the addition of by-product recovered to distillation (B_{recov}) over the tech efficiency crystallization rate (k_{ec}), expressed as shown in equation 7.

$$\mathrm{D_t} = \left((Sb_{a(t)} - \mathrm{s2})\times\left(1 - a_{coef}\right)\right) + \left(\frac{B_{recov}}{k_{ec}}\right) \qquad (7)$$

After that, the tracking of by-products recovered to distillation (B_{recov}) outstands as the result of crystallization volume (C_t) at year t, times the sugar waste rate (k_w) and the tech efficiency crystallization rate (k_{ec}), assessing the low quality syrup (L_{syr}) production in 2017.

$$L_{syr(t)} = \mathrm{s4} - \mathrm{B}_{recov} + (\mathrm{C_t}\times\mathrm{k}_w\times k_{ec}) \qquad (8)$$

An important step for the understanding of this model is the appraisal of the Sugar production, expressed in a general form in the equation 9.

$$\mathrm{S_{p(t)}} = \mathrm{S_{p(t-1)}} + (\mathrm{C_t}\times k_{ec}) - S_{s(t)} \qquad (9)$$

Where $Sp_{(t-1)}$ refers to previous year sugar production added to the outcome of crystallization volume (C_t) in year *t*, times the tech efficiency crystallization rate (k_{ec}), after that the Sugar sales of present year is taken away. In the equation 10 displayed below, the Distillation byproduct production (D_{byp}) is expressed in terms of Alcohol and Bioethanol production which are deducted from the Distillated biomass state.

$$\mathrm{D_{byp}} = \mathrm{s5} + (\mathrm{D_t}\times k_{ed}) - (\mathrm{A_t} + \mathrm{B_t}) \quad (10)$$

One of the core obstacles in data gathering for IS is that flow rates and technical coefficients of waste energy and materials are not usually measured or recorded as they are not essential for the plant. Therefore, when information was not available, missed data was calculated or estimated using design conditions and national average efficiency rates. Whenever possible, gathered data was compared to similar plants, national average data or scientific literature for verification purposes. In the equation 10, s5 illustrate the starting value, of distilled by-products, $D_{t,}$ produced in time t by the tech efficiency distillation rate, (A) is the alcohol and (B) the bioethanol produced.

$$\mathrm{C_t} = \left(\mathrm{Sb_{a(t)}} - \mathrm{s2}\right)\times\mathrm{a}_{coef} \qquad (11)$$

In the equation 11, the crystallization volume of year t (C_t) is estimated throughout the allocation of available sugar beet dismissing the sugar beet storage. We can observe in equation 11 that sugar beet storage (s2) is withdrew from Sugar beet availability at year t ($Sb_{a(t)}$), then multiplied by the sugar production allocation coefficient ($a_{coef,}$). Moreover, the CO_2 emissions model (E) at year t is shown in the equation 12.

$$\mathrm{E_t} = \left(\mathrm{k}_{c1}\times\mathrm{S_{p(t)}}\right) + \left(\mathrm{k}_{c2}\times\mathrm{D_{byp(t)}}\right) \quad (12)$$

Regarding the feedback loops mechanisms in the model, the equation 12 exemplifies the difference between emissions rates resulting from the sugar production (S_p) and low quality syrup (k2). Finally, the sugar beet value chain model in the BPP is completed by the Stillage estimation function (F) at year (t) as shown in the equation 13, where the sugar production volume (Sp) and the distilled byproducts (D_{byp}) at the year t, are both multiplied by their respective stillage production rates for sugar (k_{ssu}) and low quality syrup (k_{ssy}). This model depends on the sugar beet biomass harvested, which in turn depends on the efficiency rates and production yields.

$$\mathrm{F_t} = \left(\mathrm{S_{p(t)}} \times k_{ssu}\right) + \left(D_{byp(t)} \times k_{ssy}\right) \qquad (13)$$

Outcomes

The systems dynamic model presented in this paper entail the sugar beet value chain in the Bazancourt-Pomacle Platform including the sugar beet production mix over the last 10 years and the strategic decisions of individual firms on sugar, bioethanol or alcohol production. Therefore, it is possible to improve our understanding of biophysical exchanges in the IS by unfolding the synergic input-output flows between firms at the BPP, those flows were usually considered as black boxes, since they are considered of less importance for individual firms and therefore, they are generally not monitored or even measured. The outcomes of this paper seek to encourage stringent regulations in terms of industrial ecology, leading multilayer agreements for territorial sustainability, since territorial system dynamics is the methodology able to integrate the complex systems within a meso analytical scale.

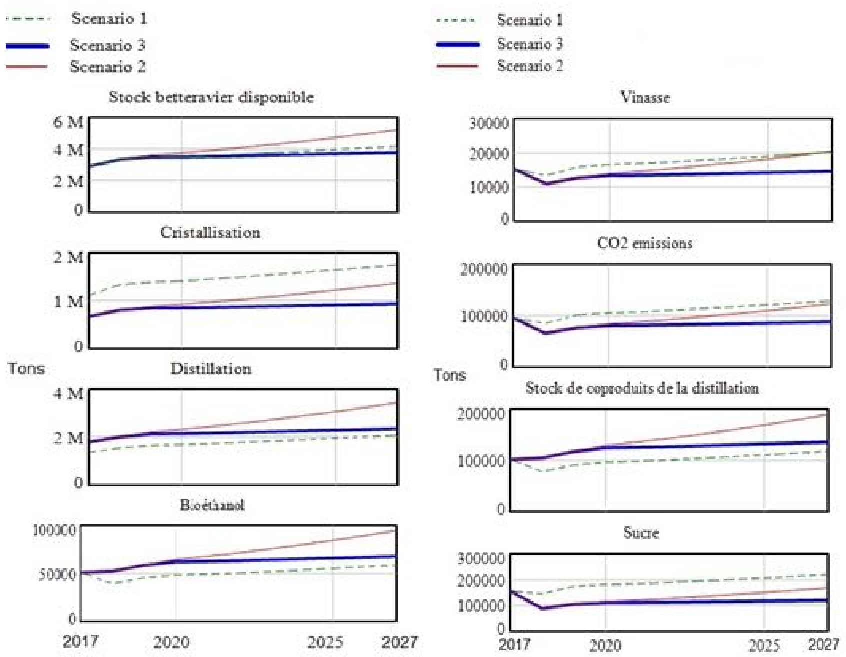
Although, simulations provide a larger scope in the territorial management in a complex agroindustrial ecosystem like the BPP, this is also conditioned to a series of exogenous technical, economic and political variables, over which the system's actors have no control, such as the international market price and European agricultural policies. The territorial system dynamics, which is the methodology that develop the simulations, is based on a rational allocation of products and by-products derived from the sugar-beet value chain. This paper identifies the exogenous and endogenous variables of the model, giving answer to an important challenge in the IS research field, because once identified those flows, stocks, actors and motivations potentially influenced by the system, we can develop a functional systemic model where the endogenous key drivers are not underestimated. Therefore, since the model is composed mainly by variables over which the system has control, the simulations produced by the model gain in political relevance as political decision tool.

One of the advantages provided by those simulations is the possibility to test impacts and effects of resources allocation. Our results suggest that decisions to invest in the distillery lead to a reduction in sugar production, and hence a reduction in by-products that can be reused and made profitable via the synergies at the BPP, which could put such synergies at risk. Once complete, this type of tool provides information on incoming and outgoing flows, on the stocks in the system, and on scenarios likely to improve the performance of the agro-industrial ecosystem. For example, set up the products and byproducts mix that utilize sugar beet as input, confirm our hypothesis about the relationship between the decrease in the sugar beet stock and production and the strategic turn in the allocation of available sugar beet to higher value added market segments like biofuels, biotechnology, bioplastics, biomolecules, etc.

We decide to present three scenarios in this paper, all of them coming from the territorial system dynamics model, which is able to simulate the trajectories of the BPP sugar beet ecosystem in the period from 2017 to 2027:

- **Scenario 1 (baseline)**: The starting conditions presented in 2017 continue with the trends until 2027.
- **Scenario 2**: The rate of sugar and alcohol production changes from 50%-50% to 30%-70%, with an annual increase in the cultivated area of 6%, resulting from a decision to specialize in distillation processes providing more added value. This enables us to simulate the consequences of such a choice in the face of falling sugar prices.
- **Scenario 3**: It incorporates the hypotheses of scenario 2, and adds the hypothesis that sugar beet production will fall by 5% per year, that is, a lower deceleration than the 15% observed in France in 2010, 2011, and 2012. This enables us to simulate the impact of climate change resulting in extreme periods of rain or drought. The outcomes of the three scenarios are depicted in Figure 2.

Figure 2. Systemic simulation trends of PBP from 2017 to 2027



- The dotted green line shows the trajectory in the baseline scenario, (illustrating a stable system), which assumes a moderate increase in sugar and bioethanol production
- The solid red line shows the increase in sugar beet stocks and the fall in sugar production. The difference in the starting point for Distillation and Crystallization in the baseline scenario is due to the fact that the change in the spread between sugar and alcohol production takes effect as soon as the decision is taken. There is also a short-term fall in stillage and CO_2 production, but the levels later recover. These changes could engender a temporary crisis in the reuse of CO_2 by Air Liquide and in the reuse of stillage for soil conditioning.
- The solid blue line shows beet stock levels similar to that in the reference scenario, but also a lack of improvement in sugar and bioethanol production, which leads us to believe that a production mix that strongly favors sugar beet biomass distillation over sugar production becomes more vulnerable in the long term, because by concentrating on bioethanol and alcohol for beverages, the center would be subject to the risk of a less diversified market.

Conclusion

This paper try to clarify the way in which industrial ecology principles work in a complex bioeconomic context. We identify territorial system dynamics as the best methodological tool to describe, analyze and model the complex stock and flows dynamics, encompassing the actors' behaviors effects in the system. The territorial approach related to Industrial Ecology field in general, facilitate the identification of values and interests that govern the local structure at the agro-industrial ecosystem, then integrated into a collective rational allocation of common resources within collaborative players. Herein, we advance the idea that former waste, herein conceptualized as by-product act as commons from the social choice theory (Sen, 2012) and institutional change theory (Callon, 2016; Ostrom & Basurto, 2011) perspective, insight that would be furtherly developed by the author. System dynamics methodology lead us to merge the biophysical and social influence of actors and their impact on the emergence and sustainability of IS platform. As this study focuses on the material synergies between firms, the energy flows is not considered in this analysis. Further research is therefore needed to investigate the energy potential of BPP. Assessing material and energy aspects together will lead to a better understanding of IS contribution to sustainability.

From the findings presented in this paper, we can conclude that functional understanding of systems gains in appeal when it combines the material stock and flows understanding with the distortions caused by market power relationships on a micro scale. For example, the end of European quotas in 2017 and the production mix change (products and by-products) for sugar beet biomass. Our results suggest that decisions to invest in the distillery lead to a reduction in sugar production, and hence a reduction in by-products that can be reused and made profitable via the synergies at the BPP, which could increase risk for such synergies.

Once complete, this type of tool provides information on incoming and outgoing flows, on the stocks and scenarios likely to improve the performance of the agro-industrial ecosystem. It makes the role of local stakeholders in BPP circular bioeconomy strategies clearer, and provides recommendations for public policy. Thus, territorial system dynamics let innovative practices emerge in the analysis, because business as usual could be overcome throughout the functional understanding of leverage points able to influence pathway dependencies, i.e., the investment practices in eco-efficiency that lead to a significant reduction in by-products synergies potential.

It should be noted that collaboration between industries in bioeconomy for symbiotic exchange is entwined with social interactions. Regarding our research methods and conclusions, this study is not criticisms free, the robustness and validity of our model could be questioned due to the difficulties in data gathering, because flow rates of waste materials are usually not measured or recorded, as they are not essential for the individual firms. Moreover, the ideas gathered during the literature review about industrial symbiosis are not always directly transferable to the bioeconomy. However, the originality of this methodology can contribute to improve our understanding of the territorial role in the narrowing strategy from circular Bioeconomy. The novelty of territorial system dynamics stands on the insightful ideas coming from different scientific fields supporting the comprehensive treatment of quantitative and qualitative data, structured in a systemic and reproducible way and acknowledged through adapted sustainability indicators.

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Circular Economy, A new Paradigm For Europe?

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Abstract: Circular economy generally refers to an economic model whose objective is to produce goods and services in a sustainable way, limiting the consumption of resources and the production of waste. The aim of circular economy is to decouple from the linear economic model, shifting from the extract-produce-consume-throw away model to a "circular" economic design. This study proposes contrasts with this narrow and reductive vision of circularity. The circular economy should not be reduced to an economic model, as it is mainly a paradigm shift that is part of strong sustainability. It renews industrial standards by advocating symbiotic relationships built on cooperation rather than competition. It implies the use of "Systems Thinking" to draw its foundations from interdisciplinarity and the study of complex systems. Finally, it refers to challenges that are ecological, political, social, economic and managerial at the same time. The article considers that this paradigmatic vision could lay the foundations for a new model for Europe.

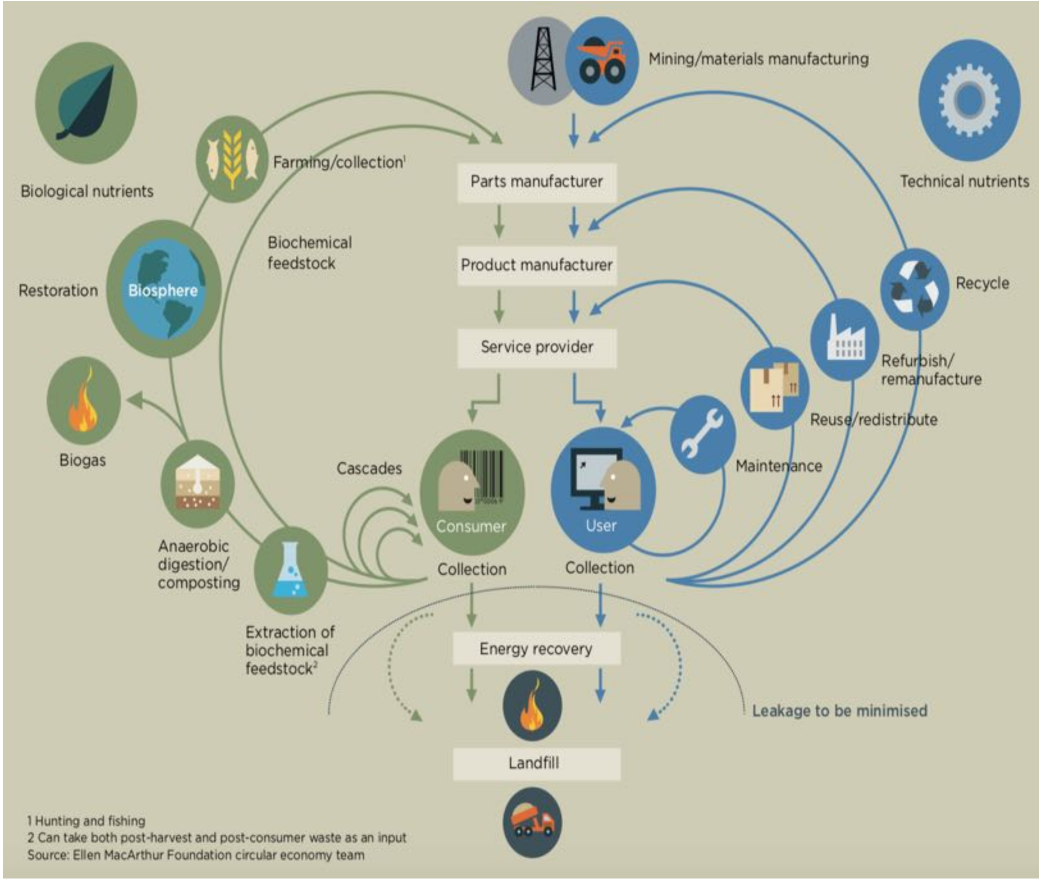
Keywords: Circular economy, Industrial symbiosis, Paradigm, System thinking, Sustainability

Introduction

The contemporary understanding of the Circular Economy (CE) counts on abundant conceptual and theoretical literature (Pinto, 2019), ranging from its practical applications in industrial processes to its macro-economic effects, the 3R Principle (reduce, reuse, recycle) being a noteworthy example (Lewandowski, 2016; Haas et al., 2015). Geissdoerfer et al. (2017) defined Circular Economy as a regenerative system in which resource input, waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops, via long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing and recycling. Prieto-Sandoval et al. (2018) considered CE to be a paradigm shift that requires industries, policy-makers and consumers to innovate in the way they produce, legislate and consume, respectively. Circular Economy approaches materials from two perspectives (EMF, 2012): (a) *biological nutrients*, which should eventually reintegrate into the biosphere without causing any harm –, and (b) *technical nutrients*, which circulate in the economy. In order to promote the shift from traditional linear production economies towards circular behaviour, CE suggests that all industrial activity should be performed by using waste flows as inputs, by adopting renewable and clean energy sources and by designing outputs in such a way that allows for collection, recycling, refurbishing, reuse, redistribution, maintenance and sharing throughout their life span (EMF, 2014, 2015, 2016, 2017).

Additionally, CE also suggests that the monetary flows that permeate the materials in circulation directly reflect the biophysical costs of their extraction, transformation, use and reinsertion into either economy or biosphere, minimizing speculation as much as possible in order to protect the cost-effectiveness of the model (Pinto, Sverdrup, Diemer, 2019). In 2012, Europe committed itself to the application of CE as its economic model, boosting a transition to resource-efficient practices that would eventually lead to regenerative progress towards nature (EMF, 2015, 2018, 2019).

Figure 1: Outline of Circular Economy

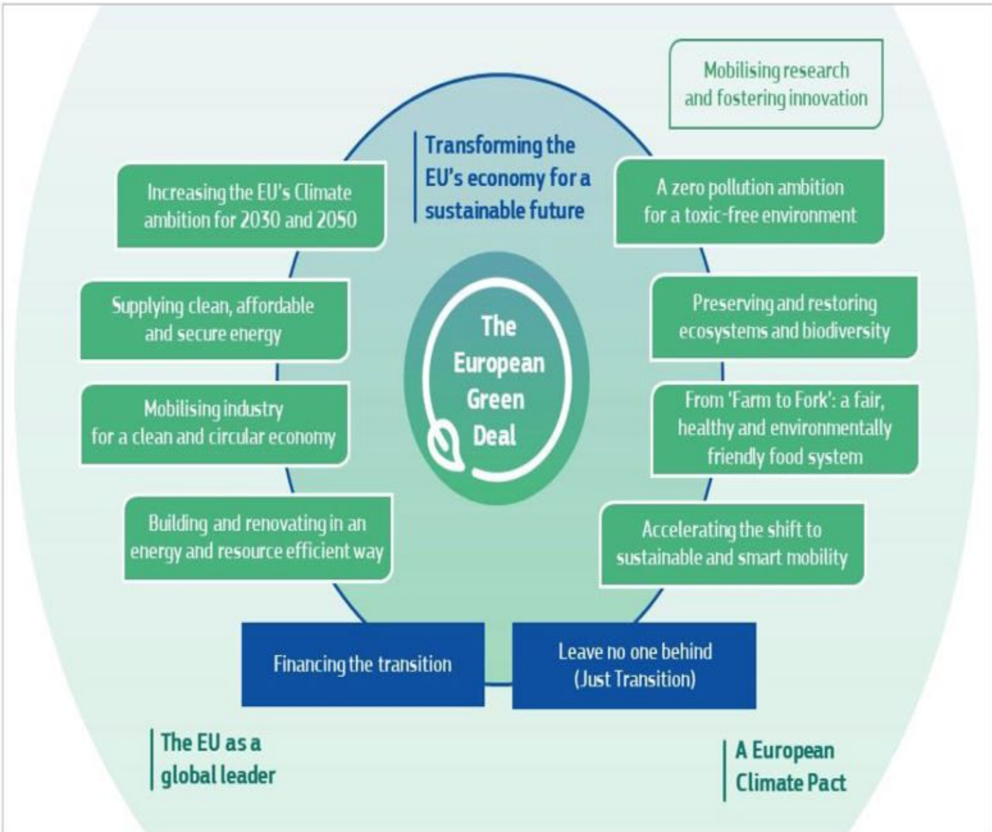


Source: EMF (2012, 2017)

The Ellen MacArthur Foundation played an important role not only in the popularization of the concept in the 2010s, but also in the development of many Circular Economy tools for businesses, academia and policy-makers. Circular Economy is defined as "*an industrial system that is restorative by intention and design. In a circular economy, products are designed for ease of reuse, disassembly and manufacturing – or recycling – with the understanding that it is the reuse of vast amounts of material reclaimed from end-of-life products, rather than the extraction of new resources, that is the foundation of economic growth*" (EMF, 2012). From a practical point of view, what caught the industry's attention the most were the concepts within CE, some of which borrowed from the previous Green Economy Framework: Biomimetics, Cradle-to-Cradle Design, Ecolabelling and Industrial Ecology (Winans et al., 2017; EMF, 2013).

In December 2019, European Commission proposed a *European Green Deal* (EGD) for the European Union and its citizens (European Commission, 2019). This commitment is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy, decoupled from resource use and set to become carbon neutral by 2050. A roadmap of the key policies and measures needed to achieve the European Green Deal has been presented and today the EGD is an integral part of the Commission's Strategy to implement the United Nation's 2030 Agenda and the Sustainable Development Goals. The following figure illustrates the various elements of the Green Deal.

Figure 2: European Green Deal



Source: European Commission (2019)

In the Communication on the EGD, the European Commission committed to the adoption of a new Circular Economy Action Plan to accelerate and continue the transition towards a circular economy (COM 23/12/2019). for the Commission, Circular Economy is defined as an "*economic system in which the value of products and materials is maintained for as long as possible; waste and resource use are minimized, and resources are kept within the economy when a product has reached the end of its life, to be used again and again to create further value*" (EC, 2012). In March 2020, the action plan was to be associated with the EU industrial strategy in order to mobilize the industrial sector and all the value chains towards a model of sustainable and inclusive growth. Leverage points have be identified: (1) Move away from a linear economy and mitigate its associated impacts on the environment; (2) Boost design, production and marketing of sustainable products; (3) Empower consumers to contribute to the circular economy; (4) Reduce waste generation and support the modernisation of certain waste laws ; (5) identify actions to address high impacts sectors (textiles, construction, electronics, plastics); (6) integrate social and geographic impacts of circular economy; (7) develop innovation and investment opportunities for circular business models.

While the European Green Deal is close to a real transformation of the European economy (the shift towards more sustainability), circular economy has also started a similar process, which can be associated with a new paradigm (Arnsperger, Bourg, 2016). By paradigm, it is meant a representation of the world, a way of seeing the world and taking distance from usual practices. This paper aims to engage the circular economy in a "*strong sustainability paradigm*". By these terms it is meant, on the one hand, that the flows of matter and energy related to our human activities must be compatible with planetary boundaries. On the other hand, that humanity needs to close the loops of our ecosystem at the macro level. The following three issues are discussed in the following sections: (1) circular economy must rely on symbiotic relationships in order to reach the state of "industry 6.0"; (2) circular economy requires "Systems Thinking" and the integration of tools that draw their strength from interdisciplinarity; (3) circular economy must take up new challenges, including that of an economy of temperance and sobriety.

Industrial symbiosis, the driving-force of circular economy

Within the framework of circular economy, the study and the promotion of Industrial Symbiosis (IS) plays an important role (Erkman, 1997; Chertow, 2000; Morales, Diemer, 2016; Diemer, 2017). In ecology, the concept of symbiosis describes a closed and often long-term interaction between two or more different biological species. This long-term association may, but does not necessarily, benefit both participants. Symbiotic relationships take place naturally in an ecosystem Based on the concept of biophysical symbiotic exchanges, Industrial Symbiosis engages "*separate entities in a collective approach to competitive advantage involving physical exchange of materials, energy, water and by-products*" (Chertow, 2000) for mutual economic and environmental benefits (Christensen, 2006). Industrial Symbiosis closes loops by turning waste into valuable materials, which can then replace raw materials in an industrial system, emulating natural closed ecosystems.

Multiple references of industrial symbiosis can be traced back to the IS complex in Kalundborg, Denmark (e.g. Ehrenfeld, Gertler, 1997; Esty, Porter, 1998; Ehrenfeld, Chertow, 2002; Brings, Jacobsen, Anderberg, 2004; Christensen, 2006). This model can be viewed as either a paradigm or an isolated phenomenon, where a number of companies were coincidentally bound together by waste, water and energy exchanges based on mutual contractual dependency. The development of industrial symbiosis in Kalundborg has been described as an evolutionary process in which a number of independent by-product exchanges gradually evolved into a complex web of symbiotic interactions among five collocated companies and the local municipality (Ehrenfeld, Gertler, 1997). The symbiosis includes a powerplant (Asnaes), an oil refinery (Statoil), a biotech and pharmaceutical company (Novo Group), a producer of plasterboard (Gyproc), and a soil remediation company (Soilrem). The various material flows among these companies are based on water, solid waste and energy exchanges. For example, the power plant produces heat for the town of Kalundborg and steam for Novo Group and for the Statoil refinery. Heated cooling water leaving the Asnaes powerplant and is piped off to a nearby fish farm, which uses it to ensure full scale productivity of the fish. The Industrial Symbiosis exchanges at Kalundborg have significant economic and environmental benefits, as a result of direct substitution, utility sharing or water/energy redistribution. Nevertheless, it is also interesting to understand and interpret the success of Kalundborg. Jorgen Christensen (2006), consultant to the Symbiosis Institute, considers that the success of IS exchanges depends greatly on the historical context and perspectives in which inter-firm arrangements are viewed. Industrial Symbiosis is not regarded as an isolated environmental solution, but rather as part of a process of improving the total performance (environmental, economic, social, cultural) of individual companies as well as the collective organization. Five factors are at the origin of the success of Kalundborg : (i) collaboration between different industries; (ii) the importance of identifying a market solution; (iii) short physical distance between the participants (Regional Industrial Ecology); (iv) willingness to work together and share values; and (v) good communication between partners.

In the State-of-the-Art, Industrial Symbiosis is often associated with process studies (industrial metabolism) and tools (material and energy flows, input-output analysis, life cycle analysis), efficiency improvements, social context, and dynamics of the learning process of inter-firm organizational strategy. While these approaches have made it possible to better understand the process of symbiosis emergence – as well as the diffusion of social innovations -, to identify the economic and environmental benefits of such an approach, and to identify the constraints and opportunities of an inter-firm strategy; they have the great disadvantage of reducing symbiosis to its simplest expression, that of a collective organization built on synergies.

By insisting on the fact that industrial symbiosis is indeed a key driver in the transition to the second generation of circular economy, and thus to the emergence of a new paradigm, this study postulates that industrial symbioses (and thus the circular economy) will be led to redesign the industrial challenges of the future (industry 6.0). They are thus part of a transitional process, which started in the 19th century with the concept of Industry 1.0 (see table 1 below).

Table 1: Stages of industrial transition

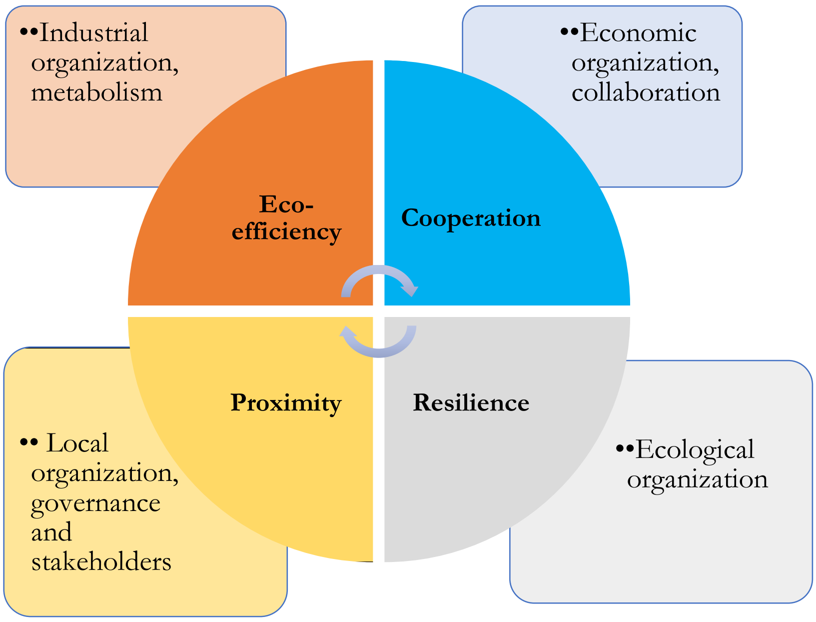
Industry 1.0	Industry 2.0	Industry 3.0	Industry 4.0	Industry 5.0	Industry 6.0
Mechanization and standardization of work. Performance focus on human productivity. Introduction of steam in the mechanization of work	Introduction of electricity in the various production processes. Use of assembly lines. No discontinuities in the production	Introduction of computer and automation to rule the industrial process. Use of robots in the production (linear program managed by human)	This is the era of Cyber Physical Systems (CPS) which comprises of smart machines, storage systems and production facilities capable of autonomously exchange information, triggering actions and control each other independently.	Willingness to reinject human beings into industrial production: this is the current worldwide trend, with the creation of intelligent factories, the development of the IoT ("Internet of Things") and collaborative industries.	To develop more sustainable societies, industries need to better understand how to respond to environmental, economic, social, cultural, technical and political challenges and transform industrial behaviour. Are Industries able to be sustainable (oxymoron?)

Industry 6.0 should be the next step of a long process, the societal challenge which requires to drive industries toward sustainability and to convert traditional organizations into Industrial Symbiosis. This change of perspective makes it possible to consider Industrial Symbioses as forms of social innovation that can respond to the following eight challenges: (1) position the industry at the heart of sustainability; (2) define the industrial ecosystem at a local scale (eco-industrial parks or industrial corridors); (3) reintroduce industry into the urban ecosystem in a hybridisation process that no longer seeks to reject industry and remove it from a city's boundaries, but is based on the search for potential synergies within the sustainable city; (4) introduce agriculture and agricultural activities into symbioses and in particular urban symbioses (urban agriculture development); (5) develop Bio-Based Economy or Bioeconomics projects by linking matter, energy and information,

and more generally, biology, thermodynamics (entropy) and information science); (6) transform CO_2 into products; (7) define a reference framework for industrial symbioses likely to identify islands of sustainability; (8) rethink the social dynamics accompanying the different phases of the industrial transition.

This transformation of industry (more especially European industries) should be able to cover many areas (understand local/global levels of IS - bottom-up vs top-down strategies- and cross-scales for urban and industrial symbiosis ; Social/environmental/economical/cultural aspects of the IS dynamics ; Industries and economic sectors challenging renewable energy transition, emissions of GhG, electronic waste, products with rare metals) and how integrate these challenges in the supply chain ; new opportunities for IS and circular economy in specific sectors and integration of end-of-life services) and to reach expected impacts (understanding the dynamics of industrial processes and closed loops in circular economy paradigm, modelling industrial symbiosis dynamics, identifying the strong sustainable pillars of IS - eco-efficiency, proximity, resilience and cooperation - ; understanding the learning process of IS emergence ; producing case-studies to improve the knowledge of the learning process necessary to create Industrial Symbioses ; reconnecting Urban Dynamics and Industrial Dynamics in the renewable energy transition and climate change context).

Figure 3: The four key-drivers of strong sustainability for industrial symbiosis



Source: Revised figure from Diemer and Morales, 2016

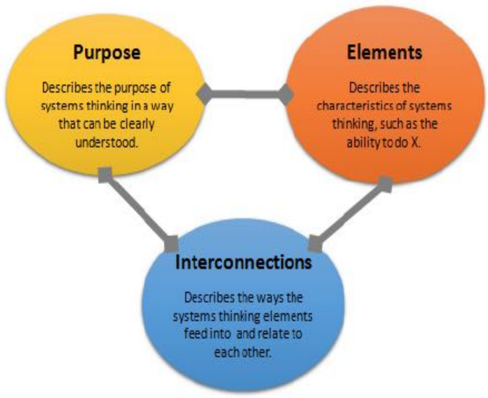
Circular Economy, from Systems Thinking to integrated tools

As a new paradigm, circular economy needs a new research program integrating methodology and tools. "System Thinking" seems appropriate to redesign circular economy because it implies an underlying philosophy strongly embedded in interdisciplinarity. Integrated tools from interdisciplinarity reinforce the usefulness and broaden the spectrum of circular economy.

Systems Thinking for Circular Economy

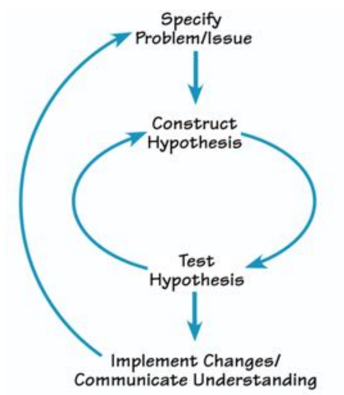
Donella Meadows (2008) defined a system as "*a set of things of things – people, cells, molecules or whatever – interconnected in such a way that they produce their own pattern of behaviour over the time*" (2008, p. 2), System thinking is the "*ability to understand these interconnections in such a way as to achieve a desired purpose*" (Stroh, 2015). Systems thinking is a sensitivity to the circular nature of the world we live in; an awareness of the role of structure in creating the conditions we face; a recognition that there are powerful laws of systems operating that we are unaware of; a realization that there are consequences to our actions that we are oblivious to. The overall concept underpinning this approach is that systems thinking is the art and science of making reliable inferences about behaviour (Richmond, 1994) or the discipline for seeing wholes and interrelationships (Senge, 1990), and thus it is helpful and relevant to raise and solve problems. Helpful (figure 4), because it is a simple way to describe the purpose, the elements and the interconnections. Relevant (figure 5), because it gives a clear picture of the interactive step process used in applying system thinking. Firstly, you specify the problem or the issue you wish to explore or resolve. Secondly, you construct hypothesis to explain the problem and test them using mental models and computer simulation models. When you are content with what you developed, you can communicate with clarity and begin to implement change, while continuously testing the impact of the measures you want to implement and thus monitor system behaviour. Systems Thinking describes how the world works and allows us to imagine how the world could be.

Figure 4: The system Test



Source: Arnold and Wade (2015)

Figure 5: The Step Process



Source: Richmond (2000)

The main ideas, assumptions and models for circular economy match what we call the seven critical Systems Thinking Skills (Richmond, 2000): Dynamic Thinking, System-as-Cause Thinking, Forest Thinking, Operational Thinking, Closed-Loop Thinking, Quantitative Thinking, and Scientific Thinking.

Dynamic thinking must help us to define the problem we want to tackle, in terms of a pattern of behaviour over time. The main hypothesis of the paper is that industrial and urban symbioses are the main pillars of circular economy. In particular, symbiosis dynamics tackles biophysical and socioeconomic circularity. The problem raises two questions: (i) How symbiotic relations may challenges climate action, environmental impacts, resource efficiency and scarcity of critical raw materials? and (ii) How symbiotic relations between different stakeholders of the circular economy entailed a systemic transformation of goals (eco-efficiency vs efficiency), entire value chains (shared value vs individual profit), business models (cooperation vs competition), space and time scales (local vs global), social issues (social norms, social behaviours). This transformation is complex and will take time, as the transitional process will follow different steps and pathways.

System-as-Cause Thinking is the following step. After proposing a pattern of behaviour over time, the next step is to construct a model to explain how behaviour patterns. It is necessary to define the boundaries of the system. The extensive boundary explains what to include and what to leave out. The intensive boundary defines the depth or level of detail at which the items included in the model are represented. Here, we postulate that the system is concerning relevant sectors selected from few criteria and is driven by internal/external forces. System-as-Cause thinking introduces the question of the resilience of the symbiosis and so on, the stability of circular economy.

Forest Thinking groups the details to give us an "average" picture of the system. It reduces the complexity of the model to similarities and main pathways. The project will use this approach to propose a biophysical model for companies and an integrated local dynamic model for Metropoles. For Metropoles, the model will challenge the Sustainable Development Goals (SDGs) with the hypothesis that circular economy – via industrial and urban symbiosis – may integrate different cross-sectoral issues to propose relevant actions for decisions makers.

Operational Thinking is dealing with causality and correlation issues. This step answers to the following questions: How is behaviour actually generated? What is the nature of the process? The project assumes that complex and interdependent relations between elements of the system make the correlation test and the success list of factors non-relevant. The design of the system has to focus on causalities. This step captures the nature of the learning process by describing its structure. Mapping the industrial process in industry and identifying best practices for business companies or designing new policies tools should improve the dissemination of the circularity concept.

Closed loops thinking assumes that causality is not projected one way and that each cause is not independent of all the others. The effect usually feeds back to influence one or more of the causes and the causes themselves affect each other. In System Dynamics, Causal Loop Diagrams (CLD) are a simple map of a system with all its components and their interactions. ***CLDs aid in visualizing a system's structure and behaviour, and analysing the system qualitatively.*** In this project, driving forces can stimulate the transition to circular economy (CE) but CE may also reinforce the driving forces. There are two feedback loops in any CLD. The Reinforcing Feedback Loop (R) is positive and self-enhancing, leading to exponential growth or to runaway collapses over time. The Balancing Feedback Loop (B) is negative and is equilibrating structures in systems. This loop is a source of stability and of resistance to change. Here, implications of the transition to Circular Economy, both reinforcing and balancing for the economy, for the environment and for the society will be assessed qualitatively. In the step of closing the loops, key drivers are integrated as trade flows, value chains, use of energy, land, water, natural resources, governance, in order to map the overall structure of the system and adjust delays. Balancing and Reinforcing loops will be used to explain the behaviour of potential adopters to CE or the resistance to behaviour change.

Quantitative thinking reminds us that quantitative is not synonymous with measurable. To perform a more detailed quantitative analysis, a causal loop diagram (CLD) has to be transformed to a stock and flow diagram (SFD). This is the step to create the model, to study and analyse the system in a quantitative way. The Closing the loops step plans to integrate "soft variables" such as motivation, self-esteem, commitment or resistance to change and "hard variable" such as energy use, land, water, labour demand, raw materials by using stocks and flows. A stock is the term for any entity that accumulates or depletes over time. A flow is the rate of change of a stock.

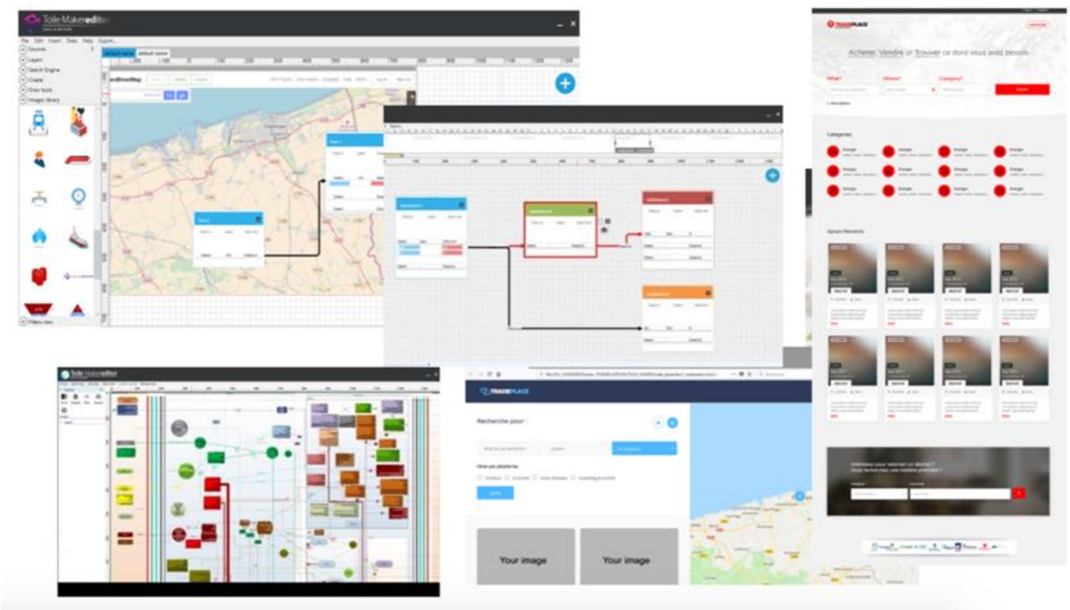
Finally, *scientific thinking* means that models should be useful. System thinkers use variables and data easy to understand, to make sense relatively to one another. They also want to know under what circumstances their model breaks down? What are the limits to their confidence that this model is useful? Where are the leverage points located? These different points engage the resilience of the Circular Economy Transition – as a process and not as a state.

Integrated tools for circular economy

Interdisciplinary combination of different tools proposes a helpful and relevant design of circular economy.

Tools for Industrial Ecology such as Material Flows Analysis (MFA) - Life Cycle Analysis (LCA) - are typically used in circular economy. These tools provide insights into the embedded carbon, water and land footprint of materials. As such, they can help identify what resource use can be avoided when implementing circular economy by means of extending a product's life time, reusing products or recycling materials. *Toile Maker* is a software solution for visualizing and highlighting interactions and flows between stakeholders of an industrial park/municipality in a dynamic and interactive way (see Fig.6). This interactive and visual mapping tool allows a better understanding and analysis of the local ecosystem. Additional functionalities in terms of the identification of industrial symbiosis are being developed using semantical analysis to foster circular economy and regional development by identifying potential complementary industries.

Figure 6: Toile Maker Project



Source: www.toilemaker.com

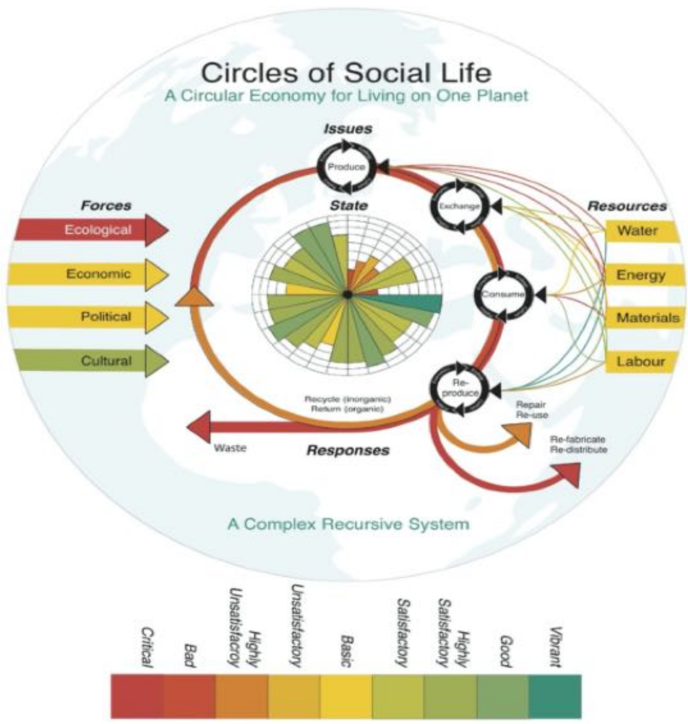
Physical Input Output Tables (PIOT) describe the flows of material and energy (*Energy Input Output Tables*, EIOT) within the economic system and between the economic system and the natural environment (Altimiras Martin, 2014). These tables are key to understanding the physical structure of economies, to having a snapshot of the actual physical productive structure and to devising environmental and industrial policies. This is even more the case as studying the transition towards a circular economy requires mapping and guiding the deep overhaul of the productive structure and associated technologies. Physical Input Output Tables have been suggested by the United Nations (UN) as the new backbone for the System of Economic and Environmental Accounts. However, no country is producing PIOTs mainly due to the huge statistical effort required to compile them. On average, it takes three years to consolidate each Monetary Input-Output Table, for which a system of national accounting is already in place; but Physical Input-Output Table have no equivalent system in place. Therefore, circular economy could use a new method and data sets that may help establish new procedures to build PIOTs with low data requirements.

Conception of an integrated dynamic model (biophysical and socioeconomic) at different scales seems relevant for country, cities and companies. At the national and European level, it challenges the question of modelling the macroeconomic consequences of the transition to a circular economy. Literature review on circular economy (Mc Carthy & al., 2018) has two main variants. The first approach involves the development of scenarios regarding material circularity or technological progress in one or several sectors (Bastein & al., 2013, Ellen McArthur Foundation, 2015). Scenarios are based on expert opinion, and are typically described in terms of higher recycling, manufacturing, repair or re-use rates. The second approach involves the use of economy-wide quantitative models, such as Computable General Equilibrium (CGE) and Macro-Econometric (ME) models. These models have two limits: (i) they consider that prices play the main role in determining supply and demand for products, commodities and natural resources (this is important in the context of resource efficiency); and (ii) they are based on a simple social accounting matrix (SAM) that accounts for economic flows throughout the entire economy. It seems possible to combine PIOTs with a System Dynamics Model (T21) to capture material flows and stocks to match economic, environmental, cultural, political and technological loops, and support the design and assessment of effective strategies to achieve the SDGs (Pedercini & al., 2019). At the metropole and city level, system dynamics (CLD, SFD) and key drivers, such as population, food, energy or employment, to map activities and actor networks, seem useful to facilitate the transition to circular economy and the convergence to SDGs. At this level, the question of measuring, collecting and monitoring data is crucial and open-source platforms seem relevant for policy makers. At the company level, LCA and MFA are introduced in a system dynamics model to produce a biophysical model and challenge ecological footprint (Pinto, Sverdrup, Diemer, 2018). This biophysical model may identify symbiotic synergies aimed to create collective added value, to reduce waste and water consumption, to optimize land use or to develop secondary raw material in eco-industrial parks or industrial symbiosis.

Scenario planning gathers and transforms information to explore the space of future options (Wack, 1985). Scenario planning is in particular useful when uncertainty is high, as it is the case in transformative processes. Therefore, the method is very interesting for strategic decision making on social, economic, political, technological and environmental issues. Scenario planning will allow a multidisciplinary group to identify the relevant focal questions to be addressed to circular economy and constructs narratives about the future that will incorporate the broadest imagined spectrum of uncertainties and trends. A scenario for circular economy (or transition to) is defined (1) as a description of a possible future situation and (2) as including paths of development, which may lead to that future situation (Li, Altimiras-Martin, 2015).

Circles of sustainability is a key method to provide a relatively simple view of the sustainability of a particular city, urban settlement, or region (James, 2015). The circular figure is divided into four domains: ecology, economics, politics and culture. Each of these domains is divided in seven subdomains, with the names of each of these subdomains read from top to bottom in the lists under each domain name. Assessment is conducted on a nine-point scale. The scale ranges from 'critical sustainability', the first step, to 'vibrant sustainability', the ninth step. The Circles of Sustainability method is a part of a larger project. Here, sustainability intersects with other social conditions, such as resilience, liveability, adaptation, innovation and reconciliation, as basic conditions of positive social life. Hence, the encompassing framework is called Circles of Social Life. The circles of social life can be used to design the *Circular Economy For Living On One Planet* (CE-LOOP). This initiative is about mapping a recursive system by identifying the different stages of the circular economy, the driving forces acting at each stage and the resources involved at each of these stages.

Figure 7: Circular Economy for Living on One Planet



Source: James, 2020, in this book

Circular economy and its new challenges

Circular Economy as a new paradigm, intends to go beyond the 3Rs or 4Rs model and the strategy of decoupling the economy from the environment. It creates new challenges for the economy and the society that, in this study, are classified as follows: Ecological Challenge, Social Dynamics Challenge, Policies Framework Challenge, Economic Paradigms Challenge, Business Model Challenge.

New Ecological Challenges

This challenge is based on three postulates. Firstly, it reminds us that human activities and economic growth have to be designed inside the planetary boundaries. These boundaries define what we can do and how we can do it. Secondly, mapping the economic system is not the first step of the analytical process, even for circular economy. Circularity is above all biophysical. The aim is to identify the flows, stocks and feedback structure that best explain the problem. Thirdly, if circular economy has often been presented as a way to reduce ecological footprint, the decoupling strategy (relative or absolute), which explains that economic activity could keep growing while reducing waste and greenhouse gas emissions, seems inefficient and counterproductive. By integrating environmental constraints, ***circular economy emphasizes the importance of the resilience pillar - the ability of organizations to resist external shocks***, such as climate change.

Social Dynamics Challenges

Social dynamics refers to the behaviour of groups that results from the interactions of individual group members, as well to the study of the relationships between individual interactions and group level behaviours. This field is really connected to complex adaptive systems, which concern most of the circular economy case studies. In the state of the art, circular economy explains that good policy offers short and long term economic, social and environmental benefits (EMF, 2013). It is a win-win strategy for the companies, the consumers and the users. Social dimension cannot be reduced to social benefit. Social dynamics is allowed to track problematic behaviour, to understand the process of emergence and diffusion of social innovations, to identify the social drivers of the system, or to lay the foundations for a collective impact of the actions carried out by individuals, groups of individuals and communities. ***A new social dynamic explains how the pillar of creativity can induce local solutions to meet societal, environmental and economic needs***.

Policies Framework Challenges

Circular economy used to be connected to adapted policy and policy tools for policymakers, including regulation, taxation and subventions. In fact, the problem is not to adapt policy but to identify the obstacles and barriers to a transition to the circular economy. The policies framework concerns European level, national level, regional level and local level. A better implementation and enforcement of legislation, the promotion of green banking and socially responsible investments, or the taxation of businesses using no recycled materials are the main recommendations. Six policy interventions have been identified: (1) integrating circular economy and systems thinking into university curricula (European Chair on Circular Economy) with the help of all the partners; (2) creating a public - private platform at the city level to speed up the transition to circular economy ; (3) investing public funds in infrastructure; (4) mapping the different characteristics of European, national and local taxation to improve environmental tax and reduce labour tax and revenue tax; (5) spreading the development of industrial symbiosis and clusters at the three levels (European, national and local) to create more synergy between nations (energy solidarity), between companies (a waste becomes a good) and between Metropole and citizens (to reduce public waste) ; (6) improvement of policy tools at the metropole level, as an area where people, consumption, energy use and waste are the most important. The road to sustainable cities has to follow the circular economy pathway. **From the policy side, the proximity pillar (bottom up strategy) seems more relevant than globalization (top down strategy)**.

Economic Paradigms Challenges

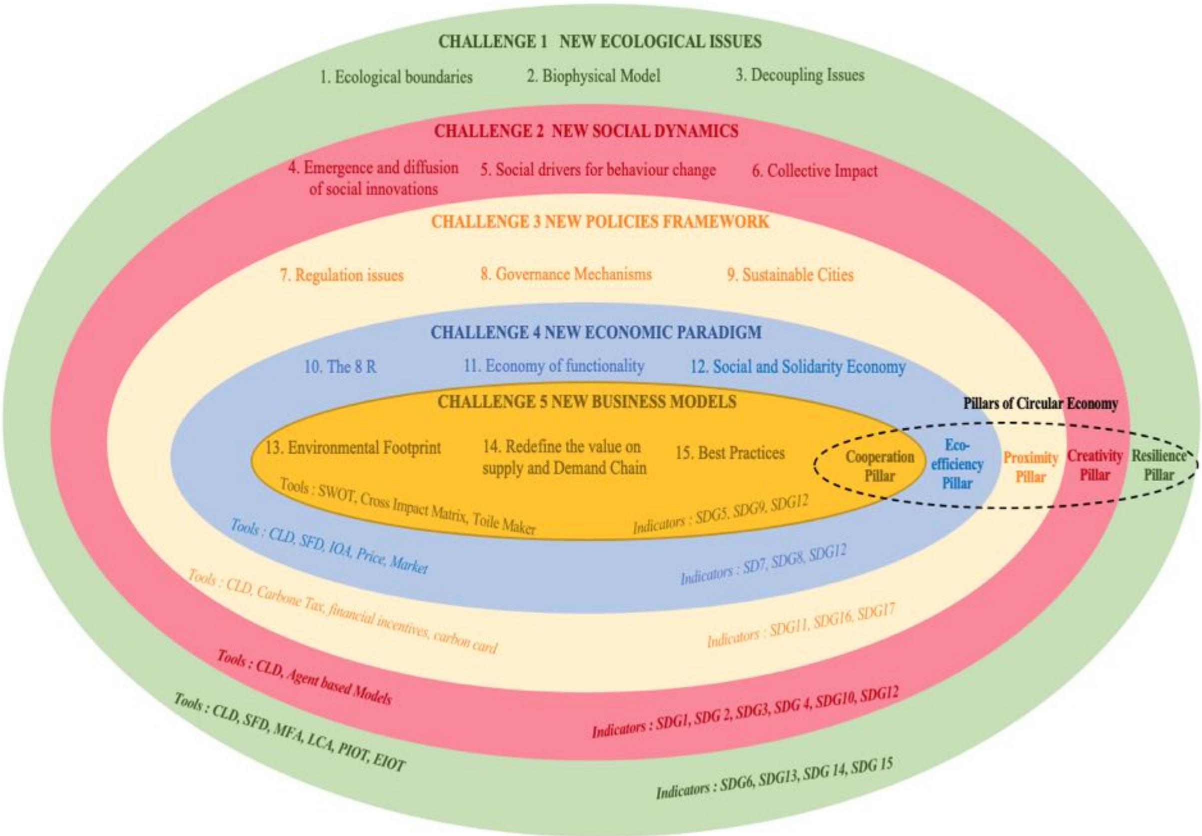
In the last years, circular economy has been presented as a new paradigm, a possible pathway to increase the sustainability of our system. This paradigm has been coded from the 4Rs (reuse, repair, recycling and Renew) to the 9Rs (Recover, Recycle, Repurpose, Remanufacturer, Refurbish, Repair, Reuse, Reduce, Rethink and Refuse). We propose to go beyond this approach and to discuss the core of the economic system. The transition to circular economy introduces three critical challenges: (1) reconnect the economic system with strong sustainability and planet boundaries. In that case, circular economy could find new dynamic from alternative models, such as degrowth. The reduction of working time, the introduction of local currencies or local food products, the improvement in the quality of products, the decrease in demand, all introduce a new way of thinking and new drivers of circularity; (2) Prosperity in a finite world invites us to question and review our economic models. In particular, we need to revisit the foundations and mechanisms that define contemporary societies today, as exchange value, property, market, price or competition. The economy of functionality (widely emphasized by Michelin) or the economy of sharing favours use, utility or cooperation over ownership, exchange value or competition; (3) The association of the circular economy with the social and solidarity economy may reconnect producers and consumers, provide innovative solution ensuring social foundations for inclusive and sustainable development. For example, agroecology may induce a circular and solidarity economy that prioritizes local markets and supports local economic development. Agroecology promotes fair solutions based on local needs, resources and capacities, creating more equitable and sustainable markets. Social innovations examples are participatory guarantee schemes, local producers' markets, denomination of origin labelling, community supported agriculture and e-commerce scheme. These innovative markets respond to a growing demand for healthier diets. Another example concerns the recycling of textiles. The community EMMAUS (France and International) started the economic activity of recycling used textiles. Today, 85% of textiles is recycled and EMMAUS keeps improving its business model, while at the same time also engaging itself to promote human values and social integration of migrants. Economic and solidarity circularity design a new socio-economic system where profit is not a goal but a way to reach a level of social and human development. Social and solidarity organizations could accelerate the transitional process to circular economy and improve the eco-efficiency pillar.

Business Model Challenges

New Economic paradigms suggest also new management and business models. Circular economy involves an operating framework that considers the high-level basis for value in an environmentally, economically and socially positive way. There is a set of business models that describes how an organization creates and delivers this value on the supply chain: (i) *Dematerialization* by reducing the amount of resources required to create products through digitalization on demand production or reusable products (Diemer and Dannequin, 2009); (ii) *circular inputs* for production (Diemer, Figuière, Praedel, 2013) ; (iii) *Product life extension* through design for durability, maintenance and repair, reuse, remanufacture (Pinto, Diemer, Sverdrup, 2019); (iv) Resource Recovery through recycling or composting (Diemer, 2012); (v) Product as a service including the Sharing Economy

(Diemer and Nedelciu, 2020); (vi) social circular economy (Diemer, 2020). Beyond these business models, CE as a paradigm could suggest few recommendations to encourage new initiatives: diffusion of laws in Europe to prevent planned product obsolescence, creation of an educational program to ensure circular economy, tax break for social circular enterprises to develop their growth. All these challenges make it possible to identify what we will call the 5 pillars of the circular economy, illustrated in Fig.8.

Figure 8: The five pillars of Circular Economy



These challenges may also specify the positive impacts that Circular Economy could provide for Europe.

Enabling more systemic policy decisions to further facilitate the transition to a safe, environmentally, friendly, efficient and effective circular economy in selected sectors

If the circular economy can be an important lever to achieve key policymaker objectives such as generating economic growth, creating jobs, and reducing environmental impact, it is necessary to design adapted policies for different scales and for different sectors. At the macro level (Europe, countries), it is necessary to summarize the opportunities and obstacles to move towards circular economy and make proposals to accelerate this process. If resource efficiency seems a prerequisite for the economy to stay within the planetary boundaries, the shift of the paradigm will challenge energy efficiency, the use of renewable energy and the largest and most resource-intensive value chains. Circular economy could identify viable options for a shift in taxation from labour to natural resource use and consumption.

Reducing waste-generation, negative health impacts, environmental pollution and greenhouse gas emissions, through efficient and effective use of both primary and secondary resources in Europe

The EU Action Plan for Circular Economy established a concrete and ambitious programme of action, with measure covering the whole cycle, from production and consumption to waste management and the market for secondary raw materials (bads become goods). The Circular Economy Paradigm aims to contribute to closing the loop of product life-cycles through greater recycling and re-use strategies and greater benefits for the environment, economy and civil society. Case studies have been selected to challenge the revised legislative framework on waste (July, 2018) : (i) EU target for recycling 65% of municipal waste by 2035; (ii) EU target for recycling 70% of packaging waste by 2030 ; (iii) Recycling targets for specific packaging materials (80% for ferrous metals, 75% for glass, 55% for plastic, 30% for wood) ; (iv) Reducing landfill to maximum of 10% of municipal waste by 2030.

Creating incentives and support the development of strategic governance mechanisms that enable the transition to a circular economy and contribute to the effective implementation of the Sustainable Development Goals in Europe

The circular economy concept has been presented at the United Nations Summits on Sustainable Development (1992) as a key to reduce demand for natural resources and to contribute to more sustainable patterns of production and consumption. Current arguments support that the growth of population and the increase of non-renewable resources exceeds several critical global, regional and local thresholds. This question is well known and the concept of "Planetary Boundaries" (Rockström, 2009) has been largely discussed. The circular economy must also be part of a logic of renewal of local governance mechanisms. Sustainable Development Goal 17 could be a factor in integrating stakeholders, initiating more systemic approaches and engaging the different actors to develop governance tools at the local level.

Supporting the achievement of climate commitments and specific quantitative targets on resources efficiency, recycling rates or waste disposal quotas

European Commission, Statistical Agencies, Foundations (EMF) and Companies have been engaged in measuring and following materials flows. Domestic material consumption or resource productivity are relevant to calculate environmental footprint. Climate change, air quality, municipality waste, land use or water scarcity introduce new scope and new targets. Modelling the biophysical flows and stocks of materials and services in a dynamic system creates increased complex challenges, especially if we are taking into account the cultural, political or ecological dimensions. Quantitative and qualitative indicators have to be considered to understand the transition to circular economy. New indicators have to be defined and tested. These include: the amount of municipal waste per capita for waste generation in metropoles; share of renewable energy and greenhouse gas emissions per capita (or GDP output) for countries; investments in human capital and non-profit indicators for companies; representations of circular economy in civil society (through surveys and interviews); share of circular economy in European and national programs of sustainable education. This last indicator is particularly crucial because companies and the civil society may lack the information, confidence and capacity to move from linear thinking to circular solutions. This is compounded by a lack of sustainability education in design, engineering, economics and other relevant subjects, and in business school. Problems may include a lack of training skills in repairing products, improving their lifetime or reusing them). European programs should integrate circular economy in education (universities, business companies, NGOs and cities) by supporting the creation of European Excellence Chairs on Circular Economy. Synergies could be developed with the Intergovernmental Panel on Climate Change to integrate circular economy in different climate change scenarios to go beyond mitigation and adaptation's policies.

Conclusion

In 2013, Paul Polman, Chief Executive Officer of Univeler signed the Foreward of the Ellen McArthur Foundation Report entitled "*Towards the Circular Economy*". In his words, circular economy promised a way out : « *Here products do not quickly become waste, but are reused to extract their maximum value before safely and productively returning to the biosphere. Most importantly for business leaders, such an economy can deliver growth. Innovative product designers and business leaders are already venturing into this space* » (EMF, 2013, Foreword). Circular economy generally refers to an economic model whose objective is to produce goods and services in a sustainable way, limiting the consumption of resources, as well as the production of waste. The aim is to decouple from the linear economy model (extract, produce, consume, throw away) for a "circular" economic model, with economic and financial benefit for all the stakeholders. The article that we propose contrasts with this narrow and reductive vision of circularity. The circular economy is not reduced to an economic model, it is mainly a paradigm shift that is part of strong sustainability. It renews industrial standards by advocating symbiotic relationships built on cooperation rather than competition. It implies the use of "Systems Thinking" to draw its foundations from interdisciplinarity and the study of complex systems. It refers to challenges that are ecological, political, social, economic and managerial at the same time. This paradigmatic vision could lay the foundations for a new model for Europe, more compatible with planet boundaries and social value. Circular economy is in line with Sustainable Development Goals (SDG), is an important way to achieve an ecologically civilized society and is opening huge opportunity to reach a sustainable urban development (cities should be the new landscape of circular economy).

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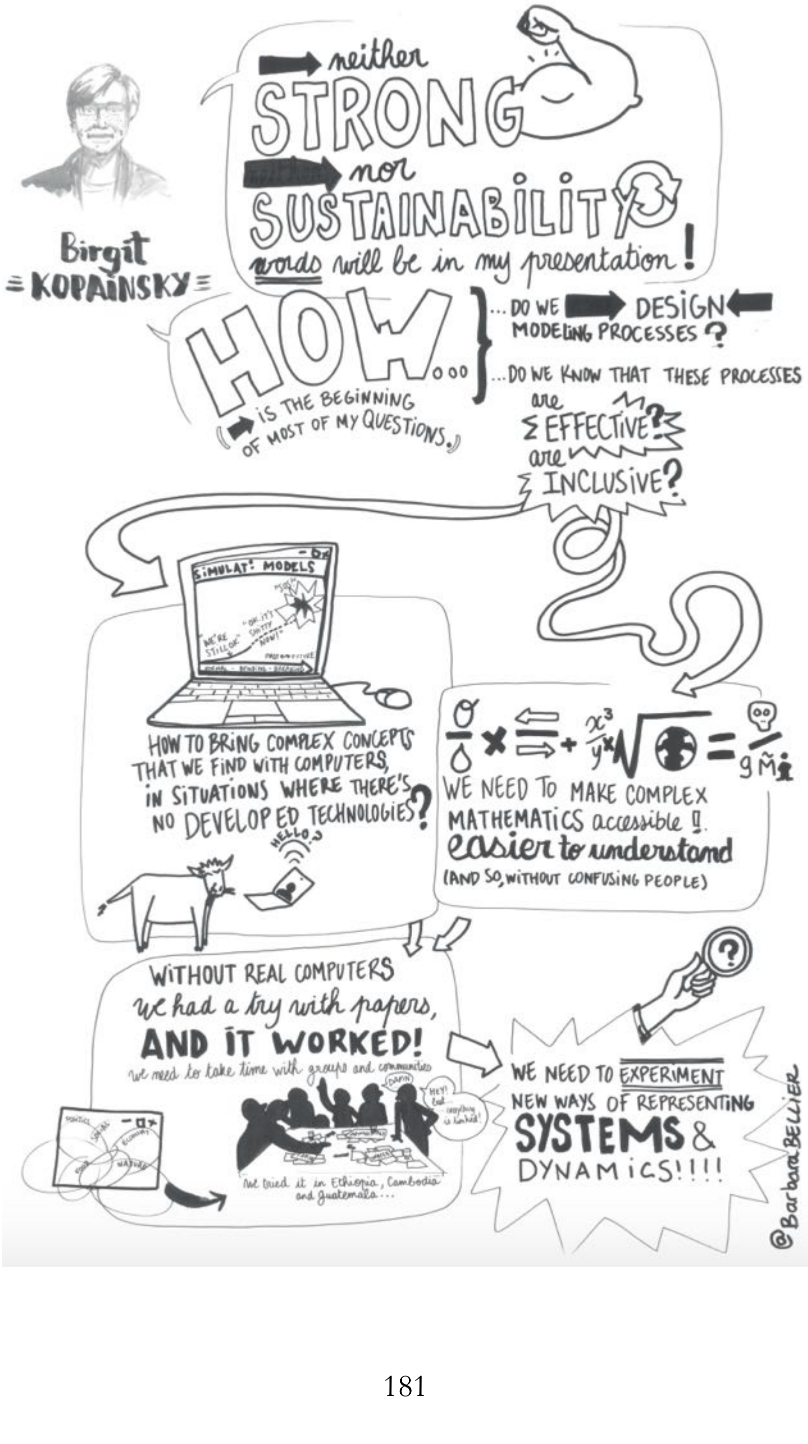
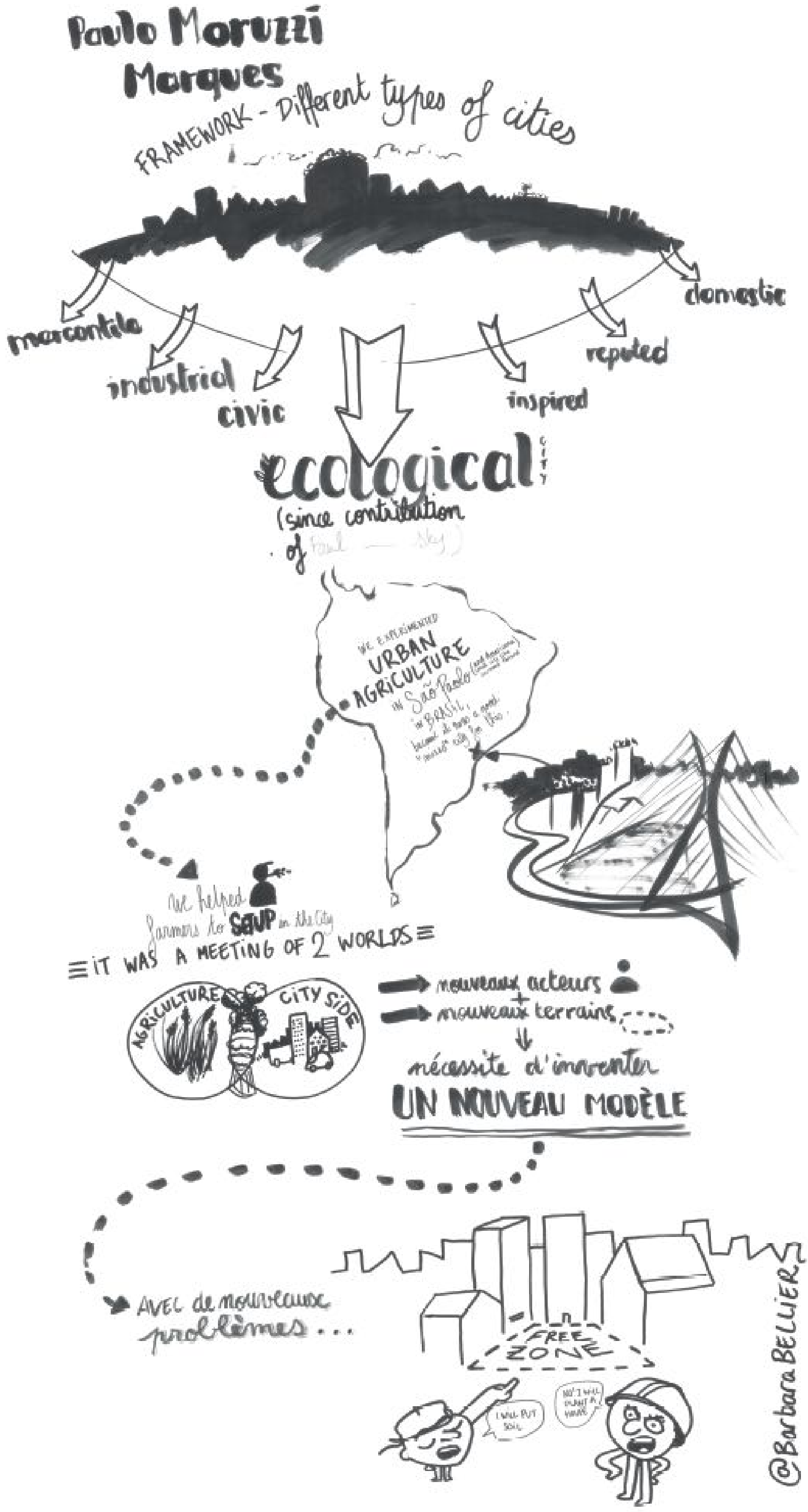
PART 3

TRANSITION TO STRONG SUSTAINABILITY




Paulo Moruzzi Marques
FRAMEWORK - Different types of cities
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FREE
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I WILL PUT
SOIL
@BarbaraBELLIER

Access to land. The perspective of food sovereignty on sustainable development through the example of urban and peri-urban agriculture in São Paulo

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Abstract: Urban and peri-urban agriculture is often considered an integral part of the Sustainable Development Goals (SDGs). This paper examines the discourses of the actors of urban and peri-urban agriculture in the state of São Paulo, Brazil. It relies on justification theory for the analysis of points of view collected through semi-directed interviews, observations and documentary analysis as well as on the notion of food sovereignty for its attention to justice. It appears that the question of the right to land can serve as an anchor for the notion of sustainable development, which has otherwise neglected the right issues. In contrast, the notion of food sovereignty points toward daily practices and calls for the inclusion of power questions in sustainability definitions.

Keywords: Urban and peri-urban agriculture, food sovereignty, sustainable development, justification theory, São Paulo

Introduction

Urban and peri-urban agriculture (UPA) and its governance constitute a dynamic field of research, driven by the increasing recognition of their connection with environmental, economic, social and public health challenges (Guiraud et *al.*, 2014; Thomson and Scoones, 2009). Among the most current approaches, and apart from the purely technical challenges of UPA, we can distinguish the questions raised in terms of citizen participation in extremely complex logistical and agronomic systems that have so far not been very transparent and reserved to market players (Moragues-Faus, 2017). In addition to these participatory issues, challenges of articulation between scales of action arise as a consequence of the transversal nature of food issues, which much similar to that of sustainable development, disrupts the ways in which social actors build strategies and evaluate their actions (Wald and Hill, 2016).

Today, we see that new actors are emerging and centre around governance in urban and peri-urban food production (Trauger, 2015). These include the particularly visible groups that explicitly or implicitly rely on the principles of food sovereignty. Food sovereignty offers a possibility to reflect on a theme that has not been at the front of discussion during this congress on sustainable development: that of power. Power allows us to anchor abstract models of sustainability in daily practices and place-based challenges. We are sensitive to calls such as the ones made by McCaulley and Heffron (2018) and James (2015) to think of justice as essential to conceptions of sustainability. In this spirit, our contribution aims to reflect on the nature of the relationships between land access issues, which rest at the heart of food sovereignty, and the way UPA actors link themselves to the notion of sustainable development. The latter is a multifunctional and dynamic phenomenon that contributes to the spatial diversification of urban land use, its development and governance

(Lohrberg and Licka, 2015). However, in order for UPA to participate efficiently in urban and peri-urban sustainable development, it is necessary to assess its potential levers and barriers within the broader territorial food system (Rich et *al.*, 2016). Our contribution also engages this issue.

The approach we adopted is located at the intersection of sociology and geography. Urban agriculture sites will be considered as integrating spatial objects (Lardon et *al.*, 2017) that constitute action arenas (Ostrom, 1990) for a series of public, private and associative actors. The data collection is based on non-participant observations, interviews and documentary analysis. It focuses on the discourses on UPA as well as on the actors' actions and spatialities. Specifically, our study is conducted in the state of São Paulo, Brazil. We seek to know how UPA citizen groups formulate their objectives, what are the principles of justice that underlie their claims, how is the notion of sustainable development mobilized by the actors, and if it satisfies the needs expressed in terms of social justice.

Among Brazilian cities, São Paulo is the setting for many urban agriculture initiatives. Americana, located some 120 km from São Paulo, is also an interesting example for our purposes. This is where the Milton Santos *assentamento* is located, thanks to the action of the Landless Workers Movement (MST). First, we will present the theoretical framework that serves as an interpretative instrument for our study by focusing on the theory of justification. We will then describe the two territories studied and the UPA actors involved before dealing with their discourses in terms of criticisms and strategies. We will see that UPA actors do not explicitly refer to food sovereignty and seldom to the notion of sustainable development. The theme of access to land is the strong element articulating the relationship between UPA actors. The notion of sustainable development is only used widely by public actors, potentially leading to mistrust toward the term among other actors. The tension between the right to housing and the right to land is one of the elements that lead us to conclude by highlighting the potential contribution that notions like well-being or quality of life hold for a better understanding of the justification principles of UPA from an environmental sustainability perspective.

From sustainable development to urban and peri-urban agriculture

Since its inception, the notion of sustainable development has absorbed numerous meanings. Indeed, one of its main thinkers, Ignacy Sachs, already considered in his 1997 evaluation of the United Nations Conference on Environment and Development, RIO92, that all references to economic growth were replaced by the term "sustainable development", thus rendering its original meaning obsolete. As Roberto José Moreira (2000) suggests, the proliferation of meanings around sustainable development is explained by the amount of divergent interests that exist in this field of idea production and ultimately empties it of meaning.

In this context, social movements and actors advocating the anchoring of sustainable development in an inclusive perspective insist on the imperative of combating social inequalities and attaining environmental citizenship (Dobson, 2003) in order to promote a development that can be reconciled with the preservation of natural resources. For example, *La Via Campesina* has promoted the notion of food sovereignty, by incorporating the defence of peasant agriculture to the preservation of the environment through agro-ecology. It values peasant know-how and traditions as guiding principles to guarantee the food supply of the world's population, thus enabling the sustainable exploitation of resources of different ecosystems.

According to the Nyéléni Declaration, food sovereignty refers to "*the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems*" (Nyeleni Declaration, 2007). The rest of the definition makes explicit use of sustainable development by emphasizing the meeting of the economic, social and ecological in a multigenerational perspective:

"[Food sovereignty] puts those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations. It defends the interests and inclusion of the next generation. It offers a strategy to resist and dismantle the current corporate trade and food regime, and directions for food, farming, pastoral and fisheries systems determined by local producers. Food sovereignty prioritizes local and national economies and markets and empowers peasant and family farmer-driven agriculture, artisanal - fishing, pastoralist-led grazing, and food production, distribution and consumption based on environmental, social and economic sustainability. Food sovereignty promotes transparent trade that guarantees just income to all peoples and the rights of consumers to control their food and nutrition. It ensures that the rights to use and manage our lands, territories, waters, seeds, livestock and biodiversity are in the hands of those of us who produce food. Food sovereignty implies new social relations free of oppression and inequality between men and women, peoples, racial groups, social classes and generations" (Idem).

The general food sovereignty framework does not prescribe a unique way to achieve it at the local scale. On the contrary, some authors emphasize the territorial character of food sovereignty processes. For instance, Wittman and Desmarais (2010, 5) state that "*Food sovereignty is very much situated; it occurs in particular places and how it is expressed is determined largely by local dynamics, but also in response to changing global dynamics*".

It is not our intention to exhaust a concept as complex as food sovereignty. We only call attention to the fact that such a perspective necessarily calls into question the historical distance that has been built between urban dwellers and agricultural production, as well as the distance between ideas of sustainability and day to day power struggles. We will also show that the issue of right to access is a condition considered necessary for the achievement of sustainable development by actors who hold the values of food sovereignty and who are active in UPA. UPA has several definitions and it is not our role here to review them. We will follow three main aspects of UPA as derived from the literature: that it is characterized by "*the integration of agriculture into the city's economic and ecological system*" (Mougeot 2000, 10); that its existence is a phenomenon as old as the city (Capel, 2002); and that it is strongly linked to the cities' food self-sufficiency objectives (Pessoa et *al*., 2006), while recognizing its multifunctional character (Nahmias and Le Caro, 2012). UPA's principles include among others the cultivation of plants and animals in urban areas, the practice of farming by urban dwellers, the use of organic waste, the reuse of water for irrigation, and proximity to the consumer market (RUAF, 2015). It should be noted that urban agricultural activities can be carried out in gaps of the urban fabric that can be of any size (Madaleno, 2002). For its part, the Food and Agriculture Organization of the United Nations (FAO) reports that UPA generally occupies small areas that may be found in public, private and communal areas, usually located on the outskirts of cities (FAO, 2018). Van Veenhuizen completes the FAO definition by adding that this source of perishable goods such as vegetables and fresh milk is important for the effectiveness of regional and national food systems (2006).

Mougeot (2000) focuses his analysis on the importance of UPA as an integral part of the urban economy, as well as the environmental and social systems of cities. He points out that urban agriculture, although different, is complementary to rural agriculture. He considers it vital to ensure proper interactions not only between UPA and all urban systems, but also with rural production and food imports. He calls for paying more attention to this interaction between urban and rural systems, which would allow the development of more appropriate public policies and techniques. However, he points out that we must not forget the specific contexts and objectives of UPA (Mougeot, 2000).

In the present contribution, we focus on the actors' discourses and the possibility of identifying the characteristics of food sovereignty and sustainable development. We also investigate what analyses the actors make with regard to their potential to channel social claims into the public sphere of decision-making. Both the actions implemented by public actors and the desires for food practices that are better articulated to the proximal spaces of civil society are subject to questions about their legitimacy. We will resort to justification theory to further explore these issues.

For the analysis of this participation in public decision-making, the justification theory (Boltanski, 1990; Boltanski and Thévenot, 1991; Moruzzi Marques, 2014) offers a useful model for identifying references to justice mobilized in the formulation of arguments by actors. Grouped into coherent sets of norms for a world conceived as just, these principles of justice support the construction of justifications for defending or criticizing a cause, for articulating demands and developing strategies. From this point of view, the success of a justification operation depends on the actor's ability to generalize, by linking his individual case to the interests of a collective. It involves articulating particular declarations with principles of justice that make its universal character credible. These principles are listed in "cities", whose legitimacy varies according to different socio-historical contexts.

Boltanski and Thévenot (1991) identify six "*cities*" (inspired, renowned, domestic, civic, industrial and mercantile), six reference frameworks that present an internal argumentative coherence based on a certain vision of the world, as well as the means to achieve a state of justice. In this paper, we explore the domestic, civic, commercial and industrial cities, as well as the ecological city, promoted by more contemporary contributions to justification theory (Van Dam and Nizet, 2012; Retière and Moruzzi Marques, 2019).

The conception of the just domestic world is based on the idea that one's position in the chains of interpersonal relationships is what determines one's value. The superior individual owes protection and justice to his subordinates, who must submit, offering services and loyalty to the king, governor or boss, establishing typically paternalistic relationships. The logic of family relations is thus transposed to the conception of a just society. These principles lead to the value of tradition, proximity and trust. The defence of Brazilian family farming often mobilizes these elements. The civil city of justice presupposes that authority takes shape through the convergence of human wills. Participation in the public space to achieve the common good above individual interests is highly valued in this city. The importance of individuals is measured by their ability to participate in public causes and to detach themselves from the particular case in order to embrace the collective desire. The foundations of an industrial and commercial city are those which, in contemporary capitalist society, have great legitimacy in public debates. On the one hand, the industrial city is based on the idea that a just society functions as an efficient production machine. The hierarchy of values is based on the social utilities of individuals according to their participation in production. On the other hand, the commercial city holds the market in high esteem, making the capacity for wealth accumulation the centrepiece of the hierarchy of power and prestige. In this way, the value of individuals is proportional to their wealth and consumption. Trade relations are perceived as soothing, channelling passions towards "healthy" competition in the market.

Despite a claim to universality, the different conceptions of the just world have varying acceptance and validity depending on the socio-historical contexts. It is therefore relevant to consider that these orders of justice can change, which implies the appearance of new "cities". On this basis, some have put forth an ecological city. Despite its contours under construction, this ecological city favors autonomy and simplicity. The preferred spatial dimension is the local scale, although always linked to global challenges. Its temporal dimension is a long-term one, as evidenced by recurrent references to future generations, which are very present in debates on sustainability (Van Dam and Nizet, 2012). Jacquemain (2001) highlighted the importance of context in the way individuals argue on issues of justice and injustice. In the following, we explore two specific concrete situations in which these discourses take place.

Two case studies: São Paulo

São Paulo is the setting for many civil society organizations promoting UPA. One could mention *Cidades Comestíveis*, which runs a digital platform through which residents are invited to exchange knowledge, seeds, food or any other resources associated with agriculture and food. Another example is the São Paulo Urban Agroecology Movement, a network of individuals and organizations whose objective is to promote agroecology in the city through training, consumer awareness campaigns, the formulation of public policy proposals, etc. Finally, the Union of Community Gardens of São Paulo is an organization that brings together 14 collectives around the municipality's communal gardens in order to promote the exchange of experiences and the strengthening of urban agriculture in the city.

In the governmental sphere, UPA also occupies an important place. In 2006, São Paulo created the Ecological Agriculture Houses in order to create peri-urban development policies. In 2014, the Strategic Master Plan for the City of São Paulo established a "rural area" within the municipality in which agriculture is conceived as an activity that plays a role in sustainable development. The year 2016 saw the implementation of the *Ligue os Pontos* project, which aims to promote agriculture in the southern part of São Paulo in order to generate income for the population and transform the region into a sustainable environmental hub. The Brazilian school food sector has also evolved, both at the national and municipal levels, to include UPA's production. Indeed, since 2009, the State has required municipalities to spend 30% of their food budgets on the direct purchase of family products under the National School Feeding Programme (PNAE), which has strengthened a number of short food supply chains.

Our first case study is that of the Association of Organic Producers in São Mateus, known as the *Associação dos Agricultores da Zona Leste* (AAZL). The AAZL has 30 members who meet weekly to maintain group cohesion and keep abreast of the association's actions. Although the number varies continuously, it is formed around a core of 16 allotment gardens. Created in 2009 after the mobilization of urban farmers, the association was supported by São Mateus sub-prefecture. As part of the preparation of the 2002 Strategic Master Plan, dozens of individuals and families producing food by exploiting space under high voltage power lines or along streams were identified and are supported by AAZL. In addition to agriculture, practices such as bartering and the use of medicinal plants were common practices among this population, which mostly originates from rural areas in the interior of São Paulo, Paraná and the Brazilian north-east. Through contact with the peri-urban areas and through the São Paulo Municipality's UPA Program, farmers see their activity as an opportunity to generate work and income that will serve as a basis for greater autonomy. They also perceive it as a relaxing, traditional activity.

Between 2015 and 2017, a project was carried out in partnership with the Kairos Institute and with the support of the local Ecological Agriculture House to recognize the AAZL organic production. A subgroup has been created within the AAZL with farmers interested in adapting to a Social Control Organization (SCO). The SCO is a means of recognizing organic production on the basis of trust established between consumers and producers. Members of a SCO must allow consumers and DAFA technicians to visit their property to control the techniques used. Public policy states that social control is not a certification process and therefore the OCS does not have access to the official organic label. On the other hand, they can mention the organic character of the practices and are authorized to sell food directly to consumers and the institutional market. The major benefits of SCOs control is the 30% increase in the price of products supplied to public procurement programs.

Two case studies: A*ssentamento* Milton Santos in Americana-Cosmopolis

The municipalities of Americana and Cosmopolis are located in the Campinas metropolitan area, about 120 km northwest of São Paulo. With a population of just over 200,000 inhabitants, these municipalities do not have the same size characteristics as the large, 20 million inhabitant's capital of the state. It is a territory marked by intense urbanization and industrialization, with a rural area characterized by a high concentration of land property, in which intensive industrial production of sugar cane is predominant. The municipality of Americana is now developing its Master Plan, a plan that promotes the urbanization of the area of interest to us, namely the *assentamento* Milton Santos.

The development of this *assentamento* is largely the result of a reorientation of MST's strategy towards agro-ecological practices. Until the 1990s, the movement favoured productivist objectives by favouring *assentamentos* located far from major consumer centers (Borsatto and Carmo, 2013). In the early 2000s, part of the MST leadership in the São Paulo state began to advocate for the settlement of landless families in areas with more infrastructure, close to consumers, constituting what was called *Comunas da Terra*. The latter are specially designed to set up short circuits with sustainable agro-ecological production projects. Engaging in the struggle for access to land around cities was more attractive to an impoverished, underemployed and increasingly urban population.

In the early 2000s, an attempt to install a *Comuna de terra* on the site failed. However, attempts to obtain land persisted, with the collaboration of other entities such as the Movement of Homeless Workers (MTST), the Limeira Metalworkers' Union, members of political parties and the Catholic Church. In November 2005, the Milton Santos colony was born on public land that had until then been irregularly exploited by Ester, a sugar cane monoculture company, which to this day still owns the remaining rural area around the *assentamento*. About 140 families participated in this search for better living conditions, security and autonomy. Implemented by the *Instituto Nacional de Colonização e Reforma Agrária* (INCRA), the colony was classified as a sustainable development project (PDS), with 68 families finally settled.

The interviewed *assentados* reveal that, at first, they were perceived in the region as opportunists or usurpers. This vision gradually changed, as they have increasingly been recognized for their role as contributors to the local food system, particularly among the poorest, through the Food

Acquisition Program (PAA). Indeed, the PAA has long played the role of the main means of marketing for *assentamento* products. The *assentamento* has improved the quality of life of families, who now have access to a healthier and more diversified diet, with the possibility of earning an income from the sale of agricultural products, as well as the possibility of building housing. In 2013, the Ester plant obtained a court order authorizing the reclamation of land occupied by the Milton Santos colony, which led to a major conflict. In this confrontation, the families of *assentados* received support from several entities, such as the Agroecology Center of the University of Sao Paulo and the Agroecology Team of Embrapa Environment. The colony received such support precisely because of the integration of agro-ecological practices, aimed at generating quality products and providing them to food-insecure families in the vicinity (Moruzzi Marques et *al.*, 2017). After a long struggle, the *assentamento* obtained the right to stay and to this day it continues its production despite the abolition of the PAA. The creation of an SCO since 2014 has allowed the partial recognition of the organic nature of production and led in particular to the marketing of baskets of organic products distributed to consumer groups in the region. This experience is developed through the creation in 2015 of a cooperative in the *assentamento*, Cooperflora, through which the food produced is distributed through short marketing channels.

Discussion

The criticisms

We have seen that justification theory defines sets of coherent principles of justice used by the actors to define the characteristics of a just world. We then briefly explained the two contexts of UPA that serve as a basis for our reflection. Now we turn to the content of the criticisms that the actors are mobilizing and situate those in justification theory's "cities". The main criticism of these interviewees concerns land issues. In the case of the city of São Paulo, tensions exist between housing rights movements and urban agriculture groups. Each of them makes requests for access to land that involve contradictory development actions on the part of the municipal government. Housing is a crucial and recurring problem for the city, whose action is strongly influenced by the interests of property developers. The increase in irregular urban sprawl tends to be faster than the urbanization projects planned by the municipality, which are complicated by negotiations involving multiple interests.

In this context, the defence of urban gardens competes with a number of other discourses and practices. In the case of AAZL, most of the land occupied is in public areas or under concession from companies providing public services, such as ENEL (electricity) and SABESP (water and sanitation). The legal occupation of these sites requires both the ratification of land use loan agreements and strict compliance to safety rules (e.g. under power lines there are restrictions as to the type of plants that can be planted). However, the interviews highlighted that while contracts once existed, they have now expired, which weakens farmers' access. Occupancy rules are sometimes unknown to municipal officials or are contradictory. The lack of technical assistance from both companies and municipal officials makes it difficult for farmers occupying the sites to adopt safe, standard practices.

Among the main challenges facing urban farmers is the potential occupation of land by shanty town dwellers who might use the available space for construction. In this sense, the interest of farmers meets that of electricity companies for whom the presence of informal housing is more dangerous than that of gardens. Other controversies refer to two urban agriculture projects. On the one hand, an NGO, *Cidade sem fome* (city without hunger) defends a productive agricultural project marked by an industrial justification and, on the other hand, if local farmers are wishing for more food through their activity, they attribute more importance to diversified and environmentally friendly agricultural activity. They mobilize the principles of civic and ecological justice.

Municipal by-laws make little reference to urban agriculture and food supply per se. Nevertheless, our interlocutors explain that it is not enough to include these issues in legislation, but rather and above all to make municipal officials aware of the strategic importance of urban agriculture. This is made more difficult by the silo divisions of the public administration. Only after these considerations do the AAZL actors mention industrial justification principles, acknowledging logistical issues related to distribution and marketing, water collection, pruning and the need for organic matter.

As far as the *assentamento* Milton Santos is concerned, the critique is also built around land-based issues. First, the *assentados* consider that the National Institute of Colonization and Agrarian Reform (INCRA) has not kept its promises to settle landless families in bigger plots. The a*ssentados* often express their willingness to prove that, even with little land, it is possible to provide families with a decent income by being creative, using the principles of agro-ecology and with an appropriate social organization. The cooperative's strengthening efforts are designed to be strategic in this regard. Second, criticisms are also frequent toward the industrial cultivation of sugar cane, which predominates on adjacent lands. The organic production of the *assentados* families is limited by the deteriorated state of the soil they found when they arrived (little organic matter) and impacted by the use of pesticides that is common in neighbouring sugar cane. Aerial spraying of pesticides contaminates their crops when it is not literally sprayed on their houses. Third, with regard to the city's new master plan, the MST is not so much opposed to the project to densify neighbouring lands. As one MST representative put it, "it will always be better than [sugar] cane". However, there is always the danger of densification beyond land's ability to supply local products. It is unacceptable, for example, that new residents would not have a plot of land to cultivate. These criticisms are based on the principles of domestic justice (family protection) and ecological justice (respect for the environment) in contrast to the industrial city, which focuses solely on the quantitative efficiency of the productive machine.

Strategies

The criticisms mobilized in the "cities" of justification theory are linked to strategies adopted by the actors. The mobilization of urban communities in favour of agriculture, organized to demand greater support from the public authorities, has helped to give visibility and legitimacy to UPA. This has led to the creation of a so-called "rural" area in São Paulo. The preparation of a plan for solidarity and sustainable rural development and agro-ecology, which resulted in the revision of the strategic master plan, is one of the most significant results of this mobilization. It can be said that the delimitation of a rural area in the city of São Paulo constitutes a step forward because it makes it legally possible to officially allocate agricultural activities in municipal public action. The "rural" label allows actors to legitimize an UPA activity. This strengthening of urban agriculture also occurs through the participation of AAZL representatives on municipal councils. The association participated in the process of drafting the municipality's most recent Master plan (2014), by taking part in public hearings. In addition, the association's representation assumes the role of a full member for the management of a solidarity and sustainable rural development plan in agro-ecology.

In the case of Americana, the development of the municipality's Master plan reveals the strategies of each of the actors involved. In the City Statute, the master plan is considered as a fundamental instrument of urban development policy and includes "the promotion of public hearings and debates with the participation of the population and associations representing different segments of the community". Nevertheless, and although legally the document must designate a "macro-zone with a predominant environmental focus" to which the *assentamento* belongs, for the time being MST representatives are choosing to refrain from participating directly. Instead, they are focusing on legal action in their strategies against industrial sugar cane production. From the point of view of a city councillor, avoiding the authorization of very small parcels (up to 150 m^2) would prevent strictly residential development and preserve the mainly environmental use of this macrozone. In any case, the current trend was toward very permissive legislation, in the interest of major real estate developers. Environmental preservation would be limited to the shores of the artificial lake a few kilometres from the site, whose degradation has contributed to the idea of creating this predominantly environmental macro-region.

In this context, the very defensive strategy articulated around legal action of the representatives of Milton Santos is oriented, on the one hand, toward the legitimization of their ecological production and solidarity marketing project, and, on the other hand, toward the delegitimization of agribusiness. With regard to the first orientation, Cooperflora is put forward as a means of combining efforts to ensure adequate production and marketing conditions through solidarity-based consumer groups. Thus, the defence of food sovereignty, as proposed by the MST and *Via Campesina*, is supported by an action that gains in robustness by allowing a reasonable economic return to families, while confirming the agro-ecological commitment of the *assentados*. With regard to the second orientation, the case of the landfill installed near the *assentamento* is illustrative. The company that manages it wants solid waste from other municipalities to be transported to the landfill. The law requires the company to propose environmental compensation actions. To this end, it expressed its wish to support the reforestation of the colony's protected areas. However, those who sat in the *assentamento* assembly refused such support in order to not give the impression of legitimizing the interests of the landfill. Here, the *assentados* resort to domestic principles of justice as opposed to the civic principles called for by the municipality.

Conclusions

Access to land as a condition of UPA is one element that stands out and is shared by our interlocutors. The discourse approach from the perspective of justification theory allows us to highlight it as a point of connection between the three axes of sustainable development in concrete life. This question of land is explicitly addressed by food sovereignty principles and points to a blind spot in sustainable development discourse. The defence of access to land for UPA is mobilized by a set of principles of civic, domestic and ecological justice. The first is to ensure rights through participation in collectives, such as associations or cooperatives, with the aim of ensuring an adequate use of public goods. The second is built by proximity to consumers, which makes it possible to devise strategies for configuring solidarity networks based on trust. The third is at the heart of the agricultural agro-ecology projects and practices.

In the case of the AAZL as in the case of the *assentamento* Milton Santos, there is a tension between the right to housing and the right to land for an UPA. These two ambitions can be linked either to the environmental or social field of sustainable development. In any case, it is through the land discourse that civil society actors address the issue of UPA. Thus, "sustainable development" is not a privileged discourse for UPA actors on the field; it is only visible in political actors' discourses. In this regard, the vocabulary associated with sustainable development is perceived by civil society as too specialized.

The discourse of food sovereignty promoted by *Via Campesina* and the MST raises legal issues, including the right to access and decision-making rights, as necessary conditions for achieving sustainable food security. This is in contradiction to the priorities of the municipality of Americana, which places greater emphasis on the need to promote the city's urban and industrial growth. This necessarily involves the creation of commercial, industrial and residential areas in the only sector that is not completely urbanized and that borders the *assentamento*. The AAZL claims to be in a kind of "competition" with the right to housing, also a sensitive issue in the peri-urban context of the megalopolis. For the Instituto Feira Livre "urban agriculture could be very simple if it were not for the question of access to land". This competition combined with the maze of bureaucratic obstacles makes UPA problematic.

The tensions between *Cidade sem Fome* and the farmers who cultivate the areas under the high-voltage lines seem similar to those between the *assentamento* and Americana: in both cases, what interests the farmers is their right to access the land. It appears that at first, they pay little attention to the political discourses on sustainable development and governance and doubt the horizontal nature of the latter. They situate their agricultural practices and their desire for access to land as part of a "bem viver", a "good living", a notion also carried by the food sovereignty movement that gives more space to ethics in the construction of sustainability. Perhaps we could question research on sustainable development based on discourses that explicitly address it, because some actors are suspicious of the very use of the term, which in their eyes denotes a political instrumentalization that reduces their room for manoeuvre. In contrast, future investigations could focus on well-being and quality of life. It might give access to elements that are rooted in everyday life and more likely to include civil society actors.

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Cooperation in an age of emergency? Climate action as the catalyst for rapid transition towards strong sustainability

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Abstract: *In a period defined by its recent drift away from, rather than towards, global cooperation, it is difficult to imagine a theory of change, democratic or otherwise, that could bring about a global-scale, cooperative and peaceful transition to 'strong sustainable development' at the required speed. In this paper, we argue that the widespread acknowledgement of a 'climate emergency' demanding radical, coordinated action on the basis of 'civilisational climate risk', can be the catalyst with the power to rapidly transform values, norms and political discourse. Citizens need to become extraordinarily engaged with a compelling narrative that mobilises a global movement, one that can sustain political influence and overcome powerful denialist and delayer forces and lay the foundations of a more complete 'doughnut' (Raworth, 2017) of strong sustainability. Although, for some, a reformist advocacy coalition operating within incumbent power structures and populated by diverse actors from civil society, business and politics, may seem inadequate to the larger, system-transformative task, in getting from here to there we have to think strategically, and urgently, about the all-important first step.*

Keywords: *climate emergency, rapid transition, sustainability*

Introduction

Any scenario of 'strong' sustainable development for this century inevitably depends on a process of deliberate and large-scale societal transition or transformation (Bonnedahl and Heikkurinen, 2019). It is equally inevitable that this period of '*creative destruction*' (Schumpeter, 1942/1994; Hausknost, 2019) will create winners and losers and that the expected losers – fossil fuel incumbents, associated 'sunset' industries and neoliberal think tanks – will seek to defeat or delay it. Of great concern, given what we know about – a) the problem of collective action from local to global scales; b) human cognitive biases that are almost perfectly ill-suited to prioritizing long-term, large-scale concepts; c) the destabilising effects of a worsening environment, widening inequality, austerity, populism and political polarisation – is whether a green transformation *might begin at all*, or *in time* to avert serious disruption by global overheating of ecosystems, societies and infrastructures. Other, more dystopian pathways are also possible, some would say likely (Wallace-Wells, 2019; Wainwright and Mann, 2018; Foster, 2015). The past decade has seen a plethora of ever more urgent warnings from scientists and international agencies concerning the risks from global heating and habitat loss, and the need for urgent mitigating and adaptive action at all scales (among the latest: Global Commission on Adaptation, 2019; IPBES, 2019; IPCC, 2019; SEI et al, 2019). The common theme in such reports is the enormous gap between the scale of the problems, the policy commitments made by governments and other actors, and the actual level of action achieved to date. Despite the warnings and pledges concerning the limiting of global heating to 1.5C by mid-century, the commitments made by governments worldwide to greenhouse emissions reductions are both inadequate to the task and also undermined by projected commitments to further fossil fuel production (SEI et al, 2019). The decades-long delays in taking serious action mean that very rapid decarbonisation seems essential for advanced economies, which have both the resources and the moral responsibility to lead the process (Jackson, 2019). However, we lack an account of the political, social and cultural changes that could generate widespread and sustained support for such a programme of radical change. Therefore, in attempting to describe scenarios that most embody strong sustainability, it may help to take a strategic look at how this transition – as a "*process of deliberate change and restructuring that brings the economy within planetary boundaries*" (Schmitz, 2015, 171; Köhler et al, 2019; Geels, 2004) – might best be set in motion.

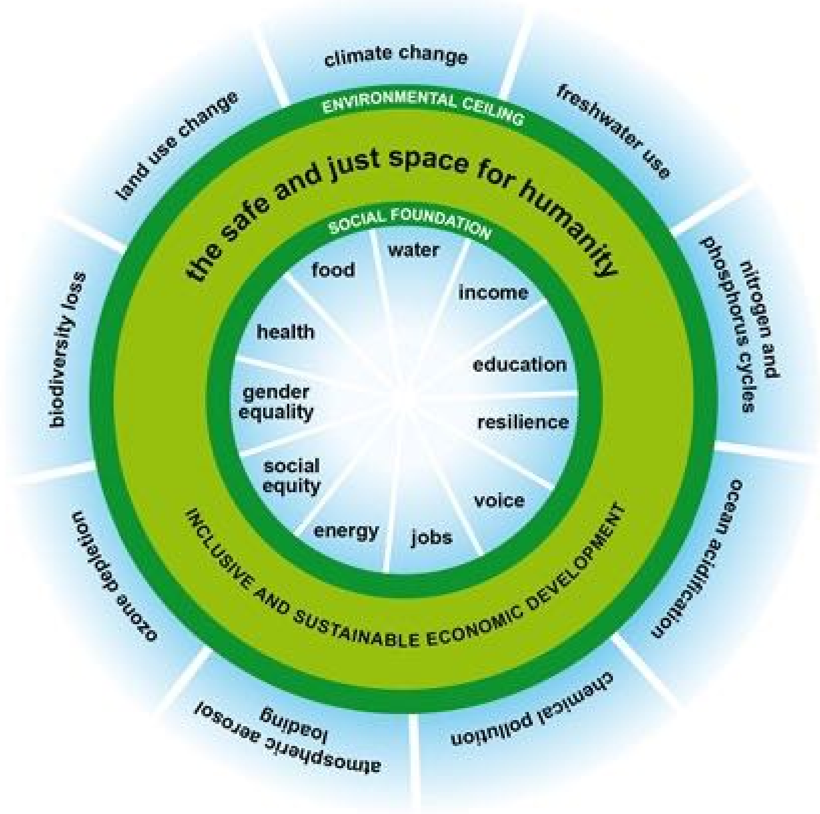
We begin by describing what a strong sustainability scenario for the rich world might look like and the key differences to today's dominant socio-economic frameworks. We go on to explore some of the political challenges in transition and conclude that strong sustainability is very unlikely to happen if all goals are pursued in full and in parallel. We then present the case for using one sustainability goal, the mitigation of climate disruption, as the leading echelon or catalyst for a rapid transition towards strong sustainability. We argue that its unique urgency, relative conceptual simplicity, issue-salience and narrative potential hold the power to rapidly transform values, norms and political discourse.

A Strong Sustainability Scenario

Efforts simultaneously to implement the full array of strong sustainability goals – as outlined for example in the Global Goals programme of the United Nations (UN, 2019) – require a massive expansion of international cooperation and agreement to manage a hugely complex and interconnected global system of investment, resource stewardship, socio-environmental management and auditing. It would require a complete reorganisation of institutions into nested hierarchies or polycentric governance systems from local to global scales (Ostrom, 1990), and a transformation of the logic of capitalism from a "growth imperative" to an "ecological imperative" (Jacobs (1991). Human well-being, including that of future people and the natural ecosystems that support them, would come first. This priority would be reflected in policy objectives and more meaningful measures of progress than GDP growth. Cooperating nations will have become 'agnostic' about GDP growth – high-income nations having undergone a phase of sufficient absolute de-growth in-line with the new objectives based on sustainable well-being. (Hoekstra, 2019; Hickel, 2020). Aggregate human impacts would be constrained within biophysical boundaries and standards of human well-being would not be permitted to fall below decent social foundations.

The ideal-type scenario for strong sustainability is most clearly illustrated in Raworth's (2017) Doughnut framework (Figure 1), which combines Rockström et al's (2009) nine 'Planetary Boundaries' or sustainable limits with a further twelve measures for minimum social 'foundations' for human well-being as identified in the United Nations Global Goals for Sustainable Development (UN, 2019).

Figure 1: The Doughnut of Social and Planetary Boundaries



Source: Raworth (2017)

Political challenges to a transformation to strong sustainability

There are many challenges to transforming to such a strong sustainability scenario in terms of technologies, food systems and resources, decarbonisation, institutions and governance, economies, individual and collective action and urban development (UN GSDR, 2019). In agreement with the German Advisory Council on Global Change's assertion that overcoming the barriers to transformation and accelerating the change "*is first and foremost a political task*" (WGBU, 2011, 1), this section explores some of those key political challenges. We identify the following types and levels of action in which the challenges of achieving cooperation for strong sustainable development play out:

- Micro-scale dilemmas;
- Macro-scale coordination;
- Public sector action;
- Private sector action;
- Civil society action.

These are considered in turn below.

The collective action challenge

Micro-scale: Collective action problems (CAPs) (Olson, 1965/1995) or social dilemmas (Dawes, 1980) – defined as conflicts between individual and collective interests (van Lange et al, 2014) – are a key feature of human life with evolutionary origins. Humans are pre-disposed to be largely cooperative, social creatures whose brains make '*satisficing', 'boundedly rational'* decisions on the basis of limited attention and memory capacity, heuristics, association, experience, habit and emotion (Simon, 1991; Batson, 2011; Fehr, 2015; Kahneman, 2011; Ostrom, 1990, 2008; Lebow, 2005). We come poorly equipped for making long-term decisions that affect large groups of people; but we have an in-built, tribal moral sensibility – based on fairness, social norms and reciprocity - that enabled us to cooperate, and thereby survive, for millions of years (Nowak, 2006; Tomasello, 2008; Cosmides, Barrett & Tooby, 2010; De Waal, 2009; Boehm, 2011). These innate, cooperative and moral intuitions make it easier to solve within-group CAPs, but not more expansive between-group CAPs (Greene, 2013). Brains capable of 'meta-moral' reasoning, that value more abstract and longer-term concepts, culminating in ideas of universal and intergenerational human rights, had to await the co-evolution of language, abstract reasoning, reflexivity and the growth of more complex societies.

Macro-scale: At the societal scale, there is another social dilemma – the cooperation/complexity paradox – which Rifkin (2009) termed the 'empathy/entropy paradox'. Given favourable conditions, human tribes throughout history have invented or copied the technologies, philosophies and methods of organisation necessary to expand into more complex tribes, chieftains, city-states, nations and empires. Cultural evolution of this kind has been recognised at least since Ibn Khaldun (1377), has developed as a field of study in the West since de Montesquieu (1748), and has included contributions from Malthus (1798), Hegel (1807), Morgan (1877), Tönnies (1887), Elias (1939), Steward (1955), Parsons (1956), White (1959), Tainter (1988), Diamond (2005), Lenski (2005), Boyd and Richerson (2005), Turchin and Nefedov (2009), Rifkin (2009) Runciman (2009) and Turner (2010). Increasingly complex societies build greater connectivity between people through a range of mechanisms including trade, transport, communications, literature, education, widening political boundaries and urbanisation (Pinker, 2011; Shermer, 2015; Benkler, 2011). Over time this connectivity expands social networks of trust, cooperation and common identity (Singer, 1981; Wright, 2000; Hunt 2007: Krznaric, 2014). The dilemma or paradox is this: that although immense quantities of energy, technology and economic development are necessary to build a globally connected and cooperative humanity, the amount of waste produced and resources consumed to achieve it (the entropy bill) has become unsustainable and threatens our very existence (Rifkin, 2009; Ophuls, 2012; Welzel, 2013). The question is, can we solve the collective action problem fast enough?

Sustainability is therefore a collective action problem at multiple scales. It is in the short-term self-interest of individual countries, politicians, citizens, businesses and even the entire present population (vis a vis future generations) to "free-ride" on the actions of others by doing nothing or too little; but it is in the long-term collective interest of all actors to cooperate to avoid a planetary catastrophe (Zenghelis, 2016). One prominent example of how nations struggle to solve their collective action problems is that, after almost thirty years of effort to devise a binding plan to stop the planet's atmosphere from overheating to dangerous levels due to greenhouse gas emissions, the best efforts of the international community have resulted in The Paris Agreement (2015), a list of non-binding 'Intended Nationally Determined Contributions (INDCs). When added up together, these INDCs are predicted to lead to around +3.2°C of overheating, beyond the safe limit of 'well-below +2.0°C' and firmly into the territory of potentially catastrophic positive feedbacks or tipping points. No G20 country is currently on track to honour even their INDC commitments. It is also important to point out that 'potluck pledges', as the climate scientist Katherine Hayhoe has characterised the INDCs, also characterised as 'self-determined fair shares' (Raworth, 2017), do not even amount to cooperation.

The sustainability literature is full of scenarios, proposals and recommendations to enact policies, redesign systems or change practices. But as Ronzoni (2019) points out, deliberate transformations to a strong sustainability scenario do not just happen 'dei ex machina'. Who initiates deliberate, radical change in the collective interest? Clearly, after half a century of increasingly urgent and alarmed warnings, 'the facts' are not enough. Let us consider the three sectors of society in turn – the public sector (governance, including political parties, police and the judiciary); the private sector (business and industry); and civil society (including religious organisations, trade unions and social movements) – to examine where change begins:

The public sector: according to theories of majoritarian electoral democracy from Aristotle to de Tocqueville, public policy responds to the preferences of the average citizen (Gilens and Page, 2014). Electoral candidates compete for voter support and must therefore be sensitive to the interests and concerns of the majority. Candidates with radical policy proposals, such as a strong sustainability scenario, would not therefore be selected. This follows from Olson's (1965) logic of collective action and supports Willis (2018) whose recent empirical work with UK parliamentarians showed that UK politicians understood the need for more radical climate policy but were mostly unwilling to make a strong case for it, partly due to a lack of support from constituents. Alternative theories of economic-elite domination, majoritarian pluralism, and biased pluralism offer even less reason to assume that politicians would pro-actively instigate policy agendas for the long-term collective good (Gilens and Page, 2014);

The private sector: business and industry play an important role in sustainability transitions as the innovators of new technologies, services and business models (Köhler et al, 2019). However, this role is subservient to their need to survive in a competitive commercial environment. The private sector usually requires government finance and investment to accelerate the pace of change and overcome path dependencies and incumbent resistance (Sovacool, 2016; Mazzucato, 2015). Olson's (1965) '*free-rider'* problem also applies here: no incentives exist for private companies to burden themselves with the unnecessary, additional costs and risks of coordinating and financing strong sustainability goals for their sector for the long-term common good (Geels, 2011);

Civil society: includes a wide range of organisations and social movements involved in sustainability transitions (Köhler et al, 2019). The role of Civil Society Organisations (CSOs) can be divide into three pathways: 1) political pathways, including the creation of publicly supported advocacy coalitions for rapid transition policies (Kern and Rogge, 2018; Markard, Suter and Ingold 2016); 2) grassroots innovations, e.g. Transition Towns; eco-village movement (Seyfang and Smith 2007); and 3) cultural initiatives that challenge entrenched practices, meanings and values (Spaargaren 2013).

While Olson's free-rider problem equally applies to civil society, i.e. that large-group cooperation tends to be undermined over time (Bowles and Gintis, 2011), theories of common pool resource governance (Ostrom, 1990; 2008), social movements (Leach and Scoones, 2015) and societal change (Green, 2016; Crutchfield, 2018; Sunstein, 2019; Dunlap and Brulle, 2015) offer a strategy for overcoming it: as demonstrated in all successful social movements from the abolition of slavery to legalisation of same-sex marriage, a sufficiently motivated network of citizens and organisations have the potential to mobilise around a common cause long enough to exceed a critical 'mass' and 'momentum' for change (Ronzoni, 2019; Centola, Becker, Brackbill and Bronchelli, 2018; Chenoweth, 2013; SCNARC, 2011). The key challenge in the longer-term lies in maintaining the authentic commitment of the social movement base and its connections to the network and organisations of the coalition (Leach and Scoones, 2015). As Crompton (2010, 18) summed it up: "*public appetite and demand for change is…of crucial importance in setting the pace and level of ambition with which governments and businesses respond*".

Without wishing to downplay many important contributions at 'lower' levels of regional, city and local government, we concur with other analysts that it is political pressure directed at the national and EU level that is the key to solving the collective action problem and accelerating progress to match the scale of the strong sustainability challenge (Data Driven Yale, 2018; Green, 2016; Crutchfield, 2018). Furthermore, and as discussed in more detail below, the effectiveness of this coalition would be improved by the participation off all sectors of civil society – citizen activists, social movements, environmental groups, lawyers, scientists, journalists, artists, politicians, religious groups, trades unions and business associations – that are committed to maintaining political pressure for strong sustainability solutions (Pralle, 2009).

The political economy challenge

Another dilemma concerns the debate over whether a reformist theory of change is capable of delivering a transformation to a sustainable future, or whether a political revolution is required to supplant capitalism with something else (Newell, 2015). The three main political economy options advanced so far in the literature are green growth capitalism (e.g. World Bank, 2012), post-growth capitalism (e.g. Daly, 1991), and post-capitalism (e.g. Magdoff and Williams, 2017). We discuss these in turn below.

Green growth capitalism: this is the dominant reformist model that argues for variations on a '*green growth'* or '*clean growth'* pathway to weak (rather than strong) sustainability, ranging from market-led to post-Keynesian approaches. It relies upon a mind-boggling expansion of hypothetical negative emissions technologies and invites further incredulity due to a complete lack of empirical evidence that sufficient absolute decoupling of GDP growth from resource use and carbon emissions is even possible (Raworth, 2017; Hickel and Kallis, 2019). It is, however, the most politically attractive option and aligns with the dominant 'GDP growth = human progress' paradigm. This paradigm succeeds up to a certain level of GDP in improving human well-being in the short-term, but which if not constrained within longer-term sustainable limits will lead to ecosystem and therefore economic system collapse.

Post-growth capitalism: post-growth ecological economists, supporting steady-state, de-growth or growth-agnostic political economies, believe that capitalism - if strictly defined as private ownership and control of the means of production - not only *could* deliver a transformation to strong sustainability, but *should* deliver it, at least in the short-term — because of the urgency of the climate and ecological emergency (Newell, 2015). This might take the form of a strengthened social democratic steady-state model, featuring a range of private firms, shared ownerships and cooperatives in a monetary economy that constrained aggregate impacts within environmental limits and social protections (Douglas, 2019; Raworth, 2017; Daly, 1997; Jackson, 2009). It may further require *de*-growth of production/consumption in high-consuming nations and a shift away from growth-focused development in the global South (Hickel and Kallis, 2019). The crucial question is whether a steady-state or de-growth model could win and maintain popular support. In theory, a 'grown-up' steady-state economy need not hinder science, technology, creativity or any other tools for human improvement (Trebeck and Williams, 2019). However, considerable historical evidence suggests there is a correlation between stagnant or falling real incomes, zero-growth and rising income inequality on the one hand, and social unrest, intolerance and regressive policies on the other hand (Friedman, 2005; Harrington and Gelfand, 2014; Scheidel, 2018; Inglehart, 2018; Anhieier, Kaldor and Glasius, 2012). Nobel Prize winning behavioural economist Daniel Kahneman claimed that "*No amount of psychological awareness will overcome people's reluctance to lower their standards of living.*" (Marshall, 2014, 58). However, as demonstrated by people's willingness to endure hardships for a common cause during wartime, material standards of living are not entirely non-negotiable. Furthermore, rapid re-evaluations of how people define 'prosperity' and 'living standards' may also be possible (Jackson, 2017).

Post-capitalism: some climate activist organisations have become aligned to anti-capitalist and eco-Marxist movements since the late 1990s (Leach and Scoones, 2015). However, the popular demand for eco-Marxism is not strong. The record of centrally planned economies, in which in the absence of markets goods are rationed, jobs are allocated by the state, industry and agriculture are nationalised, personal savings and the nation's currency and ability to borrow money are decimated, is not widely considered an attractive option. It is also unclear why a non-capitalist system would necessarily be any more sustainable than the system we have, while being less able to invest in renewable technologies or social protections in the transition.

A challenge, therefore, is that although endless GDP growth is irreconcilable with strong sustainability; and although attitude polling shows that people want a clean, healthy, sustainable future for themselves and future generations, it is not evident that they are prepared to give up a growth-based economic system to achieve it (Barasi, 2017; Poortinga, Fisher, Böhm, Whitmarsh, Steg, Ogunbode, 2018; Phillips, Curtice, Phillips and Perry, 2018).

The narrative challenge

A transformation to strong sustainability requires systemic change, which requires a global social movement, which in turn requires mass mobilisation using a compelling, unifying narrative or vision of "shared meanings that inspire people to collective action (Tarrow, 2011, p. 31; Givan, Roberts and Soule, 2010; Jackson, 2017; Monbiot; 2017; Evans, 2017; Klein, 2014; Raskin, 2016). There is evidence that positive/optimistic messaging (PIRC, 2018; Nordhaus and Schellenberger, 2007; Gifford and Comeau, 2011; Bain, Hornsey, Bongiorno and Jeffries, 2012; Stern, 2012) is more effective than negative messaging. However, there is also evidence that negative, fear/loss-invoking narratives can be highly motivational (Wallace-Wells, 2017; De Moor, Doherty and Hayes, 2018; Thunberg, 2019) where there is high perceived self-efficacy and response efficacy (Maloney, Lapinski and Witte, 2011).

Table 1: A typology of Narrative Framing

<table>
<tr><th>Motivation</th><th>Designed to appeal to</th><th>For the sake of</th></tr>
<tr><td>Ego +</td><td>Positive, self-enhancing rewards/gains, e.g. to one's reputation, legacy or personal well-being[1]</td><td rowspan="8">Climate stability for humanity and planetary ecosystems
------
Conserving the local environment

Energy security

Energy efficiency/cost

Jobs

Regional regeneration

Business development

Technological Innovation

Public health</td></tr>
<tr><td>Ego –</td><td>Negative emotions: e.g. shame, guilt; or negative consequences: e.g. punishment, sanctions[2]</td></tr>
<tr><td>Natural/cultural capital</td><td>A desire to conserve goods of natural or capital value; the love of the land, home and heritage[3]</td></tr>
<tr><td>Altruistic</td><td>A concern for the welfare of others; to evoke sympathy for their suffering[4]</td></tr>
<tr><td>Collectivist</td><td>A concern for the welfare of a specific group and associated feelings of group loyalty/ solidarity[5]</td></tr>
<tr><td>Principlist</td><td>Ethical principles of justice, fairness, humanity, rights, freedom or the greatest good[6]</td></tr>
<tr><td>Normative</td><td>The human tendency to imitate others and conform to perceived social norms[7]</td></tr>
<tr><td>Self-transcendent</td><td>The extension of one's own limited existence into a self-transcending, transgenerational cause[8]</td></tr>
</table>

Researchers continue to investigate the ability of various narratives to influence public attitudes and activism (Corner, Shaw, Clarke and Wang, 2018; Whitmarsh and Corner, 2017; Chapman, Corner, Markowitz and Wang 2018; Nisbet and Markowitz, 2016). Table 1 above offers a typology of narrative framings inspired by Batson (2011, p. 227), who encouraged "anyone interested in stimulating action to benefit others…to shift attention from the behaviour sought…to the different motives that might encourage or discourage this behaviour". Several consistent research findings reveal the importance of:

Emotional engagement: targeting deeply held morals, values and identities is more effective than providing information and deliberative thinking (Stern, 2018; Lakoff, 2010; Kahan, 2010);

1 Batson 2011; van Vugt, 2009; Wade-Benzoni and Tost, 2009.
2 Fehr and Gaechter, 2000.
3 Leopold, 1949; Birnbacher, 2009; Scruton, 2017.
4 Batson, 2011; intentional confrontation designed to induce sympathy and outrage at injustice lay at the heart of the suffragette movement, Gandhi's independence movement and the U.S. civil rights movement.
5 Batson 2011; combining sympathetic concern for one or more individuals with group solidarity is the basis of 'The Hero's Journey' (Campbell, 1949).
6 Batson, 2011; Birnbacher, 2009; Jonas, 1984; Singer, 1981.
7 Cialdini et al, 1991; Turner, 1987.
8 E.g., Birnbacher's (2009) 'transgenerational solidarity'; Jonas' (1984) 'imperative of responsibility'; Laudato si' (2015) 'intergenerational solidarity'.

Human stories: these are much more effective than statistics (Evans, 2017; Jones, 2014; Stern, 2018);

Non-violent, democratic aims: violent, anti-democratic or revolutionary language limits a social movement's potential pool of support (Glover, 2018; Della Porta and Diani, 2006; Meadowcroft, 2011);

Inclusive, superordinate goals: 'us versus them' enemy narratives are counterproductive (Krznaric, 2014; Marshall, 2014).

A values-inclusive narrative: a number of U.S. studies have revealed that many political conservatives may not be rejecting sustainability and the risks to future generations per se, but are rejecting the prevailing 'liberal-focused' environmental discourse and framing because it challenges their social identity, ideology and values (Feinberg and Willer, 2013; Feygina et al, 2010; Kidwell, Farmer and Hardesty, 2013). According to value theories, in wealthier, western countries conservatives tend to identify more readily with 'binding' values that emphasise tradition, authority, loyalty and sanctity, whereas liberals tend to identify with 'individualising' values like welfare, justice and rights (Haidt 2008/2012; Graham, Haidt and Nosek, 2009; Kahan et al, 2012; Shwartz 1992/2012). Wolsko (2017), experimenting with a values-inclusive moral framing based on Gaertner & Dovidio's (2000) common in-group identity model, succeeded in increasing pro-environmental attitudes in both political liberals and conservatives, supporting Stern's (2018, 85) assertion that "*activating…common moral foundations can help to…grow social movements.*"

Unity and Diversity: In social movements and policy coalitions it is essential to have a strong, unifying, grand narrative or central purpose (Tarrow, 2011; Sabatier and Weible, 2007). But political effectiveness also depends upon the potential of this grand narrative to be favourably re-presented as sub-narratives to a wide range of constituencies with diverse interests (Meadowcroft, 2011; Klein, 2014; Eikeland and Inderberg, 2016). In this way, actors may be recruited to the cause who are motivated for reasons other than the long-term interests of humanity and the planet (see Table 1: column C) – e.g. for energy security, job creation, business development (e.g. renewables), regional regeneration or public health (Schmitz, 2017; Hess, 2018). An example (for which we hold no sympathy) was the UK Vote-Leave 'Take Back Control' narrative, which unified over half of those who voted with a simple, clear concept that could be re-interpreted to appeal to the perceived interests of: a) ideological nationalists; b) the financially dispossessed 'precariat'; and c) financial/business elites looking to evade European regulations. A much earlier example was the "Am I not a man and a brother?" narrative that cultivated a strong inter-class coalition in the late 18th - early 19th Century English abolition movement between Quakers, Anglicans, secular enlightenment scholars and the early trade union movement (Yerxa, 2012);

Appealing to the values we have: due to the time-urgency for a sustainability transformation – particularly in relation to climate change, biodiversity and ecosystem breakdown – persuasive communications need to have an immediate impact. Narratives therefore need to "*draw out deep-seated principles and values which are already harboured by people*" (Capstick et al 2015, p. 13), rather than rely on some future '*moral awakening*' (e.g. Heinberg, 2017).

Modelling new norms: Appiah (2010) argued that moral revolutions – for example the abolition of footbinding in China – don't happen because people are persuaded by new moral arguments but because a committed movement of change-makers mobilise to redefine 'honour', or what is considered socially acceptable. Scheffler (2018) claims that people already value sustainability and future generations, which suggests that, with the help of influential leaders, language and behaviours that are currently 'honoured' – such as exotic holidays, or the 'socially organised denial' preventing discussion of the climate emergency (Norgaard, 2011) – might rapidly become 'dishonoured', as happened with many moral revolutions from the abolition of slavery to same-sex marriage.

Implications

Efforts to simultaneously implement the full array of strong sustainability goals seem highly unlikely to progress to the level of serious international discussion in the foreseeable future. Transformative change begins with civil society activism, even if its most significant, longest-lasting consequences are, eventually, state-led legislation and new societal norms. Social movements also tend to reach scale and diffuse over multiple generations, whereas the scientific evidence suggests that a global programme of investment and implementation for strong sustainability needs to be realised as soon as possible. In terms of scale, complexity and time-urgency, there is no historical precedent to the current movement for a sustainable future. One essential element of a successful movement or political coalition for change is a unifying, values-inclusive grand narrative that can be re-interpreted to appeal to diverse constituencies and thereby help to mobilise a broad-based global movement. Narratives that resonate only with a narrow, liberal elite of global-intergenerational worldviews are unlikely to generate sufficient support. It can sometimes be difficult to provide the facts about the risk of civilizational collapse without making people fearful, depressed or triggering irrational defence mechanisms. Positive, reassuring visions embodied in 'green growth' or 'Green New Deal' just transitions are attractive narratives, but governments have yet to explain how strategies relying on infinite growth can be compatible with the resource and ecosystem services limits of a finite planet. Furthermore, many people distrust the motives and the competences of an expanded state, a distrust that is shrewdly exploited and amplified in the counter-narratives of a powerful and well-financed blocking coalition.

The climate emergency as the catalyst for rapid transition

Our argument for using one of the sustainability goals, the climate emergency, as a catalyst to accelerate a movement towards a strong sustainability that encompasses the remaining ecological and social goals, rests on the unique urgency, network-building potential, conceptual simplicity, public and political salience and narrative potential of this issue.

The climate crisis is uniquely urgent

As scientists and activists point out with increasing alarm, there is literally no time left to start treating climate change like an emergency, 'war-mobilisation' situation. And if we don't succeed in stabilising the climate, the other sustainability goals become otiose. For high confidence of limiting global warming to a 'safe operating space for humanity' of +1.5°C above the pre-industrial average, and without relying on the large-scale deployment of largely hypothetical carbon dioxide (CO_2) negative emissions technologies (NETs), the Intergovernmental Panel on Climate Change (IPCC) concluded that CO_2 emissions must peak immediately, reduce 40-50% from 2010 levels by 2030, and reach net-zero by mid-century (IPCC, 2018; Hausfather, 2018; Rockström et al., 2009). A recent analysis by Jackson (2019), while emphasising the important point that "policy must specify both a target date and an emissions pathway" (Jackson 2019, p. 1) and acknowledging principles of equity and precaution, argues for a U.K. net-zero target of 2030 or earlier.

The climate issue may solve the collective action problem (CAP)

As previously discussed, the CAP is a feature of human life that makes it difficult to sustain 'between-group' cooperation or large-scale, long-term change for the common good; particularly when, as is the case with sustainability, the change is systemic, entails significant perceived cost or sacrifice, and challenges prevailing norms and incumbent power structures that deploy persuasive counter-narratives. However, radical change can be instigated by civil society activism: the history of successful social movements demonstrates that the CAP can be overcome when a sufficiently motivated network of citizens and organisations mobilise around a common cause long enough to exceed a critical 'mass' and 'momentum' for radical change.

This network appears to be far closer to critical mass in the case of the climate emergency movement than any other environmental issue or the sustainability issue in general. The evidence is the millions of climate protestors occupying streets and public spaces around the world and the phenomenal increase in media exposure of climate issues, commitments to avoid flying, policy initiatives and political discourse.

Currently, this network is comprised of a wide range of actors (see table 2) often with incompatible decarbonisation targets, pathways, economic visions and narratives. It remains to be seen whether these groups develop the closer alignment that is vital for creating rapid transitions (Roberts et al, 2018; Weible and Sabatier, 2018; Schmitz, 2015; Crutchfield, 2018).

Table 2: sectors and examples of actors engaged in the climate emergency

Sector	Actor example
Politics	The Green Party
Urban government	C40 Cities
Judiciary	Climate Litigation Network
Religion	Global Catholic Climate Movement
Citizenry	Extinction Rebellion; School Strike 4 Climate
Business	Aldersgate Group
Finance	350.org
Labour	Trades unions
Academia	Climateemergencydeclaration.org

The climate issue is relatively conceptually simple

In contrast to the complexity of some of the other sustainability goals, for example the link between nitrogen loading, soil health and food production, the importance of climate stability is a relatively straightforward issue to understand – certain gases act like greenhouse glass by trapping the Sun's heat; the more you pump into the air the hotter it gets. The consequences of failing in this particular goal are also tragically understood by the victims of extreme weather events around the world – wildfires, floods, storm surges, droughts, etc. – and by those who witness them remotely through news media. Likewise, the accelerating rate of glacial retreats, coral reef die-offs and species' extinctions can be shockingly observable from one decade to the next.

The climate issue may solve the narrative problem

We have contended that an effective global coalition for rapid transitions needs to be a broad-based movement. One pre-requisite of an effective broad base rests in the strength of the movement's narrative frames, which ought to address human cognitive biases and heuristics, cross-cultural differences and be values-inclusive. It should also reflect the importance of emotional engagement, human stories and a positive, non-threatening vision. Perhaps most importantly, an effective narrative should be capable of being re-presented or re-interpreted in ways that appeal to diverse constituencies and transcend ideological divides. And lastly, it must either find a way to disprove Kahneman and "*overcome people's reluctance to lower their standards of living*" or help them to re-evaluate those standards.

In recent years, two very different kinds of phenomena have provided clues to what this elusive grand narrative might look like: the first is the increasingly frequent linkage made in television and print news media between extreme weather and climate change. Whether in reference to the migrant crises in Central America or the Mediterranean (The World Bank, 2018), water scarcity in Rajasthan (UNWWDR, 2018), hurricanes in North Carolina (The Washington Post, 2018), flooding in the Yorkshire Dales or bushfires in New South Wales (Reuters, 2019), climate change is increasingly being understood and discussed as something happening right now that could destroy my/our home and local environment. The second is the meteoric and completely unpredicted rise and spread of Extinction Rebellion and the school strikes for climate inspired by the Swedish teenager Greta Thunberg. The leadership shown by the young people in these protests is particularly important because it gives the future a real face - the face of a child.

Far from the abstract and global concepts for the sake of humanity and the planet that have often epitomised sustainability narratives, the current 'climate emergency' moment has the potential to forge a grand narrative that is entirely 'down-to-earth', one that evokes a strong, emotional call-to-arms in defence of what we love most - our homes and our children. In doing so it captures motivations that are truly values-inclusive and transcend ideology, being based on love for one's land, home and heritage (natural and cultural capital in Table 1) and with concern for the welfare of the people we love most who will suffer the worst consequences (altruism in Table 1) if we fail. This 'home and heart' narrative can be re-presented or narrowcasted to more closely define the local experience and issues of concern to the audience in question. It is a positive, conservative vision that also aligns with religious notions of the sacred, purity and sanctity. And finally, it may even have the potential to prove the great Daniel Kahneman wrong (as we are sure he was hoping) in that we may decide, after all, that living more simply is not a sacrifice if it means that our children may simply live. In this sense, as every parent knows, sacrifice is an expression of one's own values and comes freely, from within (Maniates and Meyer, 2010).

Conclusion

This paper claims that the international community currently lacks the degree of mutual trust, cooperation and popular support required to even discuss, let alone to simultaneously implement, the full 'doughnut' programme of strong sustainability. The climate emergency could be a useful catalyst to break the inertia and accelerate a movement towards strong sustainability. If a binding framework agreement for a genuinely equitable and sustainable climate regime could be introduced – in which the 'growth imperative' is replaced by the 'ecological imperative' with respect to this one planetary boundary (alongside essential social foundations for a just transition) – it may become easier to incorporate the remaining planetary boundaries and social foundations of strong sustainability at the earliest opportunity. A disruptive – and possibly brief – political window may be opening, driven by a mass mobilisation for more radical climate action, that can unify diverse groups, overcome opposition, and rapidly transform prevailing norms. In contrast to that required for the complete 'strong sustainability' scenario, a compelling narrative for radical climate action does not depend on a global, intergenerational worldview; merely on what the vast majority of people already care most about.

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Transition through 'sustainable wellbeing,' an approach to overcome what consumes us

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Abstract: Human consumption of natural resources grows so rapidly that we are now at a critical point in the Earth's history. Forging a viable future for humanity and the natural world requires transformation of our consumption practices. Income and consumption contribute to happiness and wellbeing, but continued growth drives increasing damage to the natural world, and also to human wellbeing. Yet reversing this trend has proven beyond our grasp. A new approach of 'sustainable wellbeing', seeks to fundamentally re-balance wellbeing across life domains. It could deliver win-wins that increase human wellbeing, while reducing damaging consumption at the same time, a major opportunity for EU policy to advance wellbeing and sustainability.

Keywords : Climate change, consumption, wellbeing, low carbon transition, sustainable

Introduction

The Paris agreement of December 2015, under the United Nations Framework Convention on Climate Change (UNFCCC), set in train an international commitment for all nations to achieve significant global reductions in greenhouse gas (GHG) emissions through the 21st century. Low carbon development is now a global goal, with a necessity to continually re-invent and ramp up measures to reduce emissions, as required cuts deepen. Yet this critical policy priority is continually overwhelmed by the global megatrend of escalating material consumption. Increases in affluence and population are driving consumption and associated GHG emissions. This is a continual drag on efforts for low carbon transition, while also pushing resource exploitation and the continued viability of natural systems to planetary limits.

Fundamental to this 'societal metabolism' of consumption are the approaches to meeting the demands of human wellbeing. The pursuit of global human wellbeing, fundamentally underpinned by burgeoning consumption, puts both human and natural wellbeing at significant risk of collapse, and renders pretence of 'sustainability' a hazardous fantasy. The flip-side is that there is also conceptual recognition of fundamental links between human wellbeing and sustainable development (O'Mahony, Dufour, 2015; Anand, Sen, 1999). Consequently, there is a potential opportunity to renew development efforts, that advance both of these interdependent goals in tandem, as described by Jackson and Marks (1999). This is a critical issue for sustainability and low carbon transition (Victor & al., 2014). The essential distinctions offer rich opportunity for transdisciplinary sustainability scholarship, and ultimately a substantial transformation to win-wins for society and nature.

The approaches to sustainability in the field of sustainable consumption and production (SCP) have relied predominantly on efficiency and consumer behaviour. While these are useful tools, they do not appear sufficient to address the systemic challenges according to the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report (Fleurbaey, 2014). In countries and contexts where '*over-consumption*' is problematic, shifting from a priority on consumption to a priority on multidimensional wellbeing, could prove key to unlocking the 'double dividend'.

Achieving wellbeing is predominantly a concern for more affluent populations, where basic needs are already met and 'over-consumption' expands. However, it also has relevance even for those that are less affluent countries, or in poverty. The ability to be happy and contented with life is a central criterion of psychological adaptation and positive mental health (Lyubomirsky & al., 2005). The middle classes and elites in developing countries are also in the process of developing high consumption lifestyles (Blanco & al., 2014). At the same time, global inequality of consumption also affects the ability of those in poverty to meet their basic human needs. Despite the growing problems of over-consumption, and the related cultural phenomena of 'consumerism,' the potential significance of a multidimensional 'sustainable wellbeing' has scarcely surfaced in thinking on the low carbon transition.

This paper seeks to explore key conceptual and analytical literature on the relationships between consumption and wellbeing, and to synthesise this with current understanding of the human drivers of climate change and unsustainability. Further, it offers a critique of current approaches to change the sustainability outcomes of consumption, and develops a conceptual frame for improving human wellbeing and sustainability at the same time.

After the introduction, the paper structure is as follows: the place of consumption in context of the climate change challenge; the different functions of consumption; reviewing of sustainable consumption and production; the three approaches to delivering a sustainable consumption; shifting behaviour, shifting consumption structure and shifting the priority on life domains.; concluding remarks to synthesise the outcomes of the paper and its implications.

The place of consumption in the problem of climate change

It is recognised that the physical consumption of material resources and related GHG emissions show strong historical trends, driven primarily by economic development in industrialised and emerging countries (Fleurbaey & al., 2014). As resource use has grown more slowly than Gross Domestic Product (GDP), some decoupling by '*dematerialisation*[1]' has occurred, but this efficiency has been overwhelmed by growth in demand, leading to an inexorable rise in material consumption and associated GHG emissions. Two of the defining issues of this consumption; are the pressure this is placing on emissions and sustainability, and the major global inequalities it is deepening. It will be extremely difficult and expensive, if not entirely infeasible, to sufficiently reduce emissions through technology and efficiency alone. An optimal approach would consider the underlying development path and consumption, to fundamentally shift the system towards sustainability.

An amplified focus on consumption is now emerging globally. In IPCC fifth assessment report, Fleurbaey *et al.* (2014) highlight the centrality of these issues in mitigation by stating that; "…*overcoming under-consumption and reversing over-consumption, while maintaining and advancing human well-being, are fundamental dimensions of sustainable development, and are equally critical to resolving the climate problem*." The challenge of unsustainable consumption patterns place climate goals at risk. 'Consumerism' has been identified as a growing global cultural paradigm since the IPCC third assessment report (Toth & al., 2001). While the consumption of those in poverty is driven mainly

[1] Where the system becomes more efficient in generating GDP with less material resource inputs.

by meeting basic human needs, it is increasingly common across cultures that people seek meaning, contentment and acceptance in consumption. The spread of consumerism means that a large share of goods and services produced are 'luxuries' that only the wealthy can afford, while those in poverty are deprived of even basic goods and services (Khor, 2011). While the relationship between income and wellbeing has been investigated for a number of decades, and a positive relationship is dubious beyond a certain point, the relationship of consumption to wellbeing is less subject to investigation. Recent efforts show that the impacts of consumption on life satisfaction are diverse; across individuals, levels of development and types of consumption, and crucially includes negative impacts with some categories (Dumludag, 2015; Zhang & al., 2015; Noll & Weick, 2015; Gokdemir, 2015). In societies that are more strongly tied to consumerism[2] (Toth & al., 2011; Assadourian, 2010; Nakicenovic & al., 2000) other dimensions of wellbeing can be ignored or demoted to the detriment of overall individual wellbeing. Meanwhile, the focus on the individual appears unsuitable to capture critical systemic priorities, including the interconnected wellbeing of society and nature.

The different functions of consumption

The place of 'needs' in understanding consumption as a driver of climate change took prominence in the IPCC Special Report on Emission Scenarios (SRES) (Nakicenovic & al., 2000), using Maslow´s hierarchy of needs (Maslow, 1943), where choices are only possible once basic human needs have been met such as; food, shelter, health care, safety and education. The needs approach has proven controversial, but if we accept that consumption can indeed be problematic, or indeed that wellbeing is acknowledged as multidimensional (McGillivray, 2007; Stiglitz & al., 2009; Huppert & al., 2005) then a critique of the place of consumption is patently necessary. In a large multi-country study in 2011, Tay and Diener (2011) examined the association of needs fulfillment and subjective wellbeing, finding that needs are indeed universal, with life evaluation most associated with fulfilling basic needs, and positive feelings associated with social and respect needs. Once people's basic needs are met, factors such as luxury consumption, status and comparisons are more significant in determining subjective well-being, in countries with higher levels of development (Layard, 2005; Veenhover, 1988). Kasser (2002) showed that materialism has a cost in terms of individual wellbeing. As material commodities are poor satisfiers of social and psychological needs, materialism therefore can directly hinder wellbeing.

Aside from meeting basic needs, it must be recognised that consumption can perform various functions; assisting in the creation of meaning (Mc Cracken, 1990) and social positioning as '*conspicuous consumption'* (Veblen, 1899). Gronow and Warde (2001) point to factors in inconspicuous consumption, of convenience, habit and responses to social norms and institutional contexts. In a seminal text, Jackson (2005) has placed an important emphasis on sacred aspects of money, consumption and material goods as embodying meaning, cautioning simplistic assumptions about the contribution of material goods to our wellbeing. However, in the useful examples of both food and happiness, Gruber *et al.* (2011) highlighted that in both cases we can have too much, at the wrong time, of the wrong type or pursue in the wrong way. The different functions of consumption, and its implications, have led to research on steering consumption towards a more sustainable path.

[2] A cultural paradigm noted in wealthier countries that is spreading globally, where people seek meaning, contentment and acceptance in consumption.

Considering Sustainable Consumption and Production

The transition towards sustainable development has often been described by two different types of decoupling; *dematerialisation* and *immaterialisation*. Dematerialisation involves the decoupling of material resource consumption (including fossil fuels) and environmental impact (including climate change) from economic growth (Fleurbaey & al., 2014). Much of the focus occurs on the production side through improving production efficiency, and 'eco-efficiency' to reduce the environmental impact of activities. Sustainable consumption and production (SCP) arrived on the international policy agenda through UN Conference on Environment and Development (UNCED) in 1992. On the consumption side, its key aim was to foster the diffusion of sustainable consumer behaviour, through raising awareness of the impacts of consumption choices. Yet. while efficiency on the production side has improved, it has been overwhelmed by the absolute growth in consumption demand, and GHG emissions have continued to increase. A new perspective on consumption patterns is therefore essential to enable sustainable development according to Tukker (Turkker & al., 2008). This moves attention more towards the second type of decoupling, by *immaterialisation*, where human wellbeing is decoupled from economic growth, or from material consumption. Moving towards immaterialisation recognises that consumption, and its proxy income, cannot be described as more than contributory to human wellbeing. The importance of income and consumption is indisputable, particularly for those in poverty, and when recognising problems with inequality, but they are neither the sole means nor the ends of human wellbeing, as noted by Sen (1999). While necessary they are not sufficient for a '*sustainable wellbeing*'. Dependent on the levels, types and context, consumption can deliver very different wellbeing outcomes. In addition, consumption cannot meet all dimensions of wellbeing, and can readily lead to damage in some domains (Gruber & al., 2011). This position is in-line with what is accepted in theory and evidence from multiple independent lines of enquiry, from the multidimensional concepts of wellbeing in development studies, economic performance and social progress (McGillivray, 2007; Stiglitz & al., 2009; Sen, 1999; Nussbaum 2005) to sustainable development (Halsnaes & al., 2007) and human health and psychology (Huppert & al., 2005; Naci & al., 2015; Keye & al., 1999).

Approaches to delivering sustainable consumption

Demand for consumer goods is not a simple consequence of income levels, populations at the same income levels consume different bundles of resources, emit widely varying amounts of greenhouse gases, and experience varying levels of 'wellbeing'. This raises the feasibility of changing consumption patterns by level and type. As production side efficiency is inadequate, as stated by Tukker *et al.* (2008), the focus must now be directed towards the consumption or 'demand side'. The question that arises is how can demand for material consumption be reduced, and can this be achieved while human wellbeing is maintained or improved?

Shifting behaviour critiqued

In seeking to understand the intractable elements of changing consumer behaviour, the IPCC fifth assessment report offered systemic transdisciplinary conclusions ((Fleurbaey & al., 2014).). In contrast to rigid neoclassical assumptions on the rational choice of individuals, and utility maximisation measured in market prices and opportunity costs, this allows some of the sticking points to be more fully understood. Research in psychology, sociology, and marketing science shows that consumer behaviour is far more complicated than just a rational response to price signals (Mont & al., 2008). Consumption is influenced by a range of economic, informational, psychological, sociological, and cultural factors that operate at different levels or spheres in society — including the individual, the family, the locality, the market, and the work place (Thogersen, 2010). There are structural issues beyond the individual, family or community, which lead to consumer lock-in to unsustainable patterns. These range from product availability and cultural norms and beliefs, to working conditions that favour a 'work-and-spend' lifestyle (Sanne, 2002). The capacity of the 'green consumer' to enable sustainable consumption appears limited, when recognising not only the structural factors, but also the 'value-action' gap between 'green' attitudes, and consumption patterns and lifestyles (Barr, 2006; Young & al., 2010; De Baarcellos & al., 2011). In addition, there are also the disenabling influence of specific factors such as habit and cost (Young & al., 2010)[3]. According to Fleurbaey *et al.* (2014), the strength of the political economy factors, and the inadequate attention to them by policy, is an important cause of the lack progress towards sustainable consumption patterns.

Shifting the structure of consumption

Pogutz and Micale (2011) suggest that demand can be shifted to lower impact consumption through environmentally friendly products and services and green shopping. There is an important distinction to be made here, in that lowering material demand does not necessarily mean lowering expenditures, or indeed incomes, as highlighted by Pogutz and Micale (2011). Consumption expenditures can theoretically be shifted towards other consumption bundles that are inherently less emissions intensive, and from material consumption to services and experiential goods. Three strands could lead to lower emissions intensity of consumption by shifting structure; i) lower emissions alternative goods, ii) shifting the structure of consumption to other branches and iii) seeking quality over quantity. Shifting expenditures to consumption bundles of lower emissions intensity, can lead to win-wins, where these changes are associated with improved human wellbeing. This is illustrated by public health guidelines which recommend reductions in consumption of animal products. Value change in society is often described as a prerequisite towards higher concern for the environment and changes in lifestyle and behaviours (Gilg & al., 2005). Yet, there is also self-interest motivation for making such changes as they can enhance individual wellbeing, as one of the gateways to the 'double-dividend'. This approach relies on consumer understanding of the contribution of alternative bundles of consumption to both wellbeing and emissions. However, it is likely that it also requires systems structures and policy levers that enable and empower changes in consumption choice.

Shifting the priority of life domains

An alternative approach to reducing the impacts of consumption is to seek an absolute reduction in material consumption levels on the demand side. This is frequently connected with lifestyle and behaviour change but has failed to gain much traction. A perception exists that moving to less materially intensive lifestyles is one of cost and loss, sacrifice of quality of life (Sepa, 2012). This perception is peculiar when acknowledging the preceding evidence, such as Grubler et al. (2011),

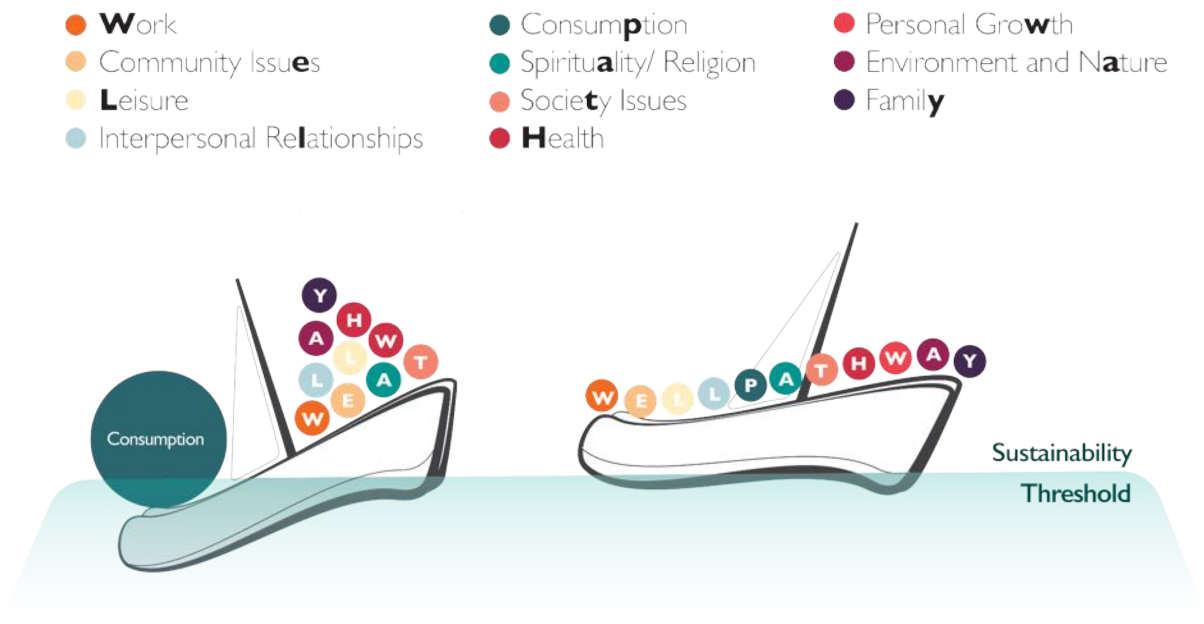
[3] Young *et al.* (39) note factors including; habit, high transactions costs, availability, affordability, and non-green criteria such as quality, size, brand, and discounts.

that not all types of consumption are equal, and some are damaging. Wellbeing is multidimensional and cannot be fully met through consumption. Consumption can even compete with or damage an array of other life domains that are potentially more beneficial, from individual physical health and creativity, to relational wellbeing including society and nature and to time available to attend to these domains. Jackson (2005) described the *´double dividend´* as an approach of reduced consumption and improved wellbeing. It is described by SEPA (2012) as the '*third way,*' that focusses on human welfare and change that is beneficial to quality of life, while also reducing emissions at source. A growing if nascent literature has sought to explain and explore this concept as a promising double, triple or even quadruple dividend (Brown & al., 2005; Gowdy, 2005; Princen, 2005; Dolan, 2006…). Yet, there remain significant gaps in knowledge in how this is conceived and implemented. Approaches framed as 'alternative lifestyles' have been elaborated as '*sufficiency*'[4] (Muller, 2009), '*voluntary simplicity'* (Huneke, 2005) and '*ecologically conscious'* or '*frugal lifestyles'* (Pepper & al., 2009). Such lifestyles are useful but may have limitations in what they can achieve in the general population. If they play into an austere narrative of reduction of 'quality of life,' they may not have wide appeal, and would require long-term value change in society to accept less. Given the variety of limitations on many demand side measures, it may be that achieving sustainable consumption requires a return to the fundamental concept of human wellbeing, and achieving balance across its many dimensions.

A promising approach to improved human wellbeing that balances the different life domains is offered by '*wellbeing pathways*' of Henderson and Knight (2012) and Huta and Ryan (2010) and '*full-life*' or *'integrated pathways*' of Waterman (1993); Seligman *et al.* (2004); Peterson *et al.* (2005) and Huppert and So (2009). Among the life domains, the social and relational feature prominently, with the key to wellbeing in achievement of balance and not necessarily 'more' as proposed by Delle Fave *et al.* (2011). Wellbeing needs to be defined individually and by different cultures[5], yet there are clear overlaps in the eight dimensions of wellbeing in development of Stiglitz *et al.* (2009)[6], the ten central capabilities of Nussbaum (2005), and the six dimension model of psychological wellbeing of Keyes and Ryff (1999). In defining wellbeing pathways, the 2011 study of Delle Fave *et al.* (2011), of seven different countries[7], outlined eleven different life domains from wellbeing research (i.e. Work, Family, Standard of Living, Interpersonal Relationships, Health, Personal Growth, Spirituality/Religion, Society issues, Community issues, Leisure, and Life in general). They found concordance with what citizens referred to when they speak of wellbeing and happiness. Interestingly, balance, family, health and interpersonal relationships were once more ranked highest, and Henderson and Knight (2012) have recommended such a categorisation of life domains for future wellbeing research. In Fig. 1, the contrast of approaches to wellbeing that place a priority on consumption, verses balanced wellbeing pathways, are adapted from Delle Fave *et al.* (2011). They are illustrated with reference to a social and environmental sustainability threshold. For the purposes of illustration, the 'standard of living' domain of Delle Fave *et al.* (2011) is replaced with 'consumption.'

[4] A 'sufficient life' is associated with moderation and prudence.
[5] Recognising the importance of freedom and the cultural context as described in the capability approach of Sen (1999).
[6] The eight dimensions of Stiglitz *et al.* (2009) are listed as; i) Material living standards (income, consumption and wealth); ii) Health; iii) Education; iv) Personal activities including work; v) Political voice and governance; vi) Social connections and relationships; vii) Environment (present and future conditions); viii) Insecurity, of an economic as well as a physical nature.
[7] Australia, Croatia, Germany, Italy, Portugal, Spain, and South Africa.

Figure 1: Contrasting approaches to wellbeing through a priority on consumption and balanced wellbeing pathways adapted from Delle Fave et al. (2011)



While Stiglitz *et al.* (1999), Nussbaum (32005) and others (Kjell, 2011; Helne & al., 2015; Alexander, 2012) have noted the importance of the 'environment,' 'nature' and 'other species,' much of applied wellbeing research has tended not to include such categories. For alignment with development studies and sustainability literature this category has been added to the domains of Delle Fave *et al.* (2011) in Fig. 1. Where the '*sustainable wellbeing*' pathways approach becomes promising in transition (O'Mahony, 2016), is when it is recognised that societies that are directed towards multidimensional wellbeing could be causally linked to lower material consumption and emissions.

As discussed above, it is known that the life domains most beneficial for human wellbeing are not income or consumption (Layard & al., 2012; Delle Fave & al., 2011), but are domains such as the social and relational. With potential policy synergies and win-wins, the 'double-dividend' becomes a highly desirable pursuit in its function to reduce emissions. In line with a lower emissions development path, 'sustainable wellbeing' could be used to facilitate and empower citizens in all nations to pursue 'the good life,' in a world where sustainability materialises as reality.

Conclusion

The troubling issue of global material consumption patterns has been prominent since the 1990's, when the debate on intergovernmental treaties on global heating accelerated. Increasing material consumption levels have continued to drive GHG emissions, placing a significant barrier in the pathway of low carbon transition, and achieving global equality and sustainable development. While acknowledging the role of income and consumption in reducing poverty, the role in delivering human wellbeing, particularly in the wealthier nations, can be questioned.

Recent studies that seek to explore the relationship of consumption to individual human wellbeing document a heterogeneous picture. Some consumption bundles contribute more to wellbeing than others, and some categories can even be damaging, particularly in forms of 'over-consumption'. From development studies to health, and from psychology to wellbeing science, a multidimensional model of wellbeing is now accepted, both by a long philosophical tradition and by emerging empirical results. At the global level, the aggregate of wellbeing and consumption are driving environmental destruction and societal inequality. Yet, development pathways that balance high levels of wellbeing and low emissions are a largely unexplored in modern history. Economic development and industrialisation have inherently favoured growth in incomes and consumption as the pathway to 'the good life,' status and national prestige.

The field of sustainable consumption and production has sought to address this paradox. The response that has emerged has centred on approaches such as 'efficiency' on the production side and the 'green consumer' and behaviour on the consumption side. While efficiency has improved, material consumption and emissions have continued to increase. It has become increasingly evident that efficiency and technological change are not sufficient to facilitate sustainable development pathways (68). A more fundamental focus looks at *immaterialisation*, through the decoupling of income or consumption from human wellbeing. A focus on multidimensional wellbeing, with consumption as only one of the contributors, is supported by both theory and evidence.

A more fundamental change involves a shift in the priority on life domains and a focus on balanced *multidimensional wellbeing pathways*, or '*sustainable wellbeing*' (O'Mahony, 2016). This could lead to higher levels of wellbeing while also reducing emissions, the essence of Jackson's '*double dividend*' (2005). Balanced wellbeing would address all of the dimensions of human wellbeing, rather than relying on income and material consumption as the utilitarian route to living 'the good life'. Recent research in wellbeing science and psychology has outlined '*wellbeing pathways*' as a unifying conception that allows a '*full-life*' '*flourishing*' concept to emerge in individuals and society. This could be used to facilitate the emergence of synergies and win-win outcomes, particularly advancement of human wellbeing, in parallel to low carbon transition and reduced environmental pressures. Engaging with this opportunity will require more conceptual and empirical scholarship, that integrates wellbeing research with sustainability science, and the transformation of systemic structures from those that constrain to those that enable 'sustainable wellbeing'.

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Local government initiatives to promote sustainable industrial development. The case of Abruzzo Region

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Abstract: The transition to sustainable industrial systems is one of the cornerstones of European Union policy to develop a competitive economy, that are progressively translating into a series of regulatory and other initiatives, both at national and local level. Although these initiatives are now numerous, few have been able to make the most of the advantages of a "bottom-up" collaborative approach, capable of synergistically exploiting the advantages deriving from incentives, financing and tax relief that European policies, at the local level, have promoted in the last few years. In this article, the "Carta di Pescara" initiative will be presented and analyzed. It is a programmatic document of the Abruzzo Region, co-designed together with the business and academic world, which incorporates the guidelines of European policies on environmental sustainability applied to industry. The article describes the inspiring principles of this governance tool, the choice of stakeholders, the structuring process, the selection and definition criteria of the rankings, the rewarding mechanisms. Finally, the first results will be exposed, some statistics on the current members and the potential benefits as well as the criticalities of this initiative.

Keywords: Sustainable Industrial Development; Circular Economy; Regional Policy.

Introduction: The role of regional policies in promoting an industrial sustainable development

Since the 1970s, environmental issue was gradually taking shape worldwide. In this period, the strong industrial development weighed heavily on the natural environment, as there was a belief that the environment was able to metabolize all waste resulting from human activities. At European level, in March 1972, the Commission issued the Second Communication on the Program of the European Community for the environment, which contains the first reference to the linearity of the economy and the possibility of exploiting waste as a source of raw materials (Seconda Comunicazione sulla politica della Comunità in materia di ambiente, 1972). With the 1992 UN Conference in Rio de Janeiro on the environment and development (UN Conference, 1992) and the subsequent approval of Agenda 21, become evident the key role reserved for local governments in pursuing the goals of Sustainable Development, which was further strengthened in the 1997 during the Third Conference of European Regions, meeting in Gothenburg (European Union, 1997). Most recently, through the EU 20/20/2020 package, the European Union (EU) has promoted several policies and initiatives in order to reduce the impact of pollution by actively involving the industrial systems. In particular, this package defines three main green actions: i) 20% cut in greenhouse gas emissions; ii) 20% of EU energy from renewables; iii) 20% improvement in energy efficiency (Tol, 2012). One of the ways identified to achieve these results, is represented by the implementation of the approaches and tools of the Circular Economy concept, formally launched through the 7th Environment Action Programme (European Union Decision, 2013).

The concept of Circular Economy (CE), which is widely spreading in recent years, summarizes the current need to move towards more sustainable socio-technical systems. This concept has its origin from the Industrial Ecology (IE) paradigm (Yuan et al., 2006), emphasizing, also through the choice of the two terms 'Circular' and 'Economy', the IE's basic concept of closing the loop. Nowadays, CE has become a landmark for policymakers, companies and academia, and substantial public and private funding are turning towards it. In literature, there is still no universally recognized definition of CE; usually CE is defined through specific actions and practices (Schroeder et al., 2018), which can act at different levels and involve different actors.

In this article, the "Carta di Pescara" initiative will be presented and analyzed. It can be considered a strategic tool at company level, able to identify and guide the implementation of individual and collective actions inspired by CE principles.

The "Carta di Pescara" as a tool for the sustainable development of the Abruzzo Region

The "Carta di Pescara" for Sustainable Industry (CdP) (Regione Abruzzo, 2016) originates from the European policy on the environment, and reiterates some general principles sanctioned by the EU, such as: *precautionary*, *correction at source*, *proximity*, *prevention*, *sustainability*, *empowerment*, and *cooperation*, which have found recognition also in the national legislation with the adoption of the law on the environmental promotion of green economy measures and minimization of the use of natural resources (Italian Law, 2015). A further reference of the CdP is the so-called "Europe 2020 Strategy", a ten-year strategy for advancement of the economy of the EU, in order to reach a smart, sustainable and inclusive growth (Comunicazione della Commissione, 2010a). It provides that, at the local level, each region defines its own Smart Specialization Strategy (S3) which allows the concentration of policy interventions in those application areas that may have relevance for the european regions, in terms of competitive advantage (Comunicazione della Commissione, 2010b). This strategy commits companies, research centers and universities to cooperate to identify the most promising areas of specialization of each region, but also the weak points that hinder the innovation process. The S3 identifies, therefore, the regional research and innovation strategies that allow a more efficient use of the structural funds and an increase of the synergies among the community, national and regional policies.

The Abruzzo Region, through the entrepreneurial discovery process implemented in 2015 to put into practice the S3, has identified its own specialization technological domains, with respect to which it has decided to promote and support the birth and development of a "*Regional innovation and technology transfer system*", which includes research, companies and training of knowledge and skills in the field of sustainable industry. Among the domains identified, there are *Automotive*, *Life Sciences*, *Agri-Food*, *Fashion Design* and *ICT&Space*, first interested by the CdP.

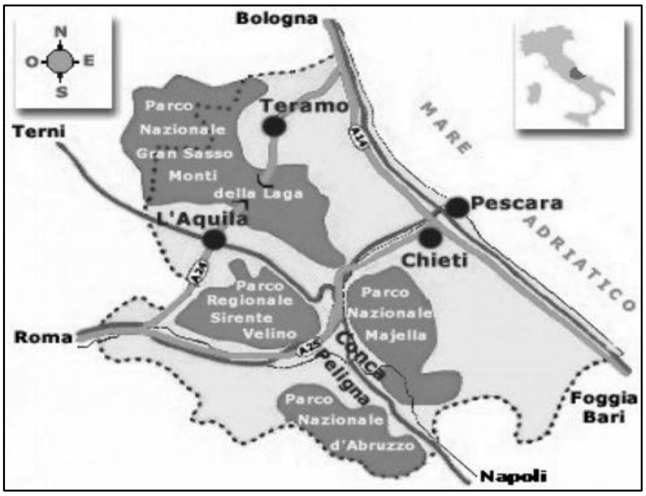
The development models based on local innovation systems and the regional territory

In the development and adoption of the regional S3, the Abruzzo Region was inspired by the model of local innovation systems, progressively spread in the EU over the last 20 years. In this broad model, the territorial innovation models and regional innovation systems (Crevoisier and Jeannerat, 2009; Moulaert and Sekia, 2003) can be recognized. These systems are defined as a set of elements connected to each other in order to create, share and spread knowledge and technological changes in a specific area, protecting their growth. They can have different spatial scales (regional, local) or different spheres of interest (sectorial, technological or organizational dynamics) and can include individuals from different contexts (public or private bodies, companies, research centers) or different levels of formalization (spontaneous or planned) (Taddeo et al., 2017).

The Abruzzo Region in application of the S3, has promoted the establishment of 14 Innovation Poles, defined as *"groupings of independent undertakings—innovative start-ups, small, medium and large undertakings as well as research organizations—operating in a particular sector and region and designed to stimulate innovative activity by promoting intensive interactions, sharing of facilities and exchange of knowledge and expertise and by contributing effectively to technology transfer, networking and information dissemination among the undertakings in the cluster"* (Official Journal of the European Union, 2006), which played an important role in the development of the CdP.

The Abruzzo Region (Fig. 1) covers an area of about 10,700 km^2 and has a population, by 2017, of about 1,317,000 inhabitants (density: 121.61/km^2). Abruzzo ranks first in Italy for its percentage of protected area, which represents 36% of the regional territory. It has three national parks, a regional park and 38 protected areas including WWF oases, national and regional reserves.

Figure 1: The Abruzzo Region



The Abruzzo Region is also one of the most industrialized regions of Italy. In 1996 it was the first region of the south of Italy to come out of Objective 1. In fact, since 1950, regional GDP has grown steadily, making Abruzzo one of the fastest growing regions in the country. In 2015, Abruzzo has reached the second-best GDP growth rate of Italy (+2.6%). In 2015, GDP per capita amounted to € 25,200, the highest in the south of Italy, but below the Italian and European averages, which account to € 27,800 and € 29,900 respectively. The region has one of the highest productivity rate in Southern Italy and its economic structure is largely based on SMEs. In 2015, Abruzzo was the one of the most industrialized region in Italy (29.3% of value added from industry). Abruzzo in fact enjoys industrialization rates that are above the National average (66 enterprises per 10,000 residents *versus* a national average of 64) (Commissione Europea, 2018).

For the reasons given above, the Region presents excellent characteristics for the implementation of the policies promoted by the CdP.

Main objectives of the study and methods of analysis

The article describes the inspiring principles of the CdP. In the following sections, the choice of stakeholders, the structuring process, the selection and definition criteria of the rankings, the rewarding mechanisms are described. The first results obtained, some data on the current members and the potential benefits as well as the critical aspects of this initiative are presented.

The research uses a scientific and secondary literature base and qualitative and quantitative data deriving from direct participation in the project and from direct interviews conducted with the regional referents of the initiative, as well as reports related to the results obtained so far.

The "Carta di Pescara" features

The CdP is the result of a participatory path of co-planning developed together with the entrepreneurial and academic world; it offers companies that sign it a "business-regional partnership path" that recognizes specific advantages for companies that are committed to pursuing the goals of sustainable industry.

In view of this commitment, the Abruzzo Region identifies some benefits in terms of:

- *simplified procedures* (level of bureaucracy and local administrative costs are minimized);
- *reduction of administrative and local taxes* (regional taxes related to production activities are as low as possible);
- *supporting legislation* (dedicated legislative initiatives for simplification are on the way);
- *priority* (every call for proposal founded by European Regional Development Fund 2014 – 2020 Axis I and III is oriented towards the 5 technological dominions; among these, specific additional evaluation score is allocated for companies partner of the CdP).

Within the S3 of the Abruzzo Region, the CdP represents the glue of industrial policy interventions and is aimed at evolving manufacturing activities in the area (or that will be attracted in the near future) by leveraging the ability to integrate and develop new knowledge and technologies and, at the same time, to maximize the synergy among the economic, social and environmental dimensions. The CdP has been defined as a transversal priority of the European Regional Development Fund (ERDF) 2014-2020.

The development path of the "Carta di Pescara"

The choice to focus on environmental sustainability emerged during the entrepreneurial discovery processes, when the stakeholders, involved in a very early stage, explained how sustainability was not just something related to the rules to be respected, but a "market choice" made to be more competitive in the international benchmarking of quality products.

From January 2016 about 500 SMEs and about 10 large companies have been selected, using some shared criteria such as: SMEs participating to Horizon 2020 or to the Seventh Framework Program or at least to ERDF 2007-2013 Program; SMEs having patents registered in the last 2 years; SMEs investing in research more than the regional average, and so on. To improve the process, the selected stakeholders were directly interviewed in order to know their main prospects for medium-term investments. At this point, the decision to focus on sustainability and the CE, as they emerged as salient and interesting aspects by all the interviews, was taken.

How to join the "Carta di Pescara"

To be eligible to become a CdP partner, the *applicant* must meet several conditions, having the environment as the priority. Depending on the number and type (quantity and quality) of conditions met, CdP membership may be "*basic*", "*intermediate*" or "*advanced*"; each level of membership will offer different types (or rate) of advantages (Fig. 2).

Figure 2: Levels and conditions for partnership.

LEVEL OF PARTNERSHIP	CONDITIONS FOR PARTNERSHIP
BASIC	To have to meet at least one basic condition for each dimension of sustainability (environmental, social and economic).
INTERMEDIATE	To have to meet two intermediate conditions of environmental sustainability + at least one intermediate condition both for social and economic dimensions.
ADVANCED	To have to meet at least three advanced conditions of environmental sustainability + at least one advanced condition of social and economic sustainability + at least one intermediate condition of social and economic dimensions.

In the CdP, 61 are the total amount of the conditions recognized for the environmental, economic and social dimensions of Sustainable Development. Among the conditions of environmental sustainability (29 in total) solutions on the adoption and implementation of plans to minimize the waste and emissions; solutions for the adoption of systems that enable recycling/re-use of water within the process; implementation of Life Cycle Analysis systems (including carbon footprint assessment) for products and processes; solutions for the adoption of tools and approaches for waste treatments inspired by CE are included.

Local stakeholders involved

The CdP is the result of the active participation of all the actors involved by the Abruzzo Region. Starting from 5 March 2016, 3 "Sustainability Forums" were organized in which the selected companies were involved. The meetings were organized in two stages, the first more theoretical, with interventions by regional and government political leaders, experts, scholars and technicians involved in the development of the CdP; in the second, more practical, working tables were set up, coordinated by representatives of the Region and of the academic world. The development process involved the three regional universities (University of Chieti-Pescara, University of L'Aquila and University of Teramo) and regional research centers, the unions, the innovation hubs, representing the 5 vertical sectors of the S3 chosen for the CdP (Automotive, Life Sciences, Agri-Food, Fashion Design and ICT&Space). At regional level, the Department of Production Activities, the in-house structures of the Region, and the regional offices corresponding to these activities, such as the

Energy and Environment Office, were involved. A control room was therefore established, chaired by the Director of the Region.

Monitoring phase

The progress of the CdP contents and the monitoring of the actual implementation of the commitments undertaken by the Abruzzo Region will be carried out by a steering Committee composed of the following members:

- General Director of the Abruzzo Region;
- Director of the Department of Economic Development, Labor, Education, Research and University;
- A representative of the regional university system;
- A business representative for each of the five technological domains of the regional S3;
- A representative of the trade union organizations.

Conclusion

The CDP, as a policy and local government tool in the direction of Sustainable Development, represents a concrete attempt to guide the change towards a regional model of CE.

It uses an *open* approach (any company operating in the Region can try to become a partner), *immediate* (the relative web platform is managed directly by the regional offices), and at *low cost* (no additional resources are needed), to support and promote innovative and sustainable companies, using the funds made available by the EU.

At present, about 130 companies are officially registered on the CdP web platform, with different levels of affiliation: 12% advanced; 25% intermediate; 63% base and actively involved in CE processes; this can be considered a direct result of the initiative. Alongside it, it is worth noting some indirect results, such as: i) stimulating companies to collaborate with each other and with universities and research centers (a foundation was born from this collaboration in 2018); ii) the possibility of orienting the ERDF towards research programs that have given birth to innovative projects, making research projects admissible even outside the Region with effects on the regional territory.

Among the critical issues recognized, there is still a limited participation of small companies and a limited involvement of the regional training system, for the creation of professional figures suited to the new and evolving context. Other refinements concern the integration of incentives that facilitate the adoption of the CdP by "excellent" companies in the region, in order to produce an emulative effect in the direction of sustainable industry in all the Abruzzo production system.

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Who participates in and drives collective action initiatives for a low carbon energy transition?

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Abstract: Broad acceptance by and support from the society for the sustainable energy transition is indispensable. Public participation and ownership - in particular through collective action initiatives - is seen as a means to foster this support. Starting with the origin of the cooperative model, we present how it has been evolving until today. We then discuss how energy CAIs are classified and discuss the legal underpinnings and how they related to democratic participation of the membership within CAIs. Statistical analysis with data from Sweden, Denmark, and Germany, questions whether they are as inclusive, just, and democratically controlled by their members as often deemed. We find that energy cooperatives are typically initiated by well-off, rural, male sexagenarians. The participation between women and men (including in decision-making) is below parity. Concluding, in practice, the mechanism of recruiting and engaging members falls behind the theoretic ideal of socially sustainable development. Although being a promising tool to curbing sustainability, current practices rather encompass a narrow perspective of sustainable development that is geared towards technological change. We conclude with a perspective of how this may be rectified in the future.

Keywords: energy transition, collective actions, energy cooperatives, public ownership, sustainability.

Collective action initiatives - Joining forces to solve local problems

Definition

A cooperative is a common form of a collective action initiative (CAI). It unites people voluntarily to fulfill economic, social, and cultural needs its members have in common. This is done by a jointly-owned and democratically-controlled organization (ICA, 2018). “In general, a cooperative comprises a voluntary network of individuals who own or control a business that distributes benefits on the basis of use or ownership where ownership is largely weighted equally across individual members” (Altman, 2009). In defining cooperative organizations, three essential criteria are distinguished based on the explanation of who is a member. First is “the user-owner principle”. Individuals who own and finance the cooperative are its users. Second is “the user-control principle,” which means that those who shape the decision-making process are users. Third, “the user-benefits principle” implies that cooperative users are gaining from being part of the organization (Barton, 1989). A normative definition of cooperatives suggests that they should be “founded on the values of self-help, self-responsibility, democracy, equality, equity and solidarity” (Gibson et. al, 2005, 2).

The origin of the cooperative model in Europe

Throughout human history, people worked together to adapt and change their societies. There is no agreement between scientists when the phenomenon of cooperativeness developed (Nilsson, 1996). The anthropology perspective suggests that this form of organization is already present in primary organizations. For example, Margaret Mead (1935) observed among the Arapesh people the sharing of garden plots. Examples of cooperation and collective resource management can be found in fieldwork done by Bronisław Malinowski (1922) and Alfred Radcliffe-Brown (1952).

Many studies suggest that the phenomenon of cooperatives developed during the Industrial Revolution in nineteenth-century Europe, especially in Britain, France, and Spain (Altman, 2009; Gibson et al., 2005). This form of economic organization has spread in Western countries due to tensions arising from industrialization processes (Forno, 2013). They are structures created to protect the interests of social classes with limited access to the means of production or power.

The Rochdale Society of Equitable Pioneers, established in 1844 in the North of England, is regarded as the prototype of modern cooperatives (Altman, 2009; Fairbairn, 1994; Mayo, 2017). Its formal principles are known as the Seven Rochdale Principles. Founded by 28 workers of a cotton factory, this initiative was intended to improve their material situation by joining groups of consumers to buy food products at better prices. The created store was not only intended to facilitate access to products, but also to create a system of dependencies based on mutual respect, commitment, and openness. The primary mechanism was to allow customers to decide what the sales profits were to be used for, and the clients were also shareholders (Fairbairn, 1994).

The Rochdale Society's success initiated the implementation of the model in other sectors of the economy. In 1863, nearly 400 cooperative associations were operating in Britain (Seth & Randal, 1999). The universality of the model resulted in the fact that in 1895, the 1st Cooperative Congress took place. The event was already of international significance. There were delegates from Argentina, Australia, Belgium, England, Denmark, France, Germany, Holland, India, Italy, Switzerland, Serbia, and the USA. A result of the congress was the establishment of the first international organization, the International Cooperative Alliance (ICA).

The cooperative model inspired a variety of forms across Europe, which spread to different sectors and were also applied in different social orders. Today, cooperatives influence a variety of different markets: marketing/producer, consumer/retail, worker/employment, housing, services, and finance (Gibson et al., 2005). Applications range from Kibbutzim (a cooperative form of farming in Israel), consumer cooperatives and non-voluntary agro-cooperatives in socialist countries to cooperatives who fight for the rights of women and minorities. We refer to them in general as "collective action initiatives (CAI)". We discuss next how the cooperative model has affected the energy sector through energy CAIs.

The spreading of the cooperative model to the energy sector

With the electrification at the turn of the 19th to the 20th century, the cooperative model also expanded towards the energy sector. In the early 20th century, several energy cooperatives have been constituted with the aim of providing electricity to population in rural areas, particularly in the alpine region including Germany and Italy (Yildiz et al, 2015; Spinnici, 2011). A compelling case of an electricity cooperative from 1920 is the Samerberg Cooperative in rural Bavaria, which was initiated by a priest (Figure 1). Its hydropower plant with 40 km of electricity grid, 70 motors, and 2500 lamps served about ten communities with more than 1000 inhabitants. The local newspaper "Rosenheimer Anzeiger" reports[1]: "*The far-sighted of the Samerberg can look back with pride*

[1] From www.e-werk-samerberg.de/historie/12-rueckblick-auf-75-jahre-eg-samerberg.html (24.11.2019).

on what has been accomplished. The importance of community-benefits and the cooperative, mutual support is very apparent at the Samerberger plant. In no other way could the unified supply of the remote villages and scattered individual farms of the local area have been carried out. Here, everyone had to stand for one and one for all."

Figure 1: *Electricity cooperative from 1920, started by a priest*

Source: OVB-online (2019).

During the second half of the 20th century, awareness about environmental problems, resource limitations, energy security, and environmental pollution was growing, exacerbated by the repercussions of the oil crisis in the 1970s as well as the nuclear arms race during the Cold War. Cooperatives were seen as a means to tackle these sustainable development problems and - last but not least - to make local voices heard and seen through providing testbeds for societal change. A prime example is the transitioning of Denmark away from fossil fuels to renewable energy, which was strongly driven by local wind energy cooperatives that grew out of networks formed from 1970s collective anti-nuclear campaigns (Mey and Diesendorf, 2018). In the 1980s, the first cooperatives started, snowballing to about 600 by 1990 and about 1000 cooperatives by the year 2000 (and declining afterward, see Wierling et al. 2018 for an exploration). For more details, see also the recent study of Gorroño-Albizu et al., 2019.

Today, examples of CAIs engaged in the sustainable energy transition can be found all over Europe, and the fields of activity and forms are investigated in the next section. A very recent example is the cooperative *E-Dörpsmobil* in rural Northern Germany. The name underlines the strong local ties, since "Dörp" is low-German for village ("Dorf"). This cooperative addresses two problems at the same time. The first concerns the lack of grid capacity for selling excess wind power, and the second is the improvement of rural mobility through shared electric cars. As of today, the model has been spreading in Schleswig-Holstein, involving 22 other communities under the motto "Dörps-mobil - we move the village. Northern lights drive e-green".

Figure 2: Electric mobility for rural areas - the "Dörps Mobil".

Source: doerpsmobil-sh.de.

The cooperative *Qvinnovindar* is an example from Sweden, which approaches the sustainable energy transition in a particular holistic way. In 2007, Wanja Wallemyr, encountered significant barriers for acquiring access to financial resources as a rural, female entrepreneur in sustainable energy. Many other women were prevented from getting engaged in this field due to banks' inexperience and, thus, reluctance in providing entrepreneurial loans to women. In response, she created a network of nine other women, who pooled their resources to purchase a share in a local wind park. She thereby launched a women's only collective, *Qvinnovindar*, to promote a better gender balance in the energy sector and to better empower women economically. The collective has since grown to over 80 members. The cooperative spun off a second similar women's energy-based cooperative, *Q2*, and has also attracted interest from other countries.

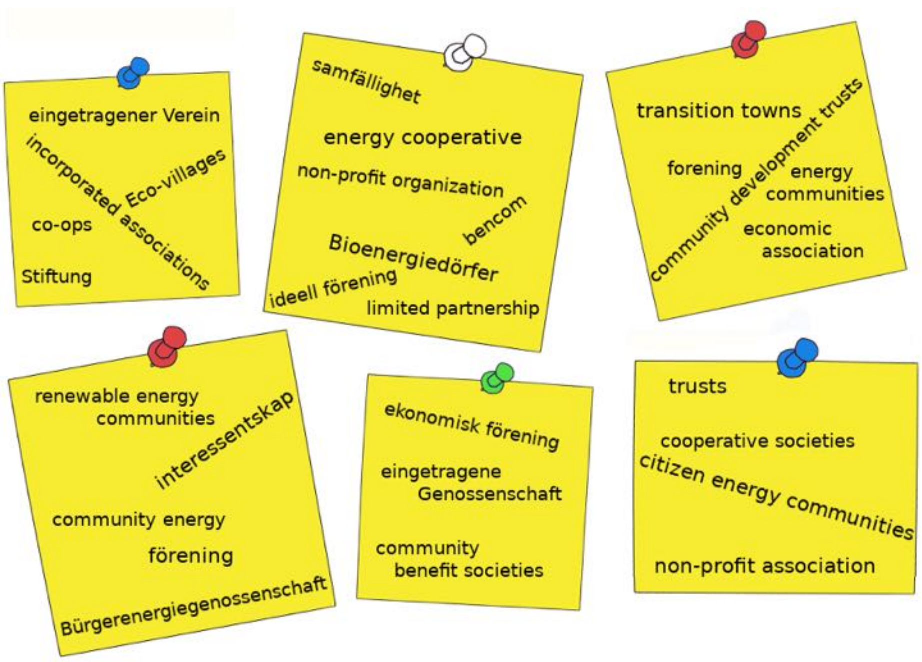
The structure and classification of energy CAIs

A number of frameworks (both from the legislative bodies and scientific literature) attempt to define and classify CAIs within the energy transition. Some focus on their specific forms, such as energy cooperatives, adopting the general definition for cooperatives provided by the International Cooperative Alliance (ICA, 2018), or local energy communities, as in the Communication of the European Commission (COM, 2016). Others zoom in on community energy (Hicks & Ison, 2018; IRENA Coalition 2018). A commonly-used classification framework for energy CAIs proposed by Walker and Devine-Wright (2018), uses two dimensions: the process and the outcome dimension. The process dimension refers to the organizational structure of the initiative (i.e., Who decides and who is involved?); whereas the outcome dimension refers to the purpose of the initiative (i.e., What are the type of community benefits generated and for whom are they intended?). In this section, we adopt these dimensions and explore the outcome dimension first (fields of activity) and then discuss the process dimension (participation structures of energy CAIs).

Fields of Activity

The historical and recent examples of CAIs presented in the previous section indicate that various forms have been and are being tested to cooperatively address local problems. Each period led to the evolution of its specific modes of organizing; and the same holds for different countries across Europe since societal characteristics, legislation (at national and/or regional level), and, last but not least, the local problems at stake strongly influence the preferred model for collective action. The outcome of a CAI is dictated by the shared collective interests of the membership, and serves as a unifying force to create an identity and establish autonomy within the community (Gregg, et al., in press; Bomberg and McEwen, 2012). Figure 3 illustrates the variety of responses to local circumstances found by creative citizens exploring the cooperative approach.

Figure 3: Variety of collective action initiatives across Europe



Source: own figure.

Pivotal to understanding the structure of CAIs are the participants' motivations and their role within the organization (both as a user of the services and products provided and as a decision maker); a CAI's form is ultimately shaped by the members' motivations (Gregg, et al., in press). CAIs generally foster and strive for a host of economic, environmental, social, political, and infrastructural goals. In the view of the energy sector these include aspirations to: reduce home energy bills, generate income for the communities, reduce energy poverty, promote local economic development, develop local skills, create jobs, reduce carbon emissions, improve the local environment, enhance health and well-being, support education, enhance social cohesion and social inclusion, promote volunteerism, empower the community, influence energy policy, gain community leadership, strive towards energy independence, and to refurbish buildings (Seyfang et al., 2013). Out of these goals, the top three found to be most significant in energy communities were reducing household energy bills, reducing emissions, and striving for energy independence (Seyfang et al., 2013). These motivations can manifest different fields of activity of CAIs in the sustainable energy transition in the following ways:

- Community owned generation assets *[2] The idea is to produce and sell energy to a supplier. The income from the operation is shared among the CAI members or reinvested in one or

[2] The first three fields of activities are referred to by CEER (2019), which we take over here (indicated with a star).

another way. Thus the motivations here are community autonomy, sustainable energy, and financial benefits.

- Virtual sharing over the grid*. The CAI owns and manages assets, shares the profits and the energy produced among their members. This can be organized through a common supplier that is in charge of matching supply and demand. The motivation in this case is similar to the community owned generation assets, but with less emphasis on community autonomy and more on the financial benefits. The goal of providing more renewable energy to the grid is also a motivation.
- Sharing of local production through community grids*. A community grid is developed, allowing locally sourced energy to be shared within the community. The motivations would be to attain energy self-sufficiency and collective autonomy over community energy decisions. Micro-grids and district heating are typical examples.
- Distribution and operation of electricity. Electricity is collectively purchased at the market and redistributed to members or other customers. The idea is to use the community leverage to realize economic savings or to guarantee the origin of electricity. The motivation here is collective bargaining power resulting in lower energy costs and perhaps the reduction of energy poverty.
- Light contracting. The provision of street lighting in the community is organized. A motivation is to use locally generated electricity. Often the switch to light contracting comes together with the retro-fritting of existing infrastructure (e.g., LED technology).
- Energy consulting. The idea is to provide information services to the local society on a variety of topics, ranging from the planning of renewable installations, training of operations, and energy efficiency measures to energy businesses models. Aside from promoting renewable energy, the motivation here is to develop skills and jobs to boost the local economy.
- Financial support to improve the energy efficiency of households. The idea is to enable funding schemes for low income households to improve energy efficiency. The motivation here is to reduce energy poverty within the community. This appears to be a popular field of activity for Irish energy cooperatives.

This distinction accounts for alternative technology preferences across Europe. For example, while solar energy is currently the dominant technology for energy cooperatives in Germany, wind power is more popular in Denmark and The Netherlands (Oteman et al., 2014). Furthermore, it recognizes historical developments, since the local problems addressed by CAIs are changing alongside with the society and the prevailing energy paradigm. For example, Transition Towns in the United Kingdom do not advocate for specific technologies. Instead, they emphasize the need to transition away from fossil fuel sources (Seyfang & Haxeltine, 2012). Likewise, the energy transition in Germany was influenced by elements within the civil society that opposed nuclear power after the 2011 Fukushima disaster (Moss et al., 2015).

The goals (i.e., outcome dimension) of a CAI can also be shaped by laws and regulations, e.g, stipulations on how the benefits are distributed among the members. For example, in Sweden, some CAIs are legally defined as economic associations, *ekonomisk förening*, which are created to focus on the financial interests of the membership. Non-profit associations, *ideell förening,* on the other hand, preclude member profits, and thus the focus of the association is on intrinsic social benefits (Bolagsverket, 2019a, 2019b). There is a similar distinction in the UK between cooperative societies (co-ops) and community benefit societies (bencoms), the latter of which focuses on social benefits (BIS, 2011).

Participation Structures of Energy CAIs

Similarly, the process dimension of Walker and Devine-Wright (2018) is dictated by the legal form the CAI adopts. Relevant forms for CAIs include associations, cooperatives, limited partnerships, foundations, and incorporated companies. These forms depend on the country; for instance, some countries, such as Denmark and Sweden, do not distinguish between cooperatives and associations (both are forening /förening), whereas in Germany there is a legal distinction (eingetragene Genossenschaft versus eingetragener Verein).

In the Clean Energy Package of the European Union (COM, 2016), the concept of local energy communities is defined in Article 2(6), being an "… association, a cooperative … or other legal entity which is effectively controlled by legal shareholders or members and is generally value rather than profit driven; although it performs its activities at the local level this may extend across borders …". Two forms are differentiated by their spatial and technological focus: Citizen Energy Communities (CEC) and Renewable Energy Communities (REC). REC are stricter regarding locality as all members need to be "located in the close proximity of the renewable energy project" (COM, 2018). Additionally, while CEC are technology-neutral, though limited to the electricity sector, REC foster the promotion of renewable energy technologies in the entire energy sector (CEER, 2019). In the final European legislation, the concept of Citizen Energy Communities is taken up in the directive on common rules for the internal market for electricity (EU, 2019), while the Renewable Energy Communities are defined in the directive on the promotion of the use of energy from renewable sources (EU, 2018).

Among the CAIs in the energy sector within Europe, energy cooperatives are generally the most common form seen, because this form has the best legal structure to support local ownership and equitable participatory processes (Huybrechts & Mertens, 2014; Yildiz et al., 2015). The "one-member - one-vote" is a fundamental principle to the cooperative structure, which aims to share decision-making power equitable amongst the membership (ILO, 2013; Viardot, 2013; Huybrechts & Mertens, 2014; Yildiz et al., 2015). This principle of democratic inclusion within energy collectives is codified within most European countries' laws. Out of the 28 EU member states, plus Norway and Switzerland, 17 countries have national laws that strictly require the "one member – one vote" principle for cooperatives. Three countries (Sweden, Germany and Finland) additionally allow a proportional voting system, while Slovakian law only allows proportional votes based on membership shares. Luxembourg and Portugal generally adhere to the "one member – one vote" concept, however it is possible for some members to obtain several votes and Poland only requires it for cooperatives with solely natural persons as members. Only six European countries - Belgium, Bulgaria, Hungary, Ireland, Malta and the Netherlands - do not require specific governance structures for cooperatives (Cocolina, 2016; Karakas, 2019).

The fact that there is a legal underpinning to the "one member - one vote" principle leads to a prevailing conclusion that energy CAIs engage in the energy transition not only to promote the deployment of renewables, but also to support just and inclusive participation. In the next section, we explore this notion in more detail by investigating empirical evidence on "Who participates and who drives the collective model to engage in the energy transition?". The focus countries for the statistical analysis are Sweden, Denmark, and Germany.

Investigating the claim of inclusive, just, and democratic control

As shown above, CAIs in the energy transition can take various forms regarding technological focus, organizational structure, legal forms, and approaches to distribute the benefits generated to their members and the wider community. Yet, one main theme can be found in all of them - the key element of inclusive, just, and democratic control that members of the initiatives are possessing (e.g. Hicks & Ison, 2018; IRENA, 2018; ICA, 2018; Walker & Devine-Wright, 2018). For this reason, CAIs are often seen as a way to enable "energy democracy" (e.g Klagge & Meister, 2018, Stephens, 2019), a concept, which most commonly refers to the transformation of the currently centralized and monopolized energy markets into economically and socially just, inclusive markets (Burke & Stephens, 2017; Van Veelen & Van der Horst, 2018; Szulecki, 2018).

This vision is, however, recently being challenged by questioning whether CAIs in the energy transition are indeed as inclusive as deemed. Van Veelen criticises that the current literature on energy democracy and community energy "often assumes rather than demonstrates that the forms of governance it promotes are more democratic than the status quo" (Van Veelen, 2018). Dilger et al. highlights a duality of goals of European energy cooperatives, i.e. community orientation and market efficiency, which have implications for the different business and organizational models implemented and, in turn, for the forms and levels of citizen's inclusion and participation (Dilger et al, 2017). Candelise & Ruggeri find that in Italy community energy initiatives promoted by commercial actors or more inspired by market logics tend to have lower levels of citizen's involvement and co-determination, even when the cooperative is chosen as legal form (Candelise & Ruggieri, 2017). A further issue relates to the aspect of how "community" is being defined in related community energy projects. Simcock (2014) argues that decision processes should include all who are affected by the decisions. Yet, CAIs largely only enable democratic control for their members; the wider community, which is still affected by the decisions taken, is often left out. An example provided by Simcock (2014) is the decision on where to place new wind turbines.

The following section therefore investigates data from Sweden, Denmark, and Germany. The objective is to provide quantitative insights on who engages in and who takes decisions in the initiatives. We investigate membership structures of renewable energy CAIs in regards to income levels, age, gender distribution, location, and the composition of board members.

Collective action initiatives - Who participates and who decides?

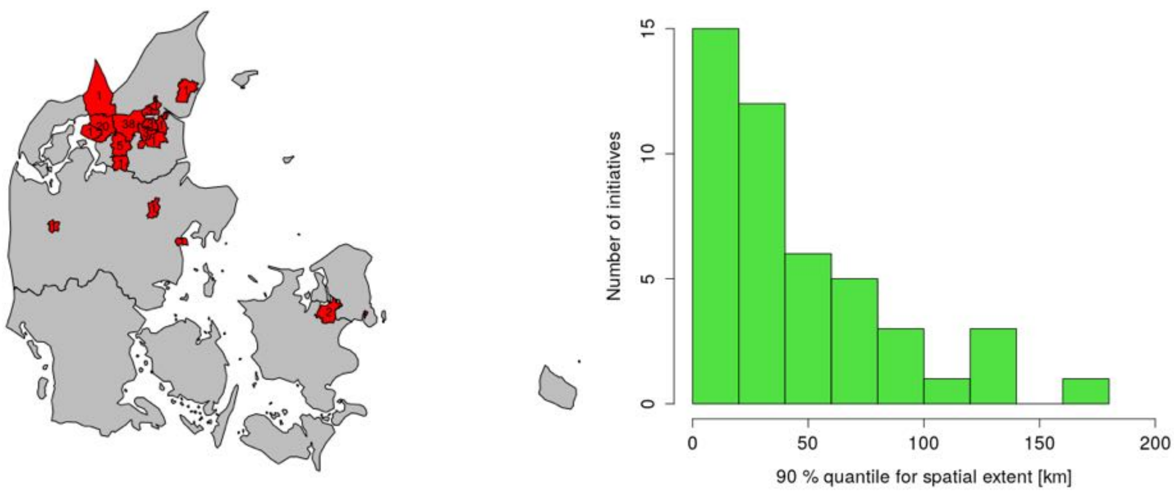
A statistical snapshot from Sweden, Denmark, and Germany

Denmark. For the statistical analysis, we query the Danish Business Register (datacvr.virk.dk). We deploy a sub-sample of partnerships (Interessentskap) engaging in wind energy (vindmøllelaug, møllelaug). In order to separate collective actions from enterprises run by individuals (prosumers), we select those where no individual owners are identified, as otherwise, it is a matter of private and not collective ownership. Excluding also initiatives with fewer than five members, the sample for

Denmark contains 46 entries. For all of them, places of residence of all members are obtained. Analyzing postal codes, we derive a locality measure. In the first step, the surface centroid is determined from the postal codes. Then the 90% quantile for the distances of the individual places of residence is calculated.

Figure 4, l.h.s., is an example of the statistical analysis undertaken for each of the 46 CAIs. Numbers equal the number of CAI members living in the same postal district. In the example shown, the CAI has 87 members altogether. The majority clusters around Northern Jutland. On the r.h.s. of Figure 4, the histogram for the full sample is shown. The majority of CAI members are located within a 50-km range.

Figure 4: The locality of collective wind partnerships in Denmark: Number of members in the same postal district (l.h.s.) for one exemplary CAI. Distribution of CAIs with members located within a specific range (r.h.s.).



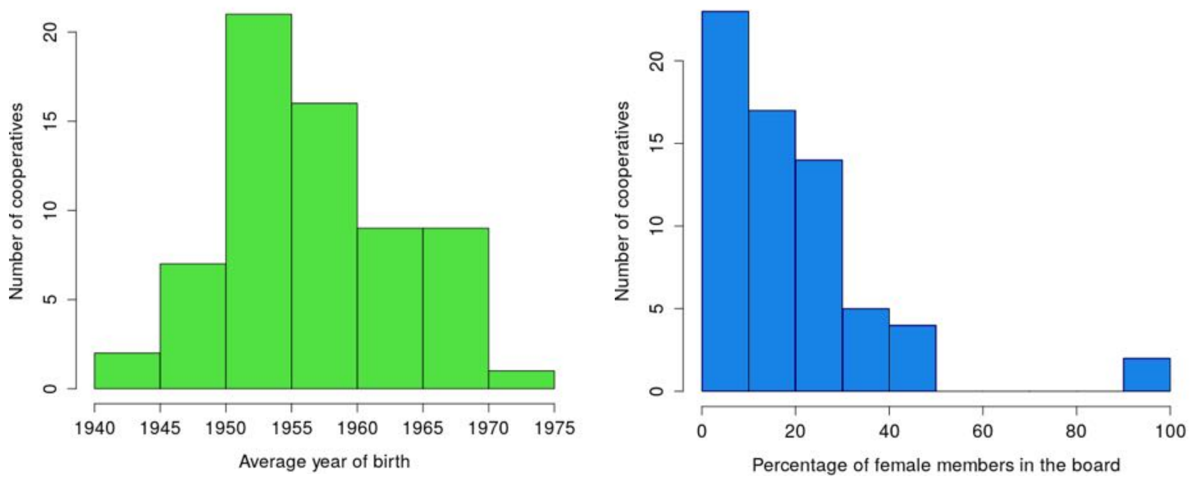
Source: Own figure, for sources of data, refer to the text.

Sweden. In the statistical analysis, we consider incorporated associations (ekonomisk förening), non-profit associations (samfällighet), and non-profit organizations (ideell förening). Swedish data are sourced from allabolag.se and vindstat.com; the former is an information service provider for Swedish companies and the latter a website providing wind statistics. Additionally, self-reporting of the initiatives on websites was used, and yearly reports were analyzed to collect information on membership data. The Swedish inventory comprises 182 entries.

Seventy-seven of the cooperatives are active in the area of wind energy, 27 in electricity distribution and trade, 17 in hydropower, 10 in solar energy technology, 8 in biogas, 8 in energy consulting, and 35 are eco-villages. As of 2016, collective energy projects owned about 2% of the total 6468 MW installed capacity of wind power in Sweden (96 out of 3342 installations).

We focus the following analysis on the subset of Swedish wind cooperatives, who are obliged to report data on members and board (65 data entries for incorporated associations). They typically have several hundreds of members, but there are few with several thousand members, and some have just a few tens. The numbers did not significantly change over the years, which is also linked to the business model of the energy cooperatives in Sweden. The purchase of a wind turbine is financed by the sale of shares ahead of the project (typically of 1000 kWh/year). Members of cooperatives purchase several shares, which is primarily driven by their own electricity consumption. Once the total costs for a wind turbine are realized, shares are no longer for sale. Our results are in agreement with those reported in Magnusson & Palm (2019).

Figure 5: Member of board demography and participation in decision-making in energy cooperatives from Sweden



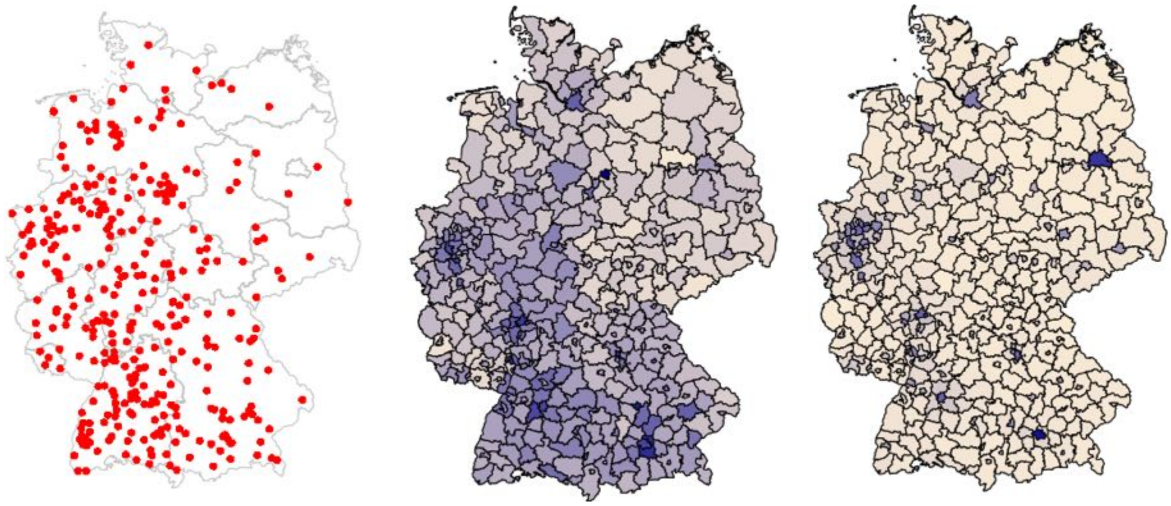
Source: Own figure, for sources of data, refer to the text.

In Figure 5, we take a closer look into the demographics of board members of wind cooperatives. As the left-hand side of the figure shows, the average age of all board members is around 63 years (as of 2020). This suggests that citizens engaged in cooperatives are comparably well off, and this can be confirmed when mapping the location of the cooperatives to the average income distribution in the respective communities (see also the case of Germany, where we show the data in Fig. 6). A similar analysis reveals that most of the cooperatives are located in rural areas. The right-hand side of Fig. 5 shows that the participation of females in the board of cooperatives is clearly below parity. The exception comes from two aforementioned women cooperatives, *Qvinnovindar* and *Q2*. Finally, we also report statistics on the participation of members in yearly meetings, which have been collected from reports of cooperatives published online (18 cases). On average, less than 15% of the members participated in the yearly meetings.

Germany. For the German sample, data are sourced from the German Business Register (www.unternehmensregister.de). We consider cooperatives active in photovoltaic installations and map their legal addresses with socio-economic data on the NUTS-3-level (Eurostat). Altogether, 407 different cooperatives with 3322 different PV installations between 1993 and 2019 were compiled. The total installed capacity is about 540 MWp.

Figure 6 shows the location of the collaborative energy projects (red dots pin their addresses at the right-hand side) vis-a-vis with the income distribution (middle) and population density (right-hand side). The cooperatives are active in rural, high-income areas.

Figure 6: Collaborative PV projects in Germany (addresses - l.h.s.) vs. gross wages in Germany (middle, light blue: low income, dark blue: high income) and population density (r.h.s.: middle, light blue: low income, dark blue: high income).



Source: Own figures, data on collaboratives from own inventory, demographic data from landatlas.de

Discussion of research findings

Who participates in cooperative energy projects?

From the examples, review, and statistical analysis, we find that dedicated individual and grassroots activists focusing on unmet needs are prominent initiators of CAIs. These typically surround a desire to have a stronger voice in the energy system and to promote sustainable energy technologies. The most important enabling factors are the change of perception towards sustainability and identity creation around the CAI. This gives a community sense of purpose among the members and a growing member base with increased visibility. However, insights from the statistical analysis indicate that members of CAIs are not representative of society. From the Swedish sample of energy CAIs, we infer that the typical member is male, with an average age above 60. All our country samples hint towards rural areas as being the core regions of activity. The Danish sample further confirms that initiatives are mostly local (falling into the 50 km range). Mapping of the German sample with income distributions at the NUTS-3 level, we furthermore find that the location of cooperatives coincides with high-income regions. Summarizing, participants in energy related CAIs seem to be well-off, rural, male sexagenarians. Our findings of limitations of inclusiveness to the membership of CAIs are in line with a recent study commissioned by the European Parliament's Policy Department for Citizens' Rights and Constitutional Affairs. The study stresses that gender inequalities are "preventing women from the involvement in the energy transition and career advancement in this area" (Clancy and Feenstra, 2019). Similarly, are the case study results presented in Fraune (2015), Rommel (2018), and Łapniewska (2019), who observe a general under-representation of women in CAIs active in the energy sector. We can add that the same seems to hold for younger generations and, in tendency, for groups with fewer financial resources available.

Our finding has consequences for the innovative potential of CAIs, which may not be tapped to the fullest extent possible. The reason is that the most significant innovations of CAIs are social innovations: the collective decision-making processes and education of local community members, both of which benefit when they are representative of the entire community and both of which support the social pillar of sustainable development. In particular, technological innovation serves as an enabler but is not sufficient on its own to build a successful movement and gain traction. In this light, a successful sustainable energy transition is more dependent on social innovation - and inclusive participation.

Who drives decisions?

The statistical analysis of the Swedish sample revealed that only a sub-group actively engages since not more than 15% on average are participating of the members are participating in the yearly meetings (AGM). This coincides with findings from interviews conducted in Van Veelen (2018, 651), who notes that "... *members are often content to leave staff and directors of the community organization 'to just get on with it' (CG2, general member). Groups' reports of low attendance figures at their AGMs and their difficulty in attracting new directors appear to confirm this assertion that many members have no desire for greater involvement.*" Furthermore, analyzing the composition of the boards of the Swedish CAIs, we find that the participation of female members is below parity.

It serves our point to quote Van Veelen (2018, 652) again: "*The frequent involvement of a small number of people in community projects can also raise concerns regarding these leaders' representativeness of the wider community, not least because community leaders often were similar in age, gender and/or socio-economic background.*" Our quantitative results provide corroborating evidence that the social dimension of sustainable development is not well addressed.

Limitations of the statistical analysis

The dataset compiled is not complete, since reporting duties vary across countries. The measure of locality is a work in progress, as boundary effects are not yet controlled. Hence, quantitative results should be used with care and not without context. Data only indicate trends. Also, we only have information on boards members for the Swedish CAIs and are aware of the fact that this may not be representative for the demography for the members itself.

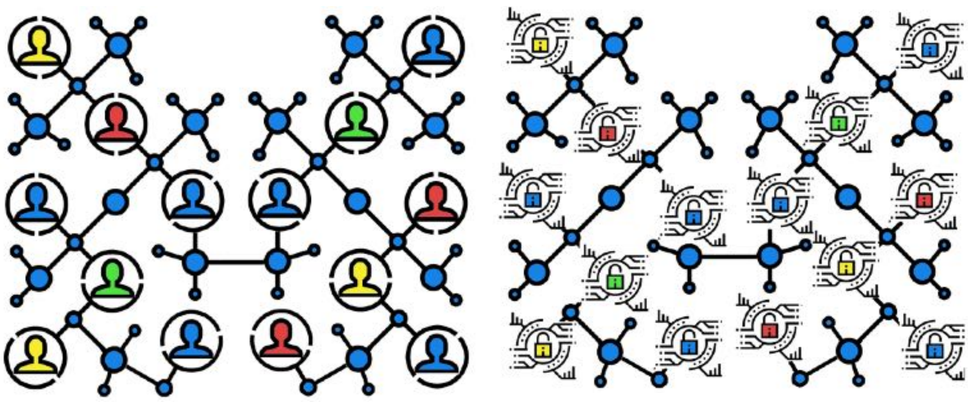
Summary and outlook

We find that collective action initiatives (CAIs) are an essential tool and testbed to solve local problems and to curb the sustainable energy transition in Europe. Moreover, the number of initiatives as well as their members are growing, and the fields of activities are broad.

While case studies may provide deeper insights into selected cases, a statistical analysis offers the possibility to identify generic features. With the availability of new and comprehensive data on CAIs, it is worthwhile to investigate their role in the sustainable energy transition beyond case studies to provide aggregated evidence. A starting point is the statistical evidence compiled by Wierling, et al. (2018), which is one of the first attempts in that direction. This chapter represents a follow up to that paper, and looks more in depth into democratic participation elements that underlie energy CAIs in Europe. We therefore question whether the often-heard claim that local collective actions are particularly democratic can be supported by statistical evidence or not (e.g., Kunze and Becker 2014).

Regarding the social sustainability of energy CAIs, we find there is still much room for improvement within Europe, particularly in regards to representativeness of the CAI participants. CAIs are typically initiated by well-off, rural men of age 60+, and it is only a core group of members that drives decisions. Moreover, the participation between women and men (including decision-making) is below parity. Altogether, participation in collective energy projects is not inclusive when compared to the cross-section of society. Concluding, in practice, the mechanism of recruiting and engaging CAI members falls behind the theoretic ideal of socially sustainable development. Although being a promising tool to curbing sustainability and reaching an impact beyond their members and locality of the initiative, current practices rather encompass a narrow perspective of sustainable development that is primarily geared towards technological change, such as the switch from fossil to renewable sources.

Figure 7: Collective action vs. distributed ledger. Both share basic features - people are interacting with each other, in the latter case through, e.g., blockchain technology.



Source: Own figure.

Future Perspective. As a continually developing social innovation, the cooperative model is flexible and well suited to address current problems, both within the energy transition and with regard to social sustainability. One means of rectifying the participation disparities would be more stringent legal frameworks for energy collectives, requiring that the founding group be demographically representative of the local community. This could have adverse effects, however, and preclude traditionally underrepresented groups and minorities from forming their own collectives (e.g. *Qvinnovindar*). Legal regulations could also enforce voting quora among the membership. However, not only would this be difficult to enforce, it would likely be a disincentive for individuals to join collectives due to the high level of demands and participation expectations. Thus, soft solutions to the representativeness issue have to be considered with great care and caution.

However, new innovations will likely have some impact in this regard. Here, it is interesting to point to the similarities between cooperative networks and other technological as well as social innovation trends such as distributed ledgers (e.g., blockchain technology; refer also to Figure 7) or the use of crowdfunding platforms in the energy sector. The former translates the concept of the 19th century into the 21st century. Through peer-to-peer contracts and trading, distributed ledgers enable activity without hierarchies and intermediaries. All participants collaborate on equal ground in the jointly operated network. As for energy cooperatives, crowdfunding platforms dedicated to energy involve citizens and other stakeholders in energy projects allowing them to invest and benefit from the return on the investment itself. The use of crowdfunding in the energy sector has in fact begun as a fairly niche application to grassroot and community energy projects, acting as a facilitator of the latter by both supporting their funding needs and opening up local initiatives to a broader group of members. The potential of crowdfunding to both support CAIs expansion (Dilger et al. 2017) and provide funding needs to the energy transition (Vasileiadou et al. 2016), as well as other such innovations, will be fruitful areas of exploration in the coming years.

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Collective Action Initiatives in the Energy Transition. Supporters of a strong sustainability paradigm?

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Abstract: The overall objective of this contribution is to investigate Collective Action Initiatives (CAIs) in the energy sector (e.g. energy communities, cooperatives and purchasing groups) as a trigger for the implementation of a strong sustainability paradigm. The assumption is that the active involvement of citizens in the energy chain is a crucial requirement when considering the diverse dimensions of sustainability and to define and implement strategies that go beyond the technology-based weak sustainability paradigm. A description is provided of the potential that CAIs have in supporting the UN Sustainable Development Goals, seen as an attempt to operationalise a strong sustainability paradigm. Then, through the analysis of a selection of case studies, we argue that CAIs development might create the conditions for supporting SDGs through the provision of relevant social and economic changes. Finally, we explore the effect these changes might have in addressing three layers of sustainability (the long-term horizon, the energy transition and the local dimension).

Keywords: energy transition, collective actions, citizen engagement, strong sustainability, SDGs.

Collective Action Initiatives (CAIs) and sustainable development

CAIs in the energy field

Collective action is seen in several forms of social life: from communities, cooperatives, collectives and groups, to teams, clans, tribes, villages and neighbourhoods. Certainly, collective action represents the bedrock for social life. Any action by a member of the social body is wrapped in bundles of collective action, which involve agents and agencies of different natures.

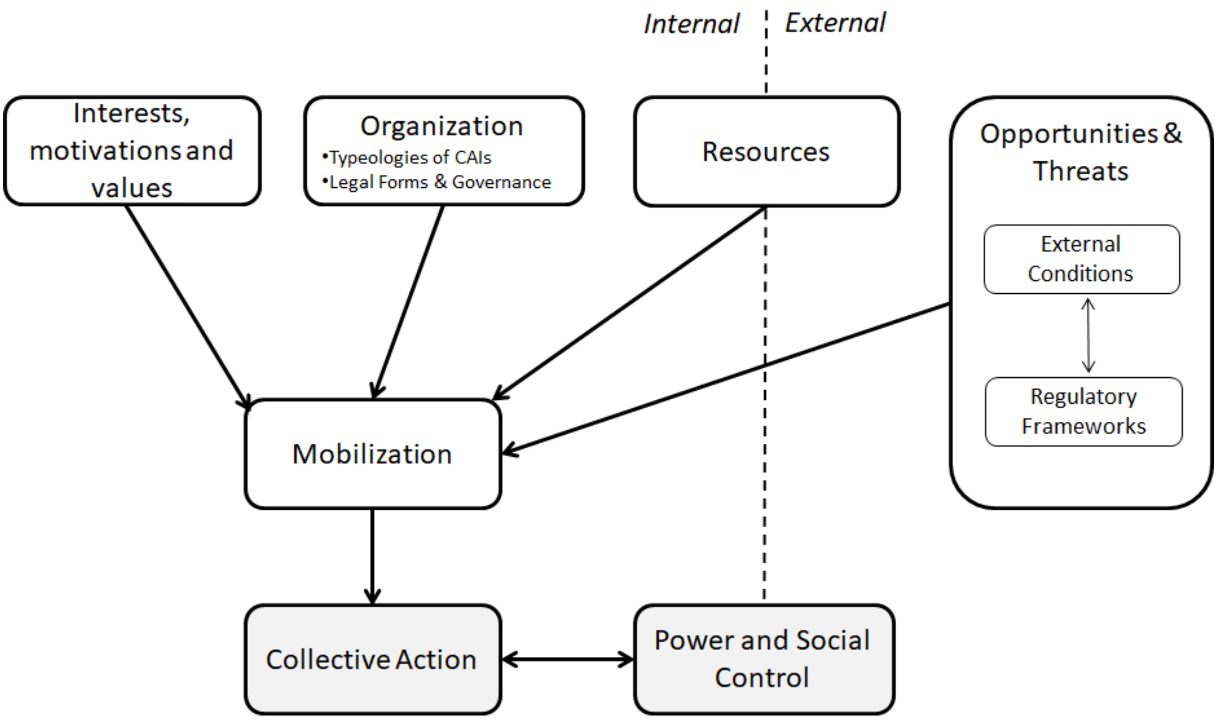
Collective action is a perennial problem for social and philosophical sciences. For instance, it is at the base of Hobbes' social contract as a rational way to escape conflicts and wars. Spinoza investigated collective action as a mode of human rationality. In a certain sense, Spinoza built a solution to any collective action problem into his definition of rational human nature. The rational individual is someone who realizes that his or her nature cannot be fulfilled except in society. This awareness inevitably leads individuals to cooperate with others on a rational basis. In a broad sense, collective action is the solution that humans embrace to cope with problems that are unsolvable as individuals (Rosenthal, 1998).

In short, by collective action, we might mean the choice by all or most individuals of the course of action that, when chosen by all or most individuals, leads to the collectively best (expected) outcome. This course of action can be also referred to as cooperative behaviour (Elster, 1985).

If, as suggested by Olson, individuals will only choose to join a group if the private benefits offered exceed the costs of their personal commitment (Olson, 1965), thus the free-rider strategy remains the likeliest for people. As Arthur Stinchcombe (1980) explains, "*each one is better off* if he *or she gets a salary without working, but all are worse off in a society of slackers*". The optimal scenario for the would-be slacker involves a society in which all citizens are cooperators; the worst scenario involves a society in which all operate egoistically (Reisman, 1990).

With CAIs being such an important piece of the fabric of social life, we must then investigate the main features of CAIs. Figure 1 shows the interaction among the four main components, or variable characteristics, of contenders in the energy field, namely: interest, organization, mobilization and opportunity. The first dimension, *Interests*, refers to the gains and losses resulting from a group's interaction with other groups. *Organization* refers to the aspect of a group's structure, which most directly affects its capacity to act on its interests. *Mobilization* connects to the process through which both the amount of resources and their collective control by the contender can increase in time. Lastly, *Opportunity* corresponds to the relationship between a CAI and the current state of the world around it. In our adapted framework, this dimension includes power, which in turn, includes the relations to other actors, governments being one of them. The opportunity dimension also includes reactions to the CAI, either facilitation or repression, that affects its cost-benefit ratio. Changes in these relationships can threaten a group's interests or alternatively provide new chances to act on those interests.

Figure 1: The mobilization model for CAIs, adapted from Tilly (1978)



Source: Gregg et al. (in press).

In relation with the energy field, rather than participating as mere and passive energy consumers, members of a collective can assume several different roles within the energy system (ILO, 2013; DECC, 2014). The concept of collective action in the energy transition is subject to different interpretations within the academic literature, which defines them as any sustainable energy initiative led by nonprofit organizations, not commercially driven or government led (Walker and Devine-Wright, 2008, Hall et al., 2016). Instead, they are often established by civil society activists and by social and/or environmental needs (Seyfang et al., 2014). For CAIs in the energy field, they have the potential to influence the ways and the extent to which energy is produced, distributed, consumed, and dissipated, thus playing a relevant role in the energy transition.

In its most basic terms, the concept of the 'energy transition' can be used to describe the shift from a situation where energy is produced through a certain energy mix - or where there is a given distribution of different energy sources - to another situation where energy is produced through a different mix. Today, in the field of environmental and energy policy, the term is used to mean the passage (expected and/or pursued) from an energy portfolio largely based on fossil fuel resources, to a mix predominantly based on renewable sources. However, as argued by sustainability transition scholars, a transition is not only to be described in its merely physical aspects, but also involves far-reaching changes along different dimensions: technological, material, organizational, institutional, political, economic and socio-cultural, namely "*sustainability transitions are long-term, multi-dimensional and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption*" (Markard et al, 2012, 956).

Therefore, the application of strong sustainability to the energy sector requires a reconceptualization of energy from a private service to a common service (Gregg, et al., *in press*). Furthermore, collective action initiatives provide a structure for fostering strong sustainability in the energy sector though inherent incentives to develop renewable resources and to promote sustainable consumption patterns. Collective action initiatives thus are a model and accelerator for the sustainable energy transition.

Weak and strong sustainability in view of SDGs

A widely recognized definition of the sustainability of a socio-economic system refers to the capability of the system to satisfy human needs at present without diminishing the opportunity of future generations to meet their own needs. This is an intergenerational rule that relies on the maintenance of capital stock and its capacity to generate a flow of goods and services that satisfy human needs. The capital stock, in the sustainability discourse, is not considered from a mere economic perspective but it is disaggregated into four different types: manufactured, human, social and natural (Costanza and Daly, 1992; Dietz and Neumayer, 2007).

The provision of human well-being results from the exploitation of these four types of capital to produce the needed flows of goods and services. But in order to guarantee their availability for future generations, the level of capital stock has to be maintained. Weak sustainability is concerned with maintaining the total capital stock, without regard to its composition. It implies that the diverse kinds of capital are more or less substitutable. Strong sustainability, in contrast, calls for the conservation of the separate capital stocks. It assumes that natural and human-made capital are not perfect substitutes, but complementary and that specific efforts to preserve natural capital are required. Moving towards strong sustainability means moving from a siloed perspective towards a holistic perspective able to jointly pursue the reproduction of economic, social, natural and human capital.

A scientific and political endorsement to this multidimensional approach to sustainability was reached in 2015 through the adoption of the UN 2030 Agenda, resulting in 17 Sustainable

Development Goals (SDGs). The aim of the goals covers all the relevant aspects to 'improve people's lives and to protect the planet for future generations'.

The approach adopted in the SDGs can be considered as an attempt to operationalise a strong sustainability paradigm as it is based on the idea that equity and equality, prosperity and development, human rights and environmental conservation cannot be addressed separately. Indeed, the SDGs have been specifically formulated on the basis of four main elements (UNEP, 2015): human well-being is intrinsically linked to the health of natural ecosystems; global environmental challenges pose a threat to the long-term prosperity of development; addressing inequalities is critical for global sustainable development; sustainable resource management, and maintenance and safeguarding of natural capital are fundamental aspects.

Given the wide-range of goals, targets and indicators, interactions among them are inevitable. Beyond the valuable proponents of the SDGs, many synergies and complementarities can exist. Moreover, trade-offs are also possible when pursuing one objective could trigger negative results in another (Miola et al. 2019).

One clear example of interaction among the goals is the potential trade-off detected between social and environmental SDGs: increasing equality across income groups could produce positive or negative impact on the environment. This, of course, varies among countries (Scherer et al. 2018). Although investigated only in pairs (e.g. water vs. food, water vs. energy) the interaction among the goals varies from indivisibility (two goals can also be pursuited jointly) to cancellation (objectives are perfectly contrasting) (Fader et al. 2018).

It is important to note that SDGs themselves and, moreover, the magnitude of these interactions, are also highly contextualized and thus the outcomes strongly depend on their localization and geographical scale (Miola, et al., 2019).

In dealing with these obscure interactional dynamics and their relevance, a systemic approach needs to be adopted both from the scientific and policy perspectives. With respect to the challenges posed by SDGs, the following section shows to what extent the collective action approach and initiatives in the energy field might play a relevant role in pursuing specific goals and in maximising synergies that addresses potential trade-offs.

The contribution of collective action initiatives to SDGs

The energy-CAIs' model has a great potential in supporting the SDGs. Not only are they directly connected with some SDGs with regards to energy provision and environmental concerns, namely renewable energy (SDG7), climate change (SDG13) and sustainable provision of material needs (SDG9 and SDG12). In addition to other collective-led initiatives, they can play a major role in achieving targets related to sustainable cities and communities (SDG11), livelihoods and employment (SDG1 and SDG8), health and well-being (SDG3), education (SDG4), inequality and discrimination (SDG5 and SDG10), as well as social/institutional innovation for effective partnership and inclusive governance (SDG16 and SDG17).

This potential may rely on the fact that the CAI's approach and ethical background may be in line with the six 'essential elements' of the SDGs: dignity, prosperity, justice, partnership, planet and people. This provides practical instances of how the SDGs could be implemented, as a test bed for a scaling-up from the local to the global level[1].

The ambition of this section is to go beyond this alignment and to propose a deeper explanation based on concrete examples of energy-CAIs. This includes mechanisms that, driven by CAIs development, are likely to support the SDGs fulfilment. In other words, to shift from what extent CAIs may impact SDGs to how this impact might be produced.

The hypothesis is that the interplay between innovation and the changes in the social and economic fabrique triggered by the development of CAIs in the energy sector is able to activate mechanisms that jointly affect a variety of SDGs dimensions, thus fostering the implementation of the strong sustainability paradigm.

The following are different domains of potential effects that might be triggered by CAIs. In the following sections, specific insights and examples are provided about the dynamics at stake.

Empowerment of citizens and local communities: the process by which individuals, groups, communities and organisations gain confidence and mastery (e.g. autonomy, self-determination, influence) over their lives (Rappaport, 1984) and in claiming their rights. In CAIs, it is also a matter of citizenship education and civic engagement promotion and can be triggered by:

- strong community engagement;
- joint ownership;
- healthy and resilient communities;
- robust local economy.

Reinforcing knowledge assets: energy-CAIs open many possibilities for reinforcing the knowledge assets of communities and collectives in a sector where participation is traditionally passive (i.e., consumption and consumer rights). CAIs might favour a knowledge building process where the gap between 'experts' and 'non-experts' is reduced and the knowledge itself will be much more distributed. Keywords of this dimension of CAIs' impact are:

- collective learning;
- community learning;
- shift in awareness on issues related to sustainability;
- spread innovation in technologies, practices and behaviors.

Improving economy: where CAIs propose new ways for locally producing and/or exchanging energy, economies are likely to be improved in quantity and quality through the creation of:.- new types of incomes and businesses;

- new and more fair jobs.

Scaling up and diffusion of collective approach: successful CAIs might attract interest from other areas involved in similar endeavours and can profitably invest efforts in cooperating with multi-regional or international groups, thus pushing an enlargement of the initiatives:

[1] http://wiki.ecolise.eu/index.php?title=Community-led_initiatives_and_the_Sustainable_Development_Goals

- from the local to national level;
- exporting the model to other countries;
- through cross-borders cooperation to increase impact and power.

Addressing social concerns: CAIs may improve the social conditions of a community as a consequence of the produced economic improvement and as an implementation of their direct commitment in reducing diverse dimensions of social gap (e.g. gender, age, income), thus addressing:

- inequalities and gender gaps;
- poverty and access to resources.

In the next sections, we argue that the CAI model has potential to contribute to achieving the SDGs. We map the above listed key effects with three layers of strong sustainability: long-term duration of the processes, the energy transition, and localization of many problems and solutions related to sustainability challenge. These layers result from the clustering of the SDGs that are most likely to be impacted by CAIs development and represent a way to grasp the potential of CAIs in affecting contemporarily many diverse dimensions of sustainability.

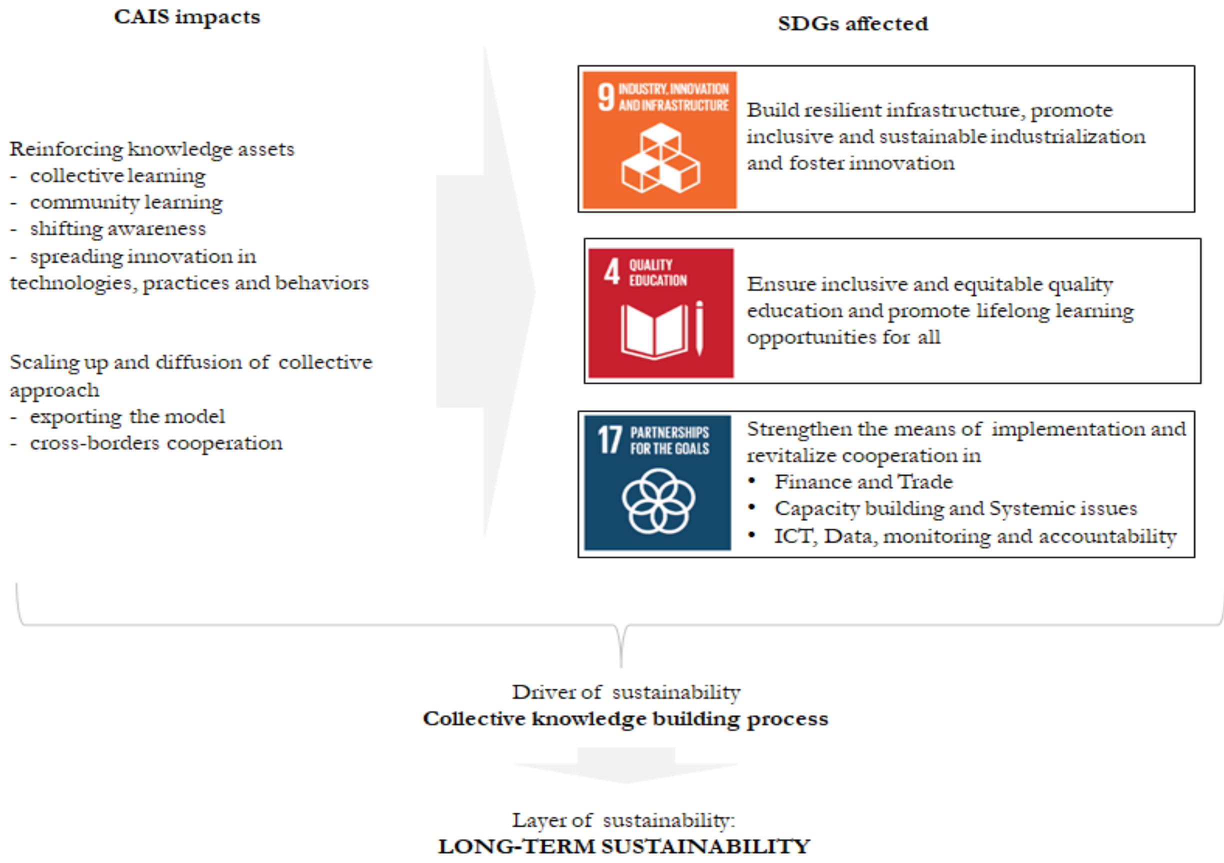
Ensuring long-term sustainability through a collective knowledge building process

As introduced earlier, the definition of sustainable development is inherently intergenerational, thus supporting long-term impacts and visions. It may happen that measures which may even have a formidable potential effect, are not durable in the medium/long run or that their potential is limited or abandoned due to the lack of the competencies and visions they reclaimed or to the insufficient endowment or ability in taking advantage of infrastructures for their implementation or, lastly, to the lack of proper networks able to catalyse resources, knowledge and legitimacy. The challenge of long-term sustainability is therefore a matter of building a strong and shared knowledge framework among the agents of the processes mainly fed by adequate education on sustainability issues (SDG4), as well as by spreading proper tools and competences to fully take advantage of innovation tools (SDG9) and by building effective partnerships and relations for exchanging information and experiences (SDG17).

CAIs have the potential to help fulfil the long-term challenges by creating a favourable environment to support the development of collective and collaborative learning processes within and among the initiatives. This is achieved by promoting awareness about sustainability issues to the citizens (SDG4 and SDG9). In order to scale up, CAIs have shown to create cooperation at varying levels of the system (i.e. rising from local to the national level) and beyond national boundaries (SDG17).

Networks of CAIs are rooted in multiple, intersecting and ongoing learning processes, drawing on collective knowledge and wisdom gained over the years by movements and communities around the world. CAIs have been known to generate and share new skills, forms of social organisation, cultural perspectives and actions necessary to the imperative needs of the SDGs. (Ecolise)

Figure 2: The Long-Term layer of Sustainability: related SDGs and CAIs impacts



CAIs have the ability to improve and generate new skills, forms of social organisation, and actions necessary to understand and respond to emerging and fast-changing global situations by envisioning, planning, implementing and monitoring regenerative development pathways in local communities. (Ecolise)

Some of this intellectual and cultural capital has been incorporated into specific trainings, such as energy efficiency and demand response seminars and training. For example, Ecovillage Design Education and Transition Training have been proven successful activities used by CAIs in Europe. In most cases, this takes the form of education about sustainable practices. Specific educational methodologies, techniques and tools, include:

Ecovillage Design Education (EDE). The EDE was born out of the experiences of long existing communities and cutting edge educators in order to teach how to create a new way of living which brings together the four key dimensions of sustainability: social, cultural/worldview, ecological and economic.

Dragon Dreaming design framework for project and team management design framework and Sociocracy system for inclusive decision-making and governance. Dragon Dreaming is a systematic design process, a philosophy and a methodological framework for the realisation of collaborative and sustainable projects, organisations and platforms, built upon three principles: (Dragon)

- personal growth – commitment to your own healing and empowerment;
- community building – strengthening the communities of which you are a part;
- service to the Earth – enhancing the wellbeing and flourishing of all life.

Other examples of collective action in network building for improving knowledge about sustainability issues:

Transition Towns. The Transition Towns is a movement that has been growing since 2005. It is about communities stepping up to address the big challenges they face by starting local. By coming together, they are able to crowd-source solutions. They seek to nurture a caring culture, one focused on supporting each other, both as groups or as wider communities. (Transition Network)

Ecovillages. An ecovillage is an intentional, traditional or urban community that is consciously designed through locally owned, participatory processes in all 4 dimensions of sustainability (social, culture, ecology, economy into a whole systems design) to regenerate its social and natural environment. Ecovillages are living laboratories pioneering alternatives and innovative solutions. They are rural or urban settlements with vibrant social structures, vastly diverse, yet united in their actions towards low-impact, high-quality lifestyles (Ecovillage GEN network).

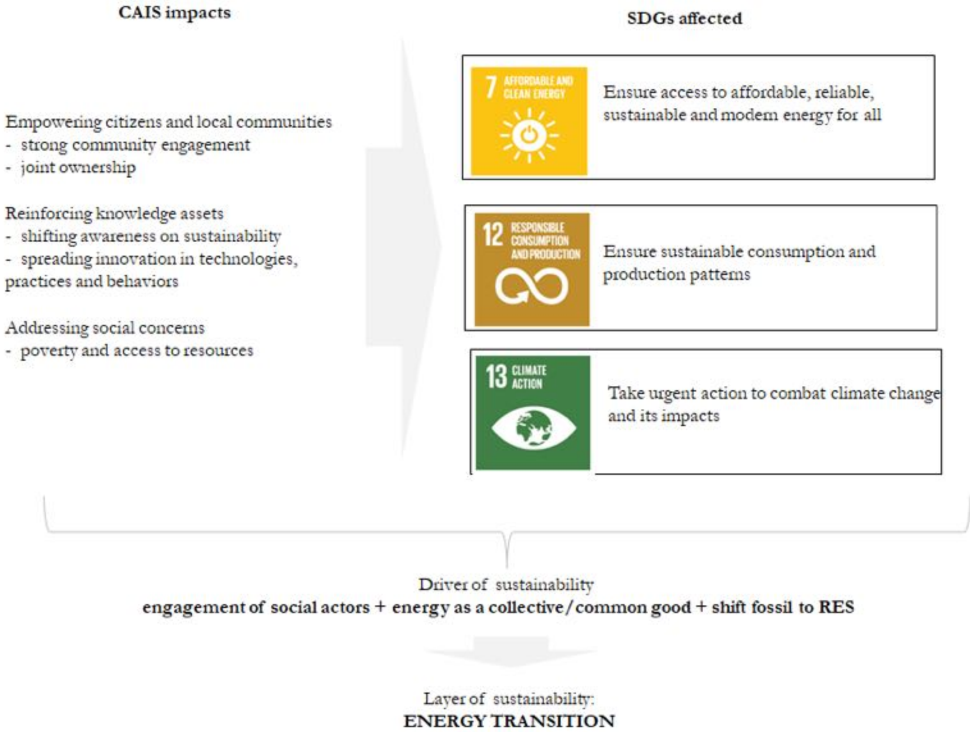
ECOLISE (European network for community-led initiatives on climate change sustainability). All ECOLISE members work on community-led transitions, with the energy transition as a key ingredient. The work of ECOLISE concerns three levels: support of community-led initiatives through knowledge sharing and training opportunities, the facilitation of collaboration among members and partners, and advocacy at the European level for the creation of policy frameworks supportive of community-led initiatives.

Supporting the sustainable Energy Transition

When discussing the 'transition' of the energy system, it should be considered not only the transition from a centralized/fossil-based system to a more decentralized/renewable-based system, but also the more complex transformation of a private good (as energy currently is) to a different type of collective/common good, owned and/or managed and/or exploited by wider groups of cooperating people to increase common welfare. In order to address this challenge, energy should be provided for all (SDG7) together with shifting the energy chain towards a more sustainable model (SDG12). Additionally, attention to the impact of energy on climate change has to be considered as a permanente reference (SDG13).

In this framework, the relevance of CAIs derives from the strong involvement of citizens that pave the way for more sustainable behaviors and practices. This is seen through the participation to the ownership of the energy plant (thus addressing SDG12), from the shift in the knowledge and attitude towards more sustainable technologies and practices (addressing SDG 12 and 13) and from the attention paid in the inclusion and reduction of social gap (thus addressing SDG7).

Figure 3: The Energy layer of Sustainability: related SDGs and CAIs impacts



Source: Own figure

Interesting examples that highlight the activation of these mechanisms on the energy transition include the following:

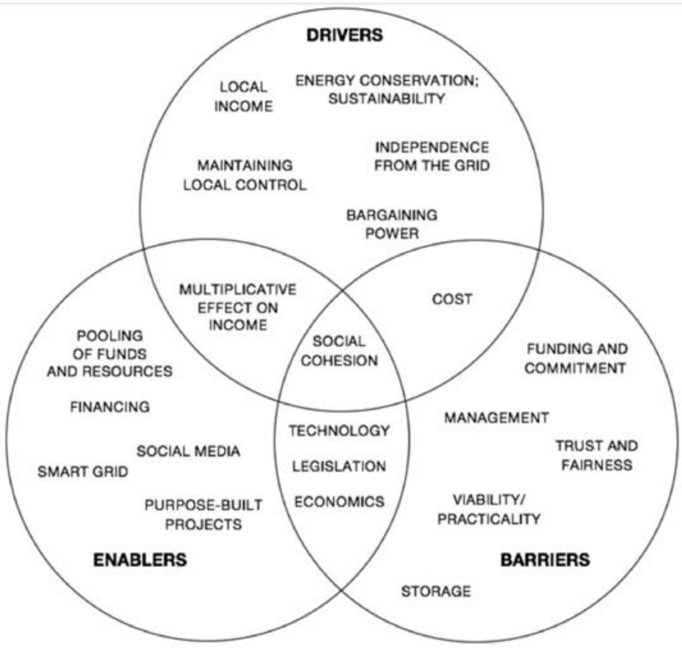
Cloughjordan Energy Collective (The Young Foundation) (Ireland). Founded in 1999 by a group of Irish individuals concerned about the climate, the aim was to create an ecovillage community where living more sustainably. The strong engagement of local communities played as a pre-requirement and was noticeable reinforced. They formed a collective, sold memberships to raise money and developed a three-pronged renewable energy strategy: low energy housing, minimizing person vehicles, and district heating. The collective then reached out to university faculty and politicians and invited them to serve on the board to provide a greater oversight of the sustainability aspects of the community and to expand the impact and awareness. The collective was supported by the Sustainable Projects Ireland Ltd. (SPIL), which linked it to the Global Ecovillage Network (GEN) and the Transition Towns project. The village struggled with the great recession but still exists.

Solar Community Bologna (Italy), a collective mechanism to promote local renewable energy generation. It was founded between 2010 and 2014 through about 150 residents in 6 neighboring towns and promoted by the municipalities, key industries, and the University of Bologna. The initiative finances new solar PV projects in the region. Relying on pre-existing solar communities, the Solar Community reinforced the engagement of citizens and, through communication campaigns, it promoted a shift in changing energy behavior and awareness targeted to adult education.

GoiEner (Spain) was founded in 2012 as a non-profit citizen cooperative. Largely based on volunteers taking part in the decision making towards implementing renewable energy systems, it scaled up to over 5000 partners that have the opportunity to purchase (contractually) renewable electricity from GoiEner. Although the change in energy tariffs experienced in Spain reduced investor incentives in renewable energy, the cooperative is still confident that the model can be duplicated throughout Spain. Based on an initial group of volunteers, GoiEner fostered the engagement of citizens in the energy field. Learning from other examples and members gaining expertise in the energy system improved cohesion and empowerment within the community through shared experiences and through the adoption of a governance based on neighbor/peer participation. The joining of a large number of enterprises gave the collective the power to trade energy in the Spanish market.

A class of CAIs experiences that is gaining momentum in the energy field is referred to the 'prosumer' groups supported by many energy policies. Funds, skills and resources can be pooled, and the increasing normalisation of collective prosumers means it is no longer seen as risky (Ford, et al., 2016). The collaborative nature of CAIs as prosumer collectives is gaining traction, but the lack of collective commitment is oftentimes a major barrier. The shift from the individual to the collective level requires social cohesion. The drivers, barriers and enablers for CAIs prosumers are summarized in Figure 4 (Ford et al., 2016).

Figure 4: Overview of drivers, barriers, and enablers of collective prosumerism



Source: Ford et al., 2016

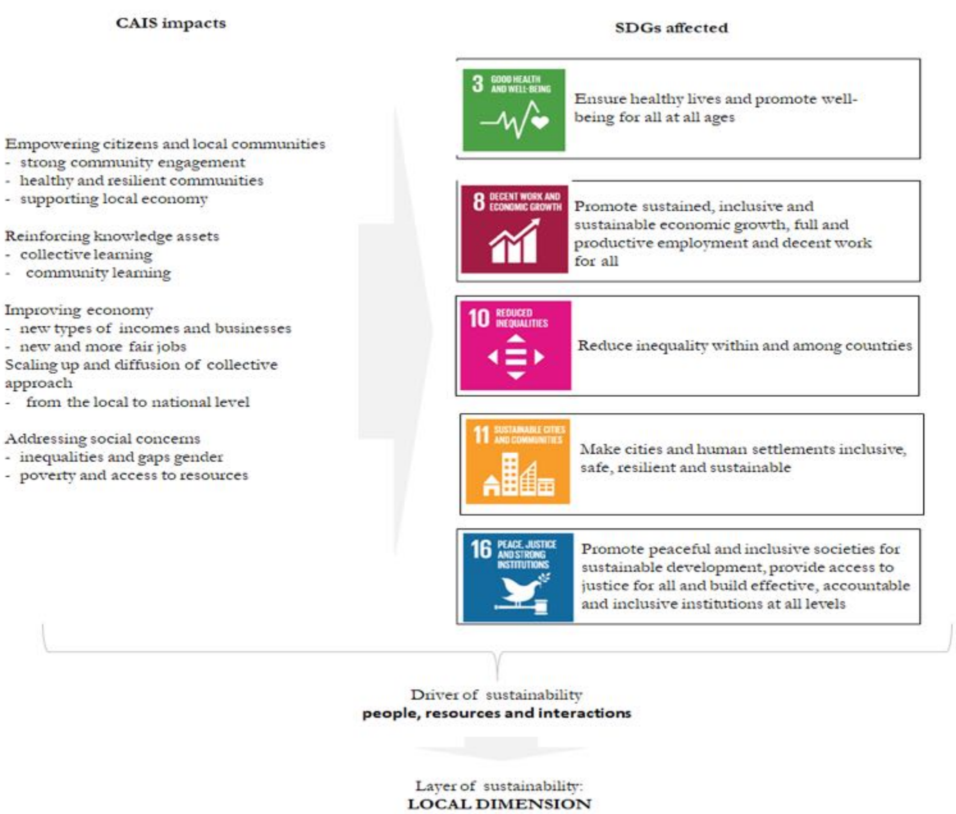
The local dimension of sustainability

If one agrees that the current unsustainability comes from the central role played so far by deterritorialized forces, in the transition to sustainability the local level should play a role which should be complementary and instrumental to the national, international and global levels. No 'local' is immune to the negative effects of the environmental crisis, nor is exempt from the efforts aimed at reducing its causes. The local dimension might play a crucial role in defining and implementing strategies for a strong sustainability. At the local level, in fact, is it possible to detect the coexistence of many conditions that are crucial for solving problems collectively.

CAIs may help in taking the local dimension into account by making the territories where they act more resilient and self-sufficient (SDG11), thus also reducing the territorial inequalities within a country (SDG10). Such outcomes could more easily come from the enactment of participatory processes (SGDG16) aimed at increasing knowledge and skills (SDG8), and by addressing the needs of disempowered individuals or groups (SDG3).

Climate change is an important driver for collective action in the energy sector, but surveys reveal that community energy security and affordability (saving energy and saving local expenses) may act as stronger motivators for community energy projects. (ISABEL 2016) Collective action to foster sustainability projects empower local communities not only to generate and export their own energy but also to reinvest part of the profits into the community. (ISABEL 2016).

Figure 6: The Local dimension layer of Sustainability: related SDGs and CAIs impacts



The following examples showcase CAIs innovation and commitment to people and community, demonstrating the power of solving problems collectively.

The municipality of Güssing (Austria). This small town is a model example of collective action in terms of "energy autonomy" and "energy-village". A consistent commitment to renewable energy provided a boost to the local economy. In the early 1990s, Güssing was characterised by high unemployment, as well as economic and demographic decline. The community decided to establish an energy system based on renewable sources, mainly from local biofuel. However, the town's renewable energy project was initiated by local citizens, who noticed that the wood that was decomposing in the nearby forest could be used as an energy source. (Kunze & Busch 2011) By 2010, Güssing become a net energy producer - generating more energy from renewables than it uses - and a net exporter of its energy. This resulted in the sum of 35 million Euros that would have otherwise been spent annually to import carbon-based energy, helping to create new jobs as it was locally re-invested. (Kunze & Busch 2011)

Kauai Island Utility Cooperative (KIUC) (United States), is a not-for-profit electric cooperative that generates, transmits, and distributes electric power on the island of Kauai. The co-op serves 29,000 members/owners, and employs 150 people and is owned by its members and governed by an elected board of directors. In an effort to reduce its power cost and its use of imported fossil fuels (around 90% in 2010) and to increase the amount of energy generated from Kauai's own renewable resources. KIUC has launched a strategic initiative to generate 70% of its electricity from renewable sources by 2030. In 2019, 55% of KIUC's electricity is generated through renewable sources (biomass, hydropower and solar.) (KIUC)

Community Power Network (CPN) (United States), is a national initiative that grew out of Washington, DC based Solar United Neighborhoods (DC SUN), built on early experiences working with neighbors across DC to refine its community-led solar cooperative model. CPN adheres to the cooperative model and works with local community partners to disseminate information about the cooperative model, create excitement about solar, and recruit residents to attend information sessions. (Fairchild & Weinrub 2017)

Energy Solidarity Cooperative (ESC) (United States), is a start-up in Oakland, California, that designs and builds community-driven, cooperatively owned solar energy projects and political educational programs. ESC focuses on building relationships with such groups as community-based organizations, schools, and places of worship in communities of color and with low income residents. The ESC model is comprised of worker members, consumer members and sustainers. Worker members are energy practitioners who offer technical services to support the development of community power projects. Consumer members are individuals and organizations who collaboratively own and operate renewable energy systems. Sustainers are community investors who directly enable the development of clean community power, while their investment is repaid with interest as the project earns revenue. (Fairchild & Weinrub 2017).

Summary and outlook

Collective Action Initiatives (CAIs) have been gaining relevance for the past several decades as an innovative actor of the energy system e.g., in the forms of energy communities, energy cooperatives, prosumer and purchasing groups. In this chapter we demonstrate the potential of CAIs in the energy field as a trigger for implementing a strong sustainability paradigm at the local and global levels. This potential has been investigated through the impact that CAIs might have on the fulfilment of a subset of the UN Sustainable Development Goals (SDGs) - considered as an attempt of operationalizing the strong sustainability paradigm - by covering the many diverse dimensions of sustainability and by claiming the need for their joint fulfilment.

On the basis of a wide literature review on CAIs components and development (requirements and impacts), and through the analysis of a limited number of case studies we found that, in addition to the direct impact on specific indicators, CAIs development might create the conditions for supporting SDGs through the provision of relevant social and economic changes:

- Empowering citizens and local communities;
- Reinforcing knowledge assets;
- Improving economy;

- Scaling up and diffusion of collective approach;
- Addressing social concerns.

We explored the effects that these changes might have in addressing three layers of sustainability (long-term horizon, energy transition and local dimensions) to which specific subsets of SDGs have been assigned. For each layer, the mechanisms activated by CAIs implementation were present and may play a role in achieving sustainability, although a measure of the relevance of this role was far beyond the objective of this work.
Now, as the planet's ecological limits are becoming ever more apparent, we collectively are becoming more cognizant of the world's global common resources and the services they provide. We also reconsider what it means to provide well-being to citizens and communities and what means are available to promote social cohesion. Because the health of the modern economy is so intrinsically linked to the energy sector, energy-CAIs could be a catalyst to the transformation to a strong sustainable paradigm, where sustainability is intrinsically incorporated into our society.
Given the potential of CAIs to support the UN SDGs, it is fruitful to explore in depth the lessons that can be learned from this type of social innovation. This would enhance our ability to achieve the SDGs. Beyond the SDGs, we find that CAIs can fulfil a vital role in achieving strong sustainability.

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How to assess sustainability: examples and challenges from the EU cohesion policies

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Abstract: Evaluation of public policies is an old field of research and practices at least since the end of the second world war. It is common sense that EU policies at various level of governance need to be evaluated and periodically re-examined considering their efficiency, effectiveness and impacts. Article 54 of the Common Provisions Regulation (Reg. 1303/2013) illustrated such a requirement for the ESIF on the current programming period 2014-20. But what about sustainability? In the European background sustainability is a "principal", as stated in the Treaty on the Functioning of the European Union (TFEU). In the 2014 evaluation guidelines of the European Regional Development Funds (ERDF) the evaluation of sustainability is only mentioned in general terms. The paper addresses the issue of evaluation considering sustainable development policies as a specific field of public policy. A specific focus is given on EU cohesion policies (Article 174 of the EU Treaty) and how evaluations concretely addressed the sustainability dimension. Main approaches and tools of ex-ante evaluation, usually used in this context (i.e. survey, desk and indicators analysis, focus-group, interviews and consistency analysis), including the Strategic Environmental Assessment, are illustrated and discussed, considering their capacity to address the issue of sustainability.

Keywords: indicators, sustainable development, European cohesion policy, Strategic Environmental Assessment, SDGs

Introduction

European Union policies at various levels of governance must be monitored, evaluated and periodically re-examined for their efficiency, effectiveness and impacts at local and global levels according to the Better Regulation Guidelines[1]. Public policy evaluation has been around since at least the end of the second world war and methodologies for evaluation have been discussed in EU institutions for decades but debate on the 'sustainable' dimension of development is more recent.

In 2013, the EU regional development unit published an update of the *Evalsed* guide illustrating approaches for evaluating EU cohesion policy fields from innovation to competitiveness and from employment to social inclusion. This guidance is a key reference for evaluators of operational programmes supported by European and Strategic Investments Funds (ESIF) [2] under the cohesion policy objective (art. 174 of the Treaty), but this only touches on sustainability[3]. For the practitioner there is clear methodological support for evaluating the efficiency, effectiveness and impacts of socio-economic territorial policies, but not for addressing sustainable development in a complex and integrated policy context.

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[1] According to the Better Regulation Guidelines, all evaluations [...] should assess the performance of an existing intervention against [...] effectiveness, efficiency, [...] and EU added value. Better Regulation Guidelines are presented in European Commission Staff Working Document (SWD) 2017, n.350. The Toolbox of the Better Regulation Guidelines is available here https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how_en

[2] According to EU Regulation 1303/2013 (Common Provisions Regulation), ESIF include (1) Cohesion Policy funds which are the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund, (2) other funds as the Fund for rural development, namely the European Agricultural Fund for Rural Development (EAFRD), and for the maritime and fisheries sector, namely measures financed under shared management in the European Maritime and Fisheries Fund (EMFF).

[3] Sustainability is referred to the sustainable cash flow of an investment over its lifespan.

This situation is partly due to different definitions used for 'sustainable development', 'sustainable' and 'sustainability' in the EU policy framework. In the Treaty on the Functioning of the European Union (TFEU), sustainable development is considered as a 'principal', guiding EU policies in various internal and external fields of intervention. In the Draft Declaration on Guiding Principles for Sustainable Development, the European Commission mentioned promotion and protection of fundamental rights, intra-and intergenerational equity, open and democratic society, involvement of citizens, involvement of businesses and social partners, policy coherence and governance, policy integration, use of best available knowledge, precautionary principle and make polluters pay. Together with smart and inclusive growth, sustainable growth is one of the three overarching objectives of the EU Strategy 2020, covering mainly energy and climate issues. Moreover, in a recent review of EU policies, the European Commission highlighted that almost all policies implemented under the Multi-annual Financial Framework 2014-20, including cohesion funds, are consistent with the United Nation Agenda 2030 objectives. These cover 17 Sustainable Development Goals (SDGs) and 169 associated targets. Similarly, the ESIF regulations mentioned sustainable development several times, giving different meanings to the term. In Common Provisions Regulation (1303/2013), covering the five European and Strategic Investment Funds 2014-2020, sustainable development is explicitly mentioned in article 8. This refers to the principle of sustainable development[4]. In addition, article 10 referring to SD notes the common strategic framework which provides 'strategic guiding principles to facilitate the programming process and the sectoral and territorial coordination […]'.[5] In the European Regional Development Fund (ERDF) regulation (1301/2013) more focus is given to sustainable tourism (with a dedicated indicator) and sustainable systems for urban mobility. Articles 3 and 5 relate to the scopes and priorities of the Fund and through urban sustainable development (mentioned in articles 7, 8 and 9), to providing support for actions and strategic plans in the field. Finally, in the European Agricultural Fund for Rural Development (EAFRD) regulation (1305/2013), 'sustainable' is mentioned several times, referring to the management, supply and use of natural resources such as water, land, forests, biomass and genetic resources.

This paper illustrates briefly how sustainable development is assessed in the ex-ante evaluation of ERDF regional programmes, giving practical examples. In the second part we show three examples of how Strategic Environmental Assessments (SEA) of cohesion policy programmes 2014-20 address sustainable development issues, taking into account key principles related to sustainable development as stressed in the EU policy framework.

Evaluation of sustainable development in Cohesion policy programmes, an overview

Article 54 of the Common Provisions Regulation (1303/2013) covers the evaluation of programmes, including horizontal aspects such as partnerships, equality between men and women and sustainable development. Evaluation should be carried out in the main programme

[4] Article 8: '*The objectives of the ESI Funds shall be pursued in line with the principle of sustainable development and with the Union's promotion of the aim of preserving, protecting and improving the quality of the environment, as set out in Article 11 and Article 191(1) TFEU, taking into account the polluter pays principle […]*'

[5] Section 5.2: '*Member States and managing authorities shall, in all phases of implementation, ensure the full mainstreaming of sustainable development into the ESI Funds, respecting the principle of sustainable development as laid down in Article 3(3) TEU, as well as complying with the obligation to integrate environmental protection requirements pursuant to Article 11 TFEU and the polluter pays principle as set out in Article 191(2) TFE.*'

implementation phases; ex-ante (programming), on-going (during implementation) and ex-post (once the programme is closed and projects are finalised).

For sustainable development, evaluation objectives, scope and instruments differ during the programming cycle and with the evaluation tools used. For example, impacts are evaluated mainly ex-post in reference to EU Strategy 2020 objectives, including the sustainable growth package which refers to climate change and energy issues. Article 55(m) relating to ex-ante evaluations requests evaluating 'the adequacy of planned measures to promote sustainable development' in more general terms. Moreover, an SEA is required to support the programme setting. SEAs address sustainable development under a multi-dimensional approach and consider some of the guiding principles including citizen participation in the decision-making process. Specific orientations on how to apply SEA to cohesion policy programmes was published in 2013 together with separate ex-ante evaluation guides for ERDF/CF and RDP programmes. Other guidance was published later for ERDF and EAFRD programmes, with more information on indicators required for monitoring and evaluation[6].

In the ex-ante guidance on evaluating programmes for ERDF, CF and ESF, evaluation tasks related to sustainable development are mentioned only in section 1.1.4, 'the evaluator should verify that the programme considers its integration in the preparation, implementation and monitoring, including the selection of operations (i.e. projects, contracts, actions or groups of projects,…)[…]'.

In the programme preparation phase, ex-ante evaluators examine sustainable development from different angles: (i) programme consistency, (ii) external coherence, (iii) consistency of financial allocation and internal coherence, and (iv) links between actions, outputs and results.

For *programme consistency*, ex-ante evaluation examines the relation of the programme development challenges with Europe 2020 objectives, Council recommendations and National Reform Programmes and focuses on how they have been included and translated in the programme intervention logic.

The evaluation of *external coherence* examines the programme complementarity with other instruments at regional, national and EU level. For instance, it shows the expected added value to other policy tools (e.g. Smart Specialisation Strategies, sustainable tourism strategy) in promoting sustainable development. Moreover, in case of cooperation programmes, the ex-ante evaluation examines the specific role of the programme vis-à-vis other strategies as the EU Blue Growth, Sea-basin strategies and macro-regional strategies whenever relevant. This analysis usually builds on document review as well as on stakeholders' consultation. Stakeholders' consultation could be necessary and organised through interviews, surveys and Delphi Analysis to collect inputs on the expected contribution of the programme, provided that some policy tools could be still under discussion.

The ex-ante evaluation also assesses the *internal coherence and consistence of the financial allocation*, by, for instance, showing the thematic concentration of resources compared with the regulatory requirements as well as with the relative intensity of needs. In other terms, a relative ranking (prioritisation) of needs helps assess the appropriateness of the resource distribution and propose possible revisions.

[6] Guidance are published on the rural network website and the DG Regio website; DG Regio stands for the Commission's Directorate-General for Regional and Urban Policy

Moreover, the ex-ante evaluation *reconstructs the intervention logic* illustrating the links between objectives, actions, outputs and results, with a thorough examination of the expected type of activities and operations for each specific objective and the related indicators system. This illustrates to what extent the programme integrates sustainable development. At least, several approaches for the inclusion of sustainable development in the programme can be identified and can be alternative and / or combined.

1. *Specific type of action*. Programmes include specific types of action which are expected to promote sustainable development by supporting resource efficiency, climate mitigation and adaptation, disaster resilience and risk prevention and management.
2. *Budget allocation*. A relative portion of the budget is allotted to sustainable development beyond the minimum regulatory requirements.
3. *Ad hoc selection criteria*. Selection procedures use criteria assessing project contribution to sustainable development.
4. *Indicators*. The programme monitoring system includes output and result indicators measuring the realisation and the benefits for local communities in terms of promotion of sustainable development.

Finally, it is clear that the ex-ante evaluation examines the programme design and assesses its potential contribution to sustainable development. Ongoing and ex-post evaluation are necessary to:

- Verify the actual capacity of the programme to address the relevant needs;
- Conduct a more accurate analysis of the project's selection criteria showing to what extent the score for sustainable development makes the difference for project approval;
- Show the figures from the monitoring system in terms of outputs and results;
- Assess the programme impact and added value (through case studies, counterfactual approach, surveys) to understand to what extent sustainable development has been taken on board by projects and have changed the living conditions of local communities.

SEA as a relevant approach to address sustainable issues in cohesion policy

ERDF and RDP programme SEAs must comply with Directive 42/2001/EC (the 'SEA Directive'). As stated in article 1 'The objective of this Directive is to provide for a high level of protection of the environment and to contribute to the integration of environmental considerations in the preparation and adoption of plans and programmes with a view to promoting sustainable development [...]'. SEA is focused on sustainable development by definition, delivering sustainable development at a strategic level (Lobos & Partidaro, 2014). SEA helps to take on board sustainable principles covering intra-and intergenerational equity, open and democratic society, involvement of citizens, involvement of businesses and social partners, policy coherence and governance, policy integration, the use of best available knowledge and the precautionary principle. Even if SEA was initially interpreted as largely environmental impact assessment based and responsive, recent studies recognise it has evolved 'to a far more proactive process of developing sustainable solutions as an integral part of strategic planning activities' (Tetlow and Hanusch, 2012). One of the main strengths of SEA is that it acts proactively in planning environmentally sustainable strategies (Cape et al., 2018). Anticipation at an early stage of programming to identifying and evaluating strategic objectives, enables the selection of alternatives. Although SEA only stresses environmental sustainability, the public process throughout the programme is important in at least partially introducing other pillars of sustainability, also by integrating new values and attitudes into the planning process (Cape et al., 2018).

From a procedural point of view, the strategic assessment on environmental effects starts at a very early stage of the programming process, when the authorities with specific environmental responsibilities – i.e. environmental agencies, public and private environmental organisations - are consulted 'on the scope and level of detail of the information which must be included in the environmental report' (Dir. 42/2001/EU, art. 5, c. 4). The environmental report is the main outcome of the assessment. This document contains analysis and assessment of potential environmental effects of the plan and programme, evaluation of the alternatives, identification of mitigation actions and the design of a monitoring system for following up on the programme over its life. Based on the environmental report there follows consultation with environmental authorities and general public. At the conclusion of the SEA procedure, and after approval of the programme the responsible authority publishes '*a statement summarising how environmental considerations have been integrated into the plan or programme and how the environmental report […], the opinions expressed […] and the results of consultations […] have been taken into account […] and the reasons for choosing the plan or programme as adopted, in the light of the other reasonable alternatives dealt with'* (art. 9 of Dir. 42/2001/EU). It also publishes the measures concerning monitoring. The SEA supports setting up the programme with constant feedback. The final programme considers conclusions from the SEA.

SEA under cohesion policy, three case studies

This section illustrates how the SEAs of three Cohesion policy programmes address the sustainable dimension in various territorial contexts, namely: ERDF Italy – Croatia Operational Programme, at cross border level; RDP Rural Development Programme of Romania, at national level and ERDF Marche Region Operational Programme, at regional level.

The Italy – Croatia Operational Programme (IT-HR OP)

IT-HR OP is a cross border cooperation programme between Italy and Croatia, co-financed by ERDF. The programme focuses on exchanging knowledge and experiences, developing and implementing pilot actions, testing the feasibility of new policies, products and services and supporting investments. The programme strategy addresses the following thematic objectives (TOs):

- TO 1 - Strengthening research, technological development and innovation,
- TO 5 - Promoting climate change adaptation, risk prevention and management,
- TO 6 – Preserving and protecting the environment and promoting resource efficiency,
- TO 7 – Promoting sustainable transport and removing bottlenecks in key network infrastructure.

Important elements of sustainable development are directly mentioned in the programme strategy. These include actions to improve the quality, safety and environmental sustainability of marine and coastal transport services (Strategic Objective 4.1) and to improve environmental quality in the Adriatic Basin by using sustainable and innovative technologies and approaches (Strategic Objective 3.2).

A specific section in the environmental report was devoted to horizontal and vertical integration of the environment with sustainable development. Cross border (national and supra-national) sustainability strategies were analysed to identify environmental objectives shared by the cooperation partners (i.e. Member States, regional authorities and the European Commission). These objectives were the basis for further analysing potential programme effects (positive and negative) on the environment. This analysis follows a qualitative structural approach ranking the environmental effects based on different weights for individual environmental effects identified as relevant (Galassi & Levarlet 2017). A territorial analysis on the main environmental and economic issues, including on energy, waste, and cultural heritage followed. Specificities of the territories were considered in the analysis, at the relevant scale including cross-border. The simulation model CO2MPARE (Hekkenberg et al., 2013) was used to compare sustainability in terms of climate change emissions under the programme alternatives.

The assessment results showed that cooperation could improve sustainability in the cross-border area, taking advantage of existing opportunities. Mitigation and orientation measures were proposed mainly relating to:

- Mitigation of negative effects, including implementing additional activities or actions to avoid, remove, or offset adverse effects; e.g. actions limiting tourism in areas with a protected habitat status.
- Orientation of Specific Objectives or actions by proposing alternative instruments or tools to be promoted by the programme; e.g. actions to increase resilience of the area, through habitat conservation;
- Green selection criteria, to improve the sustainability of projects co-financed by the programme; e.g. by assigning a higher weight to projects promoting eco-efficiency and a low-carbon footprint;
- Provisions for implementation, including guidelines for applicants in preparing and managing projects or defining specific environmental monitoring measures. These provisions refer mainly to the designation of roles and responsibilities for the monitoring system.

Analysis and consultations with public and environmental authorities under the SEA have stimulated further efforts to improve sustainability of the programme.

The main added value of the SEA is in identifying measures to not only avoid negative effects but also, explicitly, to improve the sustainability of the programme during implementation. SEA conclusions relate to the different phases of the programme life cycle and were included in different parts of the programme documents (i.e. guidance). These conclusions included introducing changes in the programme initial drafting, suggesting specific implementation mechanisms (as criteria for selecting operations), as well as designing monitoring and indicator systems capturing the potential negative effects over the programme lifespan.

The RDP Rural Development Programme of Romania

The Rural Development Programme of Romania (RDP) supports rural development in Romania from 2014 to 2020. The RDP addresses the following objectives:

1. Increase farm sustainability, modernisation and restructuring, especially small and medium-sized farms, generational renewal, developing processing and strengthening the market position of farmers;
2. Sustainable management of natural resources and climate change;
3. Diversifying economic activities, creating jobs, as well as improving infrastructure and services to improve the quality of life in rural areas.

Sustainability is at the heart of the programming strategy and environmental sustainability is the most relevant dimension mentioned several times in the document. All the programme priorities directly or indirectly address one or more dimensions of sustainability, in particular:

- Priority 2: Enhancing farm viability and competitiveness of all types of agriculture in all regions, as well as promoting innovative farm technologies and sustainable forest management. This refers to the economic and environmental dimensions, and indirectly to the social dimension.
- Priority 3: Promoting food chain organisation, including processing and marketing of agricultural products, animal welfare and risk management in agriculture. This refers to the economic dimension.
- Priority 4: Restoring, preserving and enhancing ecosystems related to agriculture and forestry, which refers to the environmental dimension.
- Priority 5: Promoting resource efficiency and supporting the shift towards a low carbon and climate resilient economy in agriculture, food and forestry, which refers to both economic and environmental dimensions.
- Priority 6: Promoting social inclusion, poverty reduction and economic development in rural areas, which refers to the social dimension.

In the SEA procedure, external coherence with the normative framework was analysed in respect to European and National Sustainable Development Strategies and to sectoral strategies related to sustainable growth. Examples include the National strategic framework for sustainable development of agri-food sector and rural areas in the period 2014-2020-2030, or Europe 2020, the European strategy for smart, sustainable and inclusive growth.

Analysis of environmental effects covered the environmental sustainability of supported actions. Assessment results point out that most RDP measures contribute to environmentally sustainable development. Indications to reduce negative environmental effects and to enhance positive ones are given for the implementation phases. These consist mainly of recommendations for consistent implementation of EIA provisions at individual project level, especially when related to infrastructure, as well as provisions on the use of pesticides to prevent negative impacts on ecosystems. Other recommendations are to support projects which show the best financial, economic and environmental return on investment.

The ERDF Marche Region Operational Programme 2014-2020 (OP-M)

The OP-M covers six TOs contributing to the EU 2020 Strategy objectives of smart and sustainable growth:

- for the economic dimension:
  - TO1 to enforce technological development and innovation;
  - TO2 to improve the access, utilisation and quality of ITC;
  - TO3 to enhance competitiveness of small and medium enterprises
- For the environmental dimension:
  - TO4 to sustain a transition to a low carbon emission economy in all sectors;
  - TO5 to promote adaptation to climate change, risks prevention and management
  - TO6 to preserve and protect the environment and to promote efficiency in the use of resources

The external coherence analysis was carried out mainly referring to the Regional Strategy of Sustainable Development, as well as sectoral plans and strategies. So, the Regional Environmental Landscape Plan and the Regional Energetic Environmental Plan were included in the analysis (13 sectoral regional plans were analysed). A description of the current environmental state and its evolution included a detailed analysis of territorial characteristics. These include biodiversity, water, soil and natural risks, climate and energy, waste, population and human health, cultural heritage and landscape. As with the other SEAs, both quantitative and qualitative methods were used to assess potential environmental effects. Selecting the best possible alternative involved the CO2MPARE method which included all the socio-economic and environmental components of the programme.

The findings from the SEA covered socio-economic and environmental recommendations. These included using criteria for selecting interventions to finance, promoting innovative projects and good practices - conditions for implementing interventions, as measures to put in place to reduce potential negative impacts. There were also additional measures not directly addressed to realising the project, such as educating and training beneficiaries. A specific focus is given to tourism and the analysis identified this as being both an opportunity and a threat for the territories involved. Consequently, the recommendations focused specifically on the:

- request to promote only eco-tourism, through hiking and cycle-tourism;
- need to support training activities of operators and beneficiaries in order to increase their awareness of sustainable development issues;
- use of selection criteria that promote less impacting projects, in terms of soil consumption and use of natural resources.

Similarly, for industry the SEA recommended including measures related to eco-innovation, as well as the use of biomass such as residuals from wood industry or agriculture as energy source.

Section of the report in which SD is mentioned	Evaluation tools used	Dimensional issues addressed	Territorial analysis	Type of conclusions	How conclusions were embedded in the programme strategy
IT-HR OP					
- Scoping - Coherence analysis - Identification of environmental objectives - Evaluation -Definition of mitigation	- Indicators analysis - Qualitative structural approach - Simulation model	Environmental	All the major environmental issues (biodiversity, flora and fauna, water, soil air) plus Energy, Waste, Cultural heritage. Territorial characteristic of specific area has been considered	- Mitigation of negative effects - Orientation of Specific Objectives - Green selection criteria - Provisions for the implementation phases	- In the programme strategy - In designing the programme mechanisms of implementation - In the monitoring systems (indicators)
RDP					
- Coherence analysis - Identification of environmental objectives - Evaluation - Definition of mitigation	- Qualitative approach	Environmental Economic Social	All the major environmental issues (biodiversity, flora and fauna, water, soil air) plus climate factors, population and human health, material assets (waste and natural resources), cultural heritage and landscape (including land use planning). Territorial characteristic of specific area has not been considered	- General contribution of the RDP to sustainable development, mainly for environmental dimension	- General indication for the implementation phase
OP-M					
- Coherence analysis - Identification of environmental objectives - Evaluation - Definition of mitigation	- Indicators analysis - Qualitative structural approach - Simulation model	Environmental Economic (only indirectly)	All the major environmental issues (biodiversity, water, soil and natural risks) plus climate and energy, waste, population and human health, cultural heritage and landscape	- Promotion of intervention - Reduction of impact in the implementation of projects - Additional measure for the promotion of SD	- In the programme strategy - In designing the programme mechanisms of implementation

Conclusion

Evaluation is requested by the Common Provision Regulation 2014-20 for all programmes under cohesion policy; including evaluation of the 'sustainable development' dimension. In the ESIF Regulations the term covers different meanings, focusing at the same time on the objective (i.e. 'sustainable growth' of the EU 2020 strategy), the sectors addressed (tourism, urban or natural resource management) or identifying 'principles' to be integrated during project selection, as well as during monitoring and evaluation of the programme.

However, how and to what extend this 'principle' should be evaluated is not clearly established in the guidance. In practice, the evaluated programmes do not provide any substantial definition of sustainable development, except by referring to the broad EU 2020 Strategy with some references to physical targets, specific integrated issues and target groups. Qualitative analyses prevailed in the programme evaluation reports, i.e. verifying the presence or not of specific pre-conditions (e.g. the identifying sustainable criteria for project selection). The personal opinions of beneficiaries and stakeholders on integrating sustainable principles in implementing procedures and the results of interventions is usually reported.

SEA is an approach which directly addresses the sustainable dimension of a programme, providing a cross-sector analysis. It considers the full environmental dimension, as well as taking on board guiding principles mentioned in the EU normative framework such as public participation, policy integration and the precautionary principle. Indeed, SEA includes recommendations for mitigation actions (to prevent potential negative effects in the future), criteria to be used in the project selection process and the design of a monitoring system. In addition, the quantification of CO2 emissions in some evaluations enables a clear view of the 'scale' of potential impacts of the programme alternatives.

SEA also has weaknesses. All the analysis is focused on the environmental dimension of sustainability, but economic and social dimensions are considered only where they are relevant for the programme strategy. A common weakness in the SEA case studies is the absence of integration of monitoring system indicators at regional level. A clear link between sustainable indicators at European or National level (e.g. Eurostat indicators) and SEA monitoring systems would concretely help to assess, monitoring and evaluating the programme contribution to the broader SD objectives.

Recent discussions at EU level on a new European agenda for sustainable development based on the UN Agenda 2030 renew the approach and make the monitoring and evaluation activities of EU policies more effective. The UN system of indicators addresses the three dimensions of sustainable development – social, economic and environmental -, defining targets and indicators, as well as cross-connection between SDGs and rules for a regular (annual) monitoring. Eurostat already has reported on SDGs at EU level, providing indications on the EU sustainable development pathway over the last years. At local level, there are some experiences in reporting SDGs (e.g. Basque country or in Lombardy regions). Next step should be to bridge Cohesion policy indicators and SDGs in order to make it consistent with the Agenda 2030 and experiences gained at local, regional and national levels.

What seems necessary for the future programming period is an effort on SD monitoring and evaluation. For monitoring, ESIF programmes could adopt a list of output and result indicators covering the topics of sustainable development and allowing for comparable data collection on programme implementation. In this regard, the ongoing discussion on the 2021-2027 regulatory proposal shows a new set of indicators which could improve data provision on programme implementation. For evaluation, the assessment of the programme contribution to the change could further combine qualitative and quantitative approaches. The theory-based approach could help identify assumptions and linkages within programme intervention logic showing how sustainable development benefits are created. Quantification of net effects and estimates of environmental benefits could be considered also by using methodological toolbox from counterfactual evaluation and cost-benefit analysis.

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Financing Sustainability at EU level: state of play and key challenges

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Abstract: European Union (EU) policy in the field of sustainable development has a long-standing tradition. The debate has been renewed with the approval of Agenda 2030 at international level. New scenarios for the European Union are in discussion under the next Multi-annual financial framework, with clear budgetary implications. The EU budget has financed sustainable development through a large range of policy instruments over the last period, including grants and financial instruments. Examples of sustainable development interventions in cities and regions financed with a EU support are many. However, how to finance sustainable development is subordinated to the definition of what sustainable development means in the various EU policy contexts. In the next future the involvement of the private sector supplementing public intervention would probably be determinant to achieve sustainable development in some key policy areas.

Keywords: EU policies, EU budget, Sustainable Development Goals, Financial instruments

Introduction

Sustainable development has been part of the EU policy debate at least since the Rio conference (1992). Initially sustainable development was mainly associated with a way of 'greening' EU socio-economic policies[1], before being considered as a goal guiding EU internal and external policy[2]. For the last 20 years, there has been a proliferation of strategies, action plans and programmes referring to 'sustainable', 'sustainability' or 'sustainable development'. However, the primary legislative texts (Treaties), as well as secondary legislation sources such as regulations, directives and decisions, do not and cannot adopt a unified definition of sustainable development (Kenig-Witkoska, 2017). This is partly because its implementation is strictly context-specific and should adapted to the specific needs of people. In the policy framework, sustainable development has been addressed mainly through general principles guiding policy interventions[3]. How they are combined to reach a sustainable development pathway depends largely on the legislative and planning context. Similarly, the question of 'how to finance sustainability?' depends on the specific policy instrument and the definition of the term in EU policies which contribute to sustainable development.

In this paper, financing EU sustainable policies is addressed at both macro and territorial levels by considering current discussions in the EU related to the sustainable development strategy to be adopted beyond 2020. Moreover, examples of cities and regions with sustainable development interventions supported by the EU budget are provided.

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[1] Treaty of Amsterdam (2007) article 3: 'Environmental protection requirements must be integrated into the definition and implementation of the Union's policies and activities, with a view to promoting sustainable development'.

[2] Lisbon Treaty (2009), Article 3 'The Union shall establish an internal market. It shall work for the sustainable development of Europe based on balanced economic growth and price stability, a highly competitive social market economy, aiming at full employment and social progress, and a high level of protection and improvement of the quality of the environment. It shall promote scientific and technological advance'.

[3] The guiding principles mentioned in the 'renewed EU Sustainable Development Strategy (EU SDS) 2009'are: policy integration and coherence, impact assessment, polluter price principal, precautionary principle, best available technology, involvement of business and social partners, involvement of citizens, promoting and protecting fundamental rights, solidarity within and between generations.

Scenarios for sustainable development beyond 2020

Sustainable development in the current policy framework

Taking stock of experiences gained over the last ten years of implementing sustainable development, the current policy debate at EU level has recently embraced the approach designed under the UN Agenda 2030 four years ago. This identified 17 Sustainable Development Goals (SDGs) and 169 associated targets, addressing five priorities: People, Planet, Prosperity, Peace, Partnership.

These cover a broad range of fields and development issues such as transport and urban issues, consumption and production patterns, energy, biodiversity and climate change, poverty and health, education and equity, water and desertification, agriculture and food security. SDGs include targets related to the fight against poverty set by the Millennium objectives in the early 2000s. Two SDGs refer directly to economic development, six are social, seven are environment-oriented while two focus on policy governance.

Figure 1: The 17 Sustainable Development Goals

Source: UNITED NATION (2015).

It is worth noting that the 17 SDGs are naturally integrated. Development issues such as poverty, human rights or environmental quality are indivisible and cross-cutting by essence, as already illustrated in the Brundtland report (1987). In that direction, the Communication 'Next steps for a sustainable European future – European action for sustainability' was published in 2016. In it the European Commission (EC) identified five key actions for effectively implementing the 2030 Agenda:

- Inclusion of SDGs in EU policies and initiatives;
- Regular reporting of progress;
- Set-up a multi-stakeholder platform to follow-up and exchange best practices;

- Prepare a long-term post 2020 vision document, and
- Disseminate 2030 Agenda implementation to other European institutions and national governments, as well as international and civil society organisations.

Integrating policies is ensured by a multi-sector approach with broad stakeholder participation in defining and implementing SDGs at all levels of the policy making process as well as monitoring progresses towards targets (Meuleman, 2018). Definition of a long-term vision means different policy scenarios for the new Multi-Annual Financial Framework (MFF) 2021-2026 as identified by the Junker Commission (European Commission, 2019). The scenarios are still under discussion in the European institutions and cover:

- An overarching SDG Strategy to guide all actions of the EU and its Member States. This is in line with recommendations from the High-level Multi-stakeholder Platform on SDGs[4]. Under this scenario a large part of EC and Member State budgets should be allocated to policies contributing to SDGs. Strong coordination mechanisms are needed between levels of governance, especially Member States and the EC as well as between institutions, policy instruments and funds;
- Continued mainstreaming of the SDGs in EU policies, but not enforcing Member State action in this direction. Member States should be free to define their own degree of commitment to SDGs. Moreover, financial allocations to SDGs should by defined within the MFF (see Table 1below)[5] and financial commitment from Members States should be variable;
- Prioritising EU external actions to promote SDGs outside the EU, while consolidating sustainability ambition at EU level. In this scenario financial allocations to SDGs are only part of the EU budget (see Table 1 below), with a likely focus on SDG 11, Sustainable Cities and Communities.

To clarify the links between current EU policy and the priorities in Agenda 2030, the EC reviewed all on-going policies in force for 2014-2020. The unsurprising results show that most EU policies cover at least one SDG, with all the priorities being addressed under Agenda 2030. The current EC budget for 2014-2020 of some 1 000 billion euro should be consistent with the 17 SDG themes (see table 1). However, thematic consistency with SDGs does not imply that the EU policy framework is sustainable *per se*. For example, not all interventions under the Common Agricultural Policy for example contribute to climate and environmental objectives. In addition, investments under the European Regional Development Fund (ERDF) are not all environment oriented and sustainable principles are not automatically taken on board by the projects supported by Horizon 2020, COSME or the Youth Initiative. Many interventions are implemented on a 'silo' approach, so they target few priorities without clear cross-connections between themes, they may also involve a limited number of stakeholders and authorities, and focus on specific fields or sectors of expertise and competence.

[4] Created in 2017, the Multi-stakeholder platform aims to support and advise the EC and all stakeholders on the implementation of SDGs at EU level.

[5] The EU long term planning financial instrument defining fields of intervention for EU institutions and the budget priority over a period of 7 years (The financial framework for the period 2021-27 is currently under discussion).

Table 1: Relevance of MFF 2014-2020 to SDGs (EUR billion, 2011 prices)

MFF 2014-20	Amount 2014-20	Related SDGs
Smart and inclusive growth	**490.908**	
Competitiveness for growth and jobs	114.888	8, 9
Economic, social and territorial cohesion	376.02	All (except 17)
Sustainable growth, natural resources	**382.927**	
Common agriculture policy (market exp. + direct payments)	281.825	2
Rural development	89.895	All (except 17)
Fishing and maritime policy	6.685	14
Environment and climate actions	3.2	6, 7, 11, 12, 13, 14, 15
Pilot projects and preparatory actions + other	1.321	-
Security and citizenship	**18.535**	
Asylum and Migration	3.433	16
Security and Justice	5.258	16, 17
Right, citizenship, civil protection, Europe for Citizens	0.835	4, 5, 16
Food and feed, Health for growth, consumer protection	2.748	1, 2, 3
Creative Europe	1.59	16
Others (e.g. decentralised agencies)	4.672	-
Global Europe	**70**	
Neighbourhood policy + IPA	28.617	10, 16, 17
Development Cooperation and Partnership	21.597	10, 16, 17
Democracy, Human rights, Stability	3.91	1, 2, 10, 16, 17
Humanitarian aid and Foreign and Security polices	8.915	1, 2, 10,16, 17
Nuclear protection	0.56	-
Civil protection and Aid volunteers	0.42	10, 16
Other	5.982	-
EU Administrations	**62.629**	-
Total - €	**1,025.00**	-

Source: own elaboration; financial figures: a budget for EU 2020, EUROPEAN COMMISSION (2011).

Sustainable development in cohesion policy 2014-2020

European and Structural Investment Funds (ESI) Funds cover ERDF, the European Social Fund (ESF), the European Maritime and Fisheries Fund (EMFF) and the European Agricultural Fund for Rural Development (EAFRD). The Common Provisions Regulation (CPR) 1303-2013 regulating the use of ESI Funds and sets out 11 thematic objectives (TOs) contributing to better territorial, social and economic cohesion in the EU (in reference to article 174 of the TFEU). The TOs also support the achievement of EU 2020 objectives, which aim for smart, sustainable and inclusive growth[6]. The sustainable growth objective covers TOs 4 'Low carbon economy', 5 'Climate change adaptation and risk management', 6 'Environment and resource efficiency' and 7 'Sustainable transport and network bottlenecks', but sustainability is also identified as a cross-

[6] TOs cover the following themes: Research and innovation (TO1); information and communications technology (TO2); SME competitiveness (including rural businesses, fisheries processing and aquaculture) (TO3); low carbon economy (TO4); climate change adaptation and risk management (TO5); environment and resource efficiency (TO6); sustainable transport and network bottlenecks (TO7); employment and labour mobility (TO8); social inclusion and poverty (TO9); education (TO10) and institutional capacity (TO11).

cutting objective to be pursued under all TOs[7]. ESI Funds involve all Member States and are implemented through 28 national Partnership Agreements, approved at national level, and more than 290 regional programmes. Each programme defines its own strategy, including implementing tools, and investment priorities based on regional needs consistent with financial resources and administrative capacities. In all operational programmes, specific criteria related to sustainable development are used for project selection as applicants are required to demonstrate how their project intends to contribute to sustainability. The regulations also require monitoring, evaluation and regular reporting on sustainable development in programme implementation[8]. The TOs with the highest percentage of funding are TOs 3 'SME competitiveness', TO 6 'Environment and resource efficiency' and TO 7 'Sustainable transport and network bottlenecks' with more than 45% of resources being allocated to the sustainable growth objective[9] (see Table 1 above).

More specifically article 7 of the ERDF regulation (Reg. 1301/2013) established that at least 5% of each Member State's allocation shall be devoted to actions for sustainable and integrated urban development (SUD). In addition, article 8 foresees Urban Innovation Action providing specific financial support to cities for sustainable development. An estimated € 15.5 billion is allocated to SUD. Of this, € 14.2 billion (92.5%) is to be financed by ERDF and € 1.3 billion (7.5%) by the ESF (in multi-fund programmes). About half of that amount is delivered through Integrated Territorial Instruments (ITI).

Financing Sustainable Development from ESI Funds

The main EU financing tools for sustainable development in cohesion policies are direct subsidies in the form of grants to public or private organizations, or financial instruments (FIs)[10]. The choice of financing tools is left to the managing authority through the operational programmes where they allocate funds to private and public organizations. The EU financing rate depends on the regional level of development and the objectives pursued by the programme. Support for enterprises is also regulated by State aid thresholds which limit public incentives allocated to private economic operators[11].

FIs have been introduced in ESI Funds at a large scale more recently and are mainly guarantees, loans and equity instruments[12]. FIs can cover any of the eleven TOs defined for the 2014-2020 period. Compared to grants only, they can bring significant additional benefit to public support for sustainable development objectives:

- FIs have to be paid back by beneficiaries, so public authorities can re-invest the resources multiple times in different projects (the 'revolving effect').

[7] Sustainable development as a 'horizontal principal' should ensure the mainstreaming of sustainable development into ESI Funds in all phases of implementation, as mentioned in section 5.2. of the Common Strategic Framework in annexe 1 of the CPR.
[8] Article 54 of the CPR
[9] See table 2 in Review of the adopted partnership agreements. Mention also cohesion policy open source platform.
[10] See Fi-compass (2015*a*).
[11] See Fi-compass (2018).
[12] See Fi-compass (2015*b*).

- They seek to attract additional public and private resources for investment in projects through co-financing and co-investments at fund or project levels (the 'leverage effect'). This increases the capital available to public authorities and territories for investments.
- They can be an incentive to selecting better quality projects, because of the greater efficiency needed to repay the support. Moreover, involving the private sector enables the public sector to gain financial and managerial skills in identifying investments suitable for FIs, as well as in assessing the financial and non-financial impacts of investments. These skills can help more broadly in efforts to improve the efficiency of public fund support.

However, the effectiveness of financial instruments should be framed within the overall context of alternative policy instruments. Grants are intended as transactional support, essentially non-recoverable 'one-off' subsidies or payments to beneficiaries with no requirement to repay or return any financial costs to the public sector. Given the requirement to repay, FIs can be more complex to implement and not appropriate for every context[13]. The major challenge is related to the need to clearly define what sustainable development investments are from an FI perspective and how much private investors can contribute to SDGs in a broader view.

Financing from EU funding sources for sustainable development in regions.

Many regions and cities are already engaged in setting up Agenda 2030 strategies. As mentioned in multiple studies, a major obstacle to SDG policies is a lack of funding sources. Local and regional authorities (LRAs) defining a sustainable development strategy find it challenging to connect SDGs with regional, national and EU funding sources that ensure continuity and consistency of medium to long term finance needed to achieve the objectives[14].

Financing sustainable development projects with grants and financial instruments (from ESI Funds) has been tried in 2014-2020 in many Member States.

Example of financing sustainable development through grants at territorial level

Romania uses the ITI instrument in the Danube Delta Biosphere Reserve (DDBR). This territory has unique natural and cultural features, such as extensive wetlands, scattered settlements, economic specialisation and vulnerability as well as limited access to basic social services and infrastructure. The Integrated Strategy for Sustainable Development of the Danube Delta (SIDDD) looks to both protect the environment and develop the local economy.

The main characteristics of the ITI are:

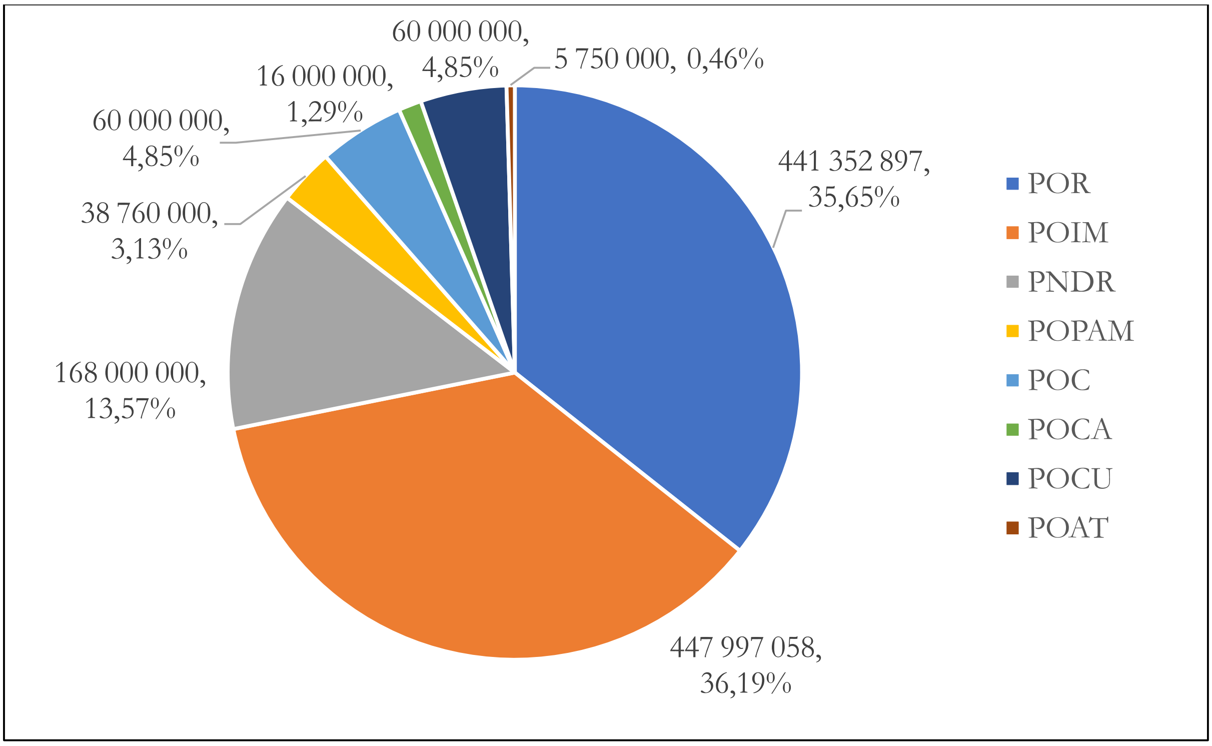
- It is easier to run territorial strategies and promote a more local or 'place-based' form of policy making based on a multi-stakeholder approach. The ITI increases the role of local authorities, NGOs and other sub-national bodies involved in managing and implementing

[13] See OECD (2017) and OECD (2018), *The theory and practice of financial instruments for small and medium-sized enterprises* and OECD (2018), *Financial Instruments in Practice: Uptake and Limitations.*
[14] See Levarlet *et al.* (2019).

ESI Funds by helping widen capacities for conducting territorial development in a more sustainable way over the longer term;

- It addresses social, economic and environmental issues in an integrated approach at territorial level. It is structured around five closely interconnected pillars; Pillar I: Protecting the environment and natural resources; Pillar II: Improving economy; Pillar III: Improving connectivity; Pillar IV: Ensuring public services; Pillar V: Promoting efficiency, accessibility and sustainability (including administrative capacity of local authorities and technical assistance in implementing the program).
- Funding sources are varied and integrated in a coherent framework. The SIDDD was drafted with World Bank expertise together with local authorities and, for 2014-2020, is implemented through ERDF, EARDF, EMFF, CF and ESF (see Figure 2 below).

Figure 2: ITI Danube Delta financial allocation by Operational Programme



Source: ITI Danube Delta, http://www.itideltadunarii.com/Finantare

Two examples of financing sustainable development through FIs at regional level

There are several examples of public authorities using ESIF funded financial instruments to explicitly support sustainable development.

CAP *Troisième Révolution Industrielle* (CAP TRI) is an FI supported by the 2014-2020 ERDF Operational Programme in the region of Nord-Pas de Calais in France[15]. CAP TRI combines resources from ERDF, the European Fund for Strategic Investments (EFSI) with EIB funding guaranteed and private investors. CAP TRI invests mainly through equity in SMEs. This FI was developed to help Nord-Pas de Calais become the first carbon-neutral region in France by 2050.

[15] Fi-compass (2016).

In 2013, the managing authority and the regional Chamber of Commerce and Industry jointly published a road map for regenerating the area through TRI. It targets 'zero carbon emissions' by 2050, looking for energy needs to be fully met through renewable energy sources. The FI finances projects that fit within the five pillars of the TRI road map: (i) renewable energy, (ii) smart buildings generating energy, (iii) energy storage, (iv) smart grids for energy, and (v) soft and smart mobility. Moreover, the FI adheres to the Principles for Responsible Investment established by global investors and supported by the United Nations. This incentivises investors to consider the environmental, social and governance principles of the companies they invest in.

The main characteristics of the instrument from a sustainable development perspective are:

- Leverage of public money. With initial investment funding of EUR 37.5 million, as well as EUR 2.5 million for technical support in the form of grants, the FI aims to stimulate investments of EUR 100 million in projects and is currently raising funds from public and private investors.
- Multi-objectives. The energy transition initiative should also result in job creation, economic development and less fuel poverty with more sustainable energy supply and usage.

The London Green Fund (LGF)[16] is another project supported by ERDF. It contributes to London's ambitious carbon reduction targets to make the city one of the world's leading low carbon capitals by 2025 and a global leader in carbon finance. LGF consists of three urban development funds investing in energy efficiency, waste and greener social housing. The ERDF contribution of EUR 60 million combined with public and private funds brings loan and equity funding for projects ranging from the city's first plastics recycling plant to energy efficiency upgrading in public buildings. This helps London's transition to a low carbon economy, which will bring economic opportunities in terms of jobs and inward investment.

The main characteristics of LGF are:

- A multi-objective purpose, to support sustainable economic growth by investing in low/zero carbon environmental infrastructure and premises, physical environmental enhancement and retrofitting existing buildings, including social housing. The beneficiaries include the Tate Modern art gallery, local authorities and a hospital.
- Multi-target groups. The loans and equities offered under LGF were open to the public and private sectors including voluntary and third sector bodies, private sector landlords, owner-occupiers, tenants, developers, energy service companies, joint ventures and special purpose vehicles.

Conclusion

The definition of future EU sustainable development policy is underway. Behind the discussion on 'how to finance sustainability', is a debate on the definition of sustainable development and its relevance in the EU policy framework in general. Embedding SDGs in EU policy would imply on one side to consider the budget implication and, on the other, to understand how to exploit the more financial opportunities for local sustainable development polices allowed by the availability

[16] Fi-compass (2015).

of more resources in a broad sense. Different scenarios on future EU strategy for sustainable development imply different amounts of financial resources allocated to sustainable development posing new challenges as well as new opportunities for public authorities on identifying the target (i.e. which SDGs to achieve in relation to territorial and people needs) and on setting-up the type of policy instruments to adopt (i.e. grants or FIs). The transversal aspects of sustainable development, in fact, imply various funding sources and mechanisms. There is no unique way to finance sustainability; it depends on the objectives, the policy fields and the beneficiaries targeted.

A large range of instruments are already applied at EU level, including both grants and FIs (considering that fiscal incentives are not under the competence of the EU). EU funding for LRAs is key to support successful local sustainable development pathways. Different instruments under the ESI Funds have been implemented at local and regional levels in rural and urban contexts, such as the Integrated Territorial Investment for an integrated sustainable development planning, Community-Led Local Development for a sustainable and place-based development in rural context or the Urban Innovation Action providing financial supports to cities for sustainable development. However, more guidance and technical support to implementing bodies and beneficiaries in using these instruments to reach sustainable development targets seem to be necessary to fully exploit their potential.

Using FIs to address sustainable development has been encouraged at different levels in the EU, to increase total support for sustainability. The main advantages of FIs are the leverage effects of private finance from public contribution and the revolving mechanism which address the question of long-term availability of financial resources. Not all SDGs can be supported through FIs, as FI implementation can require complex arrangements, skills and competences. Above all, loans, guarantees and investments in capital involve payback mechanisms which require investments to generate revenue. This can potentially increase also the quality of projects supported and better contribute to the achievement of SDGs.

On this aspect, the main challenge over the next years is to involve private investors at a larger scale and give clear instructions to markets to allow them to reach sustainable objectives in an effective, coherent and long-term framework. Recent EC guidelines have been published to regulate private involvement in this new field. Moreover, identifying ad-hoc financial solutions and mechanisms specifically designed for SDGs is another field of future research and debate, starting from the existing best practices currently implemented in European territories.

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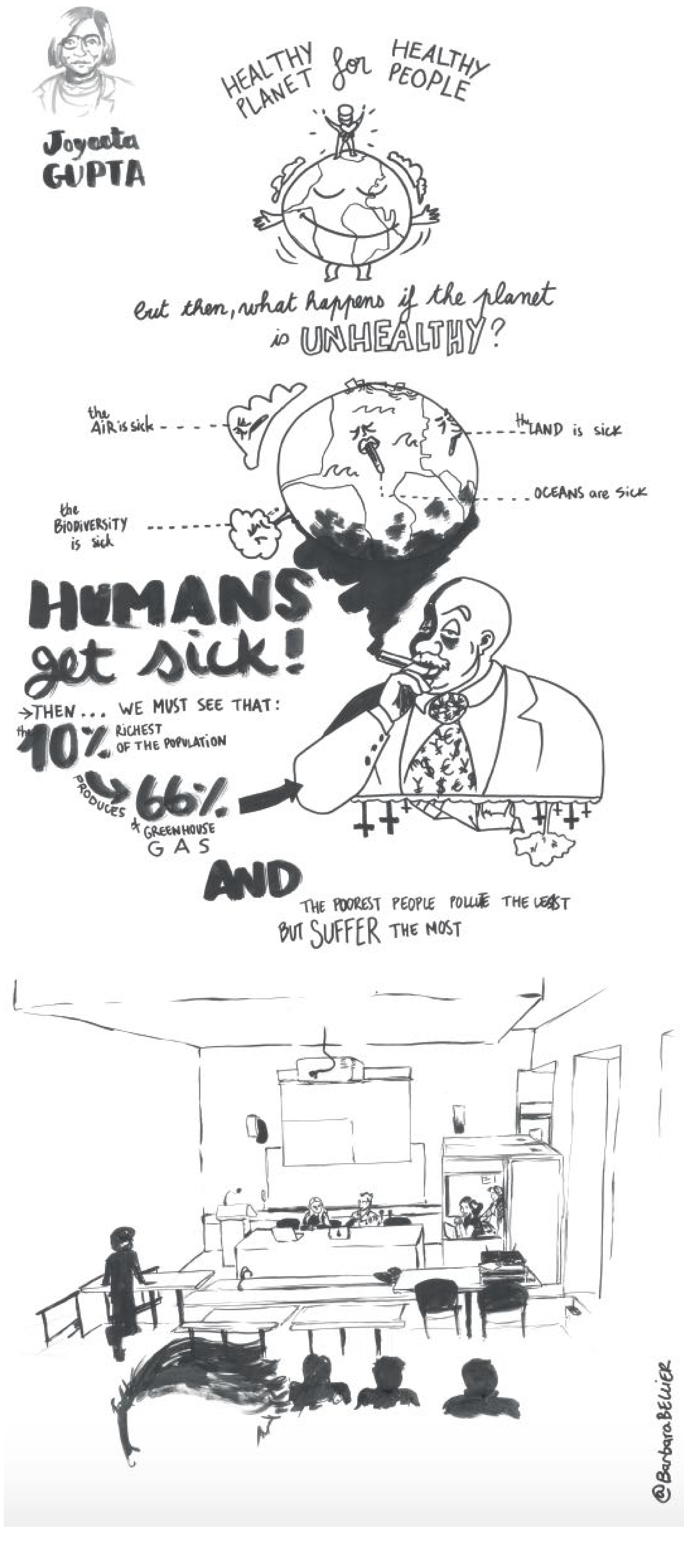
PART 4

STRONG SUSTAINABILITY FOR DEVELOPING COUNTRIES


Joyeeta GUPTA
HEALTHY PLANET for HEALTHY PEOPLE
but then, what happens if the planet is UNHEALTHY?
the AIR is sick
the LAND is sick
OCEANS are sick
the BIODIVERSITY is sick
HUMANS get sick!
→THEN... WE MUST SEE THAT:
the 10% RICHEST OF THE POPULATION
PRODUCES 66% of GREENHOUSE GAS
AND
THE POOREST PEOPLE POLLUTE THE LEAST
BUT SUFFER THE MOST
@BarbaraBELLIER

Tax revenues and social protection financing in African and Latin American countries

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Abstract: Social protection plays an important role in the achievement of development. Hence, it is highlighted in the Sustainable Development Goals (SDGS) 1,3,5,8 and 10. One of the solutions to achieve universal protection coverage, notably in African and Latin American countries, is sustainable financing. This article focuses on one type of financing, which is tax revenues and its possible effects on public social protection expenditures in percentage of Gross Domestic Product (GDP) as a proxy for social protection financing. It is assumed that the greater the share of tax revenues in GDP is, the greater the resources available for social protection programs are. This would allow better financial sustainability of these programs. Using a panel analysis, the study finds a positive but non-significant effect of total tax revenues and resource tax revenues. As for non-resource tax revenues, they have a positive and significant effect as well as the control variables "rural population", "population aged 65 years and over".

Key words: Tax revenues, Social protection, Social protection financing, SDGs, developing countries.

Introduction

Social protection can be defined as all measures enabling universal access to social security, healthcare and income security and that ensure dignity and rights for all (ILO,2014). It plays an important role in the improvement of an individual's living conditions and contributes to development. (ILO,2011; WB,2012; ILO, 2014; ILO, 2017). The main purpose of social protection is to facilitate income smoothing over time, in order to support domestic consumption, human capital and productivity support. It thus reduces poverty and insecurity risks. Hence, it is highlighted in the Sustainable Development Goals (SDGS), as it plays a transversal role in the achievement of SDGs 1,3,5,8 and 10. However, currently only 49.5% of the world's population has access to some form of social protection. When disaggregated at the regional level, this figure decreases even more for sub-Saharan Africa, where the rate is as low as 17.8% (ILO, 2014). It is therefore important to extend social protection coverage to a larger number of people and achieve universal coverage in social protection in the long term. As such, each country must be able to mobilize the resources needed to sustainably fund its social protection system.

To finance social protection systems, countries have at their disposal different types of financing, such as family or community support. Financing can also be done through social contributions to a health insurance organization, or to a pension system. Another way of financing social protection may be regular savings in an individual's accounts during their working lives, in order to finance their retirement in the future.

Finally, when social protection beneficiaries do not contribute directly, countries can use government revenues. Public resources can be constituted through tariffs; direct taxes (income taxes, wealth tax); indirect taxes (bases, VAT, taxes on financial transactions), taxes linked to the exploitation of natural resources, international aid (Cichon,2004; Bastagli et al., 2013, Duran-Valverde et al, 2013, Brun et al., 2016).

One can wonder whether each of these types of financing is sustainable over time for achieving and maintaining universal coverage in social protection. This study answers the question by looking at the method of financing through direct and indirect tax revenues.

In the following sections, it is assumed that the greater the share of tax revenue in GDP is, the greater the resources available for social protection programs are. This would allow better financial sustainability of these programs.

Other studies worked previously on the contribution of tax revenues for the financial sustainability of social protection programs. Nevertheless, they are not numerous, especially not in developing countries. One of the most recent studies has been carried out by Murshed et al. in March 2017 and published by UNU-WIDER. The authors analyze the effect of tax revenues on social protection expenditures in developing countries (98). However, their study presents some limitations, as they used only five points of observation for the dependent variable and they had to calculate averages on five years for explanatory variables. The main reason for applying this methodology was the lack of data. However, it poses the risk of bias in the results, as the continuous evolution of public social protection expenditures was not considered. Other studies such as Anton et al. (2006) and Matus-Lopez et al. (2016) put an emphasis on the important role of tax revenues mobilization by using simulation methods. Zemmour (2012) also worked on the issue by using a descriptive analysis. Nonetheless, it is necessary to conduct a more rigorous study comprising as many factors influencing sustainable social protection financing as possible.

This article contributes to the existing economic literature as it is an econometric study carried out on a continuous period from 2000 to 2010 in developing countries. This enables a better capture of the effect of tax revenues on social protection financing and a more precise magnitude of this effect. Data was gathered from different databases and subsequently harmonized. Furthermore, in the second part of this study, tax revenues are subdivided in two parts: resource tax revenues and non-resource tax revenues. This was done in order to observe which of the two has a more important effect on social protection financing[1].

The remaining part of the article is organized as follows: II) Factors influencing financial sustainability of a social protection system, III) Presentation of data, IV) Presentation of the model, V) Econometric Analysis VI) Conclusion

Factors influencing the financial sustainability of a social protection system

Theoretical aspects of the financial sustainability of social protection system

The financial sustainability of a social protection can depend on the nature of the social protection system. In economics theory, there are two main models, both originating in Europe: the Beveridgian system and the Bismarckian system. (Beveridge,1942; Stolleis,2013; Cremer&Pestieau,2003). There is also a third model which combines elements of both models. The Beveridgian system, which is characterized by universal social protection coverage for all citizens regardless of their employment status, is financed through tax revenues. Hence, its financial sustainability depends on the efficiency of the tax system put in place. This implies having enough

[1]In the study, social protection expenditures were chosen as a proxy for social protection financing. They comprise health insurance expenditures, unemployment benefits, pensions, safety nets.

resources collected and well managed to sustainably finance the social protection system. The financial sustainability of the Beveridgian system also depends on the number of taxpayers. The Bismarckian system, which is characterized by access to social protection coverage conditional to being employed, is financed through the social contributions of employees and employers. This implies that there are enough people in the labor force to have their contributions covering the benefits provided to employed and unemployed (retired persons, family members of contributors) beneficiaries and that the system is financially viable. As a result, the growing trend of population aging can be problematic for the long-term maintenance of this system.

The financial sustainability of the social protection system also depends on the type of welfare state established in the country. According to the nature of the welfare state, the administrative and financial management of the social protection system will be more or less ensured by the public authorities. In economics literature (Esping-Andersen, 1990; Vallet, 2002), three types of welfare states are defined according to three factors, namely decommodification[2], the functioning of states as a system of stratification[3] and the link between the market, the family and the state. The first type is the "liberal" welfare state, characterized by weak de-commodification. The second type is the "corporatist" welfare state, a conservative state characterized by a weak de-commodification but also by a strong social stratification. Lastly, the third type is the "social-democratic" welfare state, characterized by a strong de-commodification and the absence of social stratification. Depending on the type of welfare state adopted by each country, this results in the establishment of one of the social protection systems mentioned above.

Apart from the three aforementioned factors, the financial sustainability of a social protection system also depends of the country's economic situation (Banks et.al, 2000, Schmähl, 2001; Cichon, 2004), the situation of its labor market (Samuelson,1975, Banks et.al 2000, Schmähl, 2001; Cichon ,2004), its demographic situation (Keuschnigg et al., 2011), the governance of the social protection system (Schmähl, 2001;Cichon, 2004), and the political interests of the government in place (Samuelson 1975, Schmähl 2001, Cichon 2004).

In fact, when a country experiences a high rate of economic growth, this may enable it to release additional resources due to the increase in tax revenues collection. These resources can be allocated to the financing of social protection. In addition, if the economic growth is paired with lower unemployment rates, the labor force is likely to earn more income. This can help increase the share of the population that contributes to the financing of social protection coverage.

With regard to the labor market, the accessibility of employment and the nature of employment (formal, informal) have an impact on a number of aspects, such as: an individual's eligibility for the social protection program; the actual number of persons covered by the protection; the number of people who pay social security contributions and/or pay a tax to finance enrollment in a social protection program; and the amount of social benefits. (Banks et al. 2001, Schmäl, 2001, Cichon, 2004).

The demographic situation affects the number of persons present on the labor market and therefore the number of taxpayers, the number of beneficiaries of social protection programs, the average period of working to be eligible for the social protection program. (Viard, 2002; Keuschnigg et al., 2011; Hsu et al.,2015). Thus, if the mortality rate decreases and the fertility rate

[2] To what extent do social rights allow people to have living conditions without using the market?

[3]To what extent does the state grant social rights according to social classes?

also decreases, the population of elderly people will increase. However, the elderly are more vulnerable to health problems and often require more care. This leads to an increase in the level of health expenditure and in expenditure needed for social protection. A growing elderly population also means a larger number of pensioners, which results in a rise in pension benefits provision, and therefore in social protection expenditures.

With regard to governance, national laws on the different components of social protection can have an impact on financial sustainability. Examples include the law on the age of retirement, the law on the number of years of compulsory schooling, the law on the legal age of entry into the labor market, the quality of management and administration of the social protection system. (Banks et.al, 2000, Cichon 2004).

With respect to political interests, the incumbent government may have a tendency to adopt social protection financing policies that favor its electorate. This can be justified by its willingness to be re-elected at the next elections. As high-income households are those with significant financial resources to finance election campaigns, the state can put more emphasis on compulsory taxation as a form of social protection funding. For this type of funding to be sustainable over time, a significant number of taxpayers are needed. (Samuelson 1975; Schmäl 2001; Zemmour 2012).

Empirical aspects of the financial sustainability of the social protection system

Few papers have made an econometric study of the causal relationship between public spending on social protection and tax revenues, especially in developing countries. This is emphasized in one of the most recent articles on this subject, which is a working paper written by Murshed, Badiuzzaman and Pulok in March 2017 and published by UNU-WIDER. The authors analyze the effect of fiscal capacity on social protection spending in 98 developing countries using data from the 2014 International Labor Office and the International Monetary Fund (IMF). By adopting the instrumental variables approach and the panel approach, the study finds a positive and significant effect of fiscal capacity on social protection expenditures. This effect is amplified when the country has a good democratic system.

Other studies that have also worked on the contribution of tax revenues to social protection financing have used simulation analyses or some other types of analysis. Anton et al. (2016) used the dynamic general equilibrium model of Byod and Ibarran (2006). The authors found that universal social insurance can be financed by increasing VAT and removing subsidies to the energy sector, even in the absence of social security contributions. An increase of 1% for the VAT (excluding food and medication) and the removal of subsidies to the energy sector can increase the GDP of the country and thus create new resources for the state, which can then be invested in the financing of social protection.

Matus-López et al. (2016) also used simulation scenarios to assess the technical and political feasibility of six sources of fiscal space in Peru, in order to achieve the goal of increasing public health expenditures (component of the health insurance) to reach 6% of the GDP. They also evaluate their political feasibility. By defining three scenarios, the authors find that economic growth can allow an increase in fiscal space of 1.03 percentage points of GDP in the positive scenario; 0.56 percentage points of GDP in the neutral scenario and -1.05 percentage points of GDP in the negative scenario. The positive scenario is characterized by a future increase in GDP equal to the one observed in 2009 and 2012; the negative scenario by an increase in GDP equal to the one observed two decades ago and the neutral scenario is characterized by an intermediate value from other studies. As for taxes on rent and companies, there remains a gap of 4% GDP compared to those of the OECD. This available fiscal space could be exploited to generate more tax revenues. The political feasibility of this source of fiscal space is medium. As for the tobacco tax, it can create a fiscal space up to 0.02% of GDP. This source of fiscal space has a high political feasibility.

Zemmour (2012) has for his part carried out an analysis of the evolution of the financing of social protection in Europe over the period of 1980-2007. He used the quantitative analysis methodology with social protection expenditures being divided into social protection expenditure - known as budgetary - and those financed by social contributions. In this study, the evolution of social protection expenditure was differentiated according to the years of increase or decrease in expenditure. Based on data from the OECD and Eurostat databases, the author observed that in 12 countries, changes in social protection expenditure as a percentage of GDP can be explained by changes in budget expenditures. However, it should be noted that the evolution of social protection expenditure can be explained by other factors that were not taken into account in the study such as the situation on the labor market and demographics. Hence, it is necessary to conduct an econometric analysis of the causal relationship between social protection expenditure and tax revenues. The study conducted by Zemmour can be considered as an econometric pre-study.

Hujo et al. (2012) showed through an economic analysis the role of tax revenues from the exploitation of natural resources in the financing of social protection including pensions. The authors gave the example of Bolivia, which since 2005 has had 32% of the "Renta Dignidad" universal pension scheme financed by the tax on the production of hydrocarbons. The study shows that resource tax revenues should not be neglected when it comes to finance social protection. Nevertheless, given the volatility of oil prices (or other natural resources) and the threat of Dutch disease, tax revenues may not be collected efficiently, and it may not fully contribute to social protection financing. Hence, in the second part of the present study, the total tax revenues were separated into resource and non-resource tax revenues to obtain the respective contribution of each to the financing of social protection.

Handley (2009) and Muñoz et al. (2003), for their part, addressed the issue of the link between taxation and social protection financing by highlighting the use of additional revenue from VAT to finance the health insurance system in Ghana and social protection in the future in Ethiopia. Handley (2009) found that the increase of VAT from 12.5% to 15% in 2004 resulted in a rise in fiscal space and hence in Ghana's tax revenues of more than 1 percentage point of GDP per year. This gain was allocated to financing the country's social protection.

These studies using simulation methods or other types of analysis than econometric analysis show the significant role of different forms of tax revenue to sustainably finance social protection programs. Nevertheless, an econometric analysis should be performed to these results by including as many factors that may affect the dependent variable as possible.

Data presentation

Databases used by the study

Given the scarcity of data on public social protection expenditures, but also on the explanatory variables on African and Latin American countries, data were collected from several sources in order to build the database for this study. Since public social protection expenditures do not necessarily have the same components according to the data source considered[4], the data sometimes had to be transformed in order to be better harmonized. Table 1 below summarizes the databases that were used in the study.

Table 1: Summary of database used in the study

Variables	Database
Public social protection expenditures (%GDP)	"Public Social Protection Expenditure as a percentage of GDP, including/excluding Healthcare" from the ILOSTAT database of the International Labour Organization (ILO) from 2005 to 2012; "Expenditure on social protection" variable from IMF's "Governance Finance Statistics (GFS) database" – Expenditure by Functions of Government (table 7) 2005-2015; "Gasto social público en seguridad y asistencia social como porcentaje del producto interno bruto" from the database of the United Nations Economic Commission for Latin America and the Caribbean (CEPAL)1991-2012; "Total Public Social Protection expenditure as a percent of GDP" from the database of the report "world social protection 2014-2015"; "General Government Health Expenditure (GGHE) as % of Gross Domestic Product (GDP) from the World Health Organisation (WHO) National Health Account (NHA) Indicators database 1990 -2016.
Tax revenues (Total, resource, non- resource)	The World Bank's World Development Indicators (WDI) database; The Mansour database (WP IMF, July 2014); The ICTDGRD June 2016 database of the International Center for Tax and Development (ICTD)
CPI score	The transparency database 2000-2010
Net amount of the ODA	The Sustainable Development Goals data extract database
Population aged 65 and over	United Nations Development Programme (UNDP) Human Development Index (HDI) for 2003-2008; SSA reports "Social Security Programs Throughout the World": Africa 2003,2005,2007,2009,2011 and Americas 2003,2005,2007,2009,2011.
Under five mortality rate	The WHO National Health Account (NHA) database

Source: Author.

[4] There are databases that include total health expenditures and not just health insurance expenses

By collecting data on the different variables, 30 countries were selected for the study for the period of 2000 to 2010: Angola, Argentina, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Chile, Colombia, Congo (Democratic Republic of), Costa Rica, Ivory Coast, Ethiopia, Egypt, Ghana, Guatemala, Honduras, Kenya, Madagascar, Namibia, Nicaragua, Peru, Senegal, South Africa, Tanzania (United Republic of), Tunisia, Uganda, Uruguay, Venezuela, Zambia.

Descriptive analysis of data

The total number of observations (Number of countries studied * Number of years for which data are available) varies according to the considered variable. Thus, for the explained variable, public expenditure, it is equal to 247. For the explanatory variables, that is to say the total tax revenues, the resource tax revenues, the non-resource tax revenues, the cpi score, the share of the rural population in the total population, the net amount of international aid, the share of the population aged 65 and over in the total population, the mortality rate of children under five years old, it is respectively equal to 317,321,328,302,330,330,291,314. As a result, the panel regression model for this study is unbalanced. For the other statistical indicators, the level of public expenditures on social protection as a percentage of GDP is equal, on average, to 4.61%, which remains low enough for the universal coverage of social protection of the population of African countries and Latin America. The total variance of this variable is 17.46, which indicates a non-negligible dispersion of the values taken by the variable over the period studied around the mean value. This can be seen in the large gap between the minimum value of 0.01% of the GDP and the maximum value of 17.5% of the GDP.

For the total tax revenues, the average is 15.17% of the GDP and the variance is 32.63. There is therefore a strong dispersion of the values of this variable around the mean, thus indicating heterogeneity between the countries (and between the years considered). In general, the tax burden remains lower for the countries studied in comparison to developed countries, which exceeds 20%.

Concerning the resource tax revenues, the average is 3.45% of the GDP. The minimum value is 0 and concerns several countries that do not yet exploit natural resources. The maximum value is 41.2%. The variance is 72.22; which also indicates a strong dispersion of the values taken by the variable around the mean value. As for the variable “non-resource tax revenues”, it is on average equal to 15.14%. Non-resource tax revenues are therefore relatively more important than resource tax revenues. This suggests that they may have more impact on the dependent variable. This variable is characterized by a high dispersion of its values around the mean, since its variance is 23.74.

Presentation of the model

The construction of the econometric model of this study is based on the factors influencing the financial sustainability of social protection and highlighted in the economic theory, as well as in the empirical studies (see section II) that we considered the most relevant. It is also based on the model used in the study by J. Pan and G.G (2012) [5]on the determinants of public health expenditure per capita of Chinese provinces.

[5]We used insights of this article to define our model as it studied the determinants of public health expenditures by provinces and public health expenditures are covered by health insurance (component of social protection). In addition, it involves rigorous econometric analysis. In this study by J. Pan and G.G (2012), the determinants include

The following model is used:

$G_{SP}(i,t)=a_i+ TR(i,t)+ \sum X(i,t)+u(i,t)+e(i,t)$

With GSP (i, t) = the level of public expenditures on social protection as a percentage of GDP for country i in year t; a_i = the constant, TR (i, t) = Level of tax revenues (total, resource or non-resource) in% GDP; ΣX (i, t) = The set of control variables, namely rural population share in the total population (Rur Pop), the level of corruption measured by the CPI score, the net amount of the ODA, the share of the population aged 65 and over in the total population (Pop 65+), the under five years old children mortality rate (U5MR);u (i,t) the fixed effect country and e(i,t) the term of the error.

Econometric analysis of the data

In order to choose the most appropriate model to explain the sustainability of social protection funding, different regressions of the variable "public expenditure on social protection" on the independent variables were carried out by estimating the Ordinary Least Squared (OLS) model, the Least Squared Dummy Variable (LSDV) fixed effects model, the Within fixed effects model, and the random effects model. The same procedure was adopted for choosing the right model when tax revenues were disaggregated into resource and non-resource tax revenues. The fixed effects model was the final model chosen in all cases for further analyses.

Results and their interpretation

In model A (see Table 1), the R^2 Within is equal to 0.27 in terms of the overall significance of the model which means that 27% of the variability of public spending on social protection is explained by the model. The main explanatory variable, that is to say tax revenues expressed as percentage of GDP, has a non-significant positive effect on the financing of social protection approximated by public expenditures on social protection. Indeed, the p-value associated with the statistics of the significance test of the coefficient of the variable is equal to 0.15; which is above the thresholds of 1%, 5% and 10%. One of the possible reasons for the non-significance of the main explanatory variable is that the total tax revenues are not allocated in sufficient quantity to the financing of social protection. It is an indication that African and Latin American countries should allocate more of the collected tax revenue. Another possible explanation is a less efficient use of tax revenues allocated to the social protection sector. In this case, the management system of available resources should be reformed to finance social protection and prevent frauds. The result observed may be explained also by the nature of the social protection system and to which extent the state plays a role in managing and financing the social protection system as mentioned in the literature review.

Rural population, Population aged 65 and over, and under-five mortality rate variables have a significant effect on the dependent variable (public expenditures on social protection). In fact, the rural population variable has a significant negative effect at the 5% level. For a 1% increase in the share of the rural population in the total population, there are 20 percentage points decrease in

GDP per capita, tax revenues and transfers, the age structure in the province, local public health status, institutional quality of local health systems, health insurance coverage rate, urbanization, gender, education. The authors did an econometric panel analysis using data from 31 Chinese provinces and observed over the period 2002-2006and found a contribution of the general government revenues per capita of the Chinese provinces to public health expenditures per capita of these provinces.

public social protection expenditure as a percentage of GDP, all other things being equal. The more there is a large part of the population that is rural, the more social protection expenditures are going to be low. This can be explained by the fact that this population does not have enough resources to contribute to a form of social protection; it is also a population mainly working in the informal sector.

The "population aged 65 and over" variable has a significant positive effect at the 1% level. For a 1% increase in the proportion of people aged 65 and over in the total population, there are 0,61 percentage points increase in public social protection expenditures as a percentage of GDP. The larger the part of the retired population, the higher the income needed (as paid in the form of retirement pension) to support themselves. In addition, this category of the population is characterized by episodes of illness related to old age, hence a higher level of expenditures on social protection. It is therefore necessary for the governments of the different countries to find solutions to finance in a sustainable way the social protection system in the presence of an aging population. One of the solutions is the increase in the share of tax revenues allocated to the financing of social protection in the presence of a population aged 65 and over increasingly important.

The variable "under-five years old children mortality rate", has a significant negative effect at the 5% level. For a 1% increase in the share of the under-five mortality rate, there are 0,03 percentage points decrease in public social protection expenditure as a percentage of GDP.

Regarding the results above, one can question whether the same result would be obtained when the total tax revenues in resource and non-resource tax revenues are disaggregated. In other words, do we observe the same effect in the case of tax revenues collected on the exploitation of mineral resources, or in the case of tax revenues that do not take into account this activity?

In model B, where total tax revenues are replaced by resource tax revenues, the regression of the dependent variable on this new explanatory variable shows a non-significance of the latter, although it has a positive effect. One of the possible explanations for this result is the one provided for the result of the above model, namely an insufficient allocation of tax revenue to the financing of social protection. The result can also be interpreted as originating from the type of tax revenues considered. Indeed, they are volatile because they depend heavily on the price of natural resources, which changes with supply and demand. As a result of this volatility, these tax revenues cannot sustainably finance social protection programs on their own. Hence in this regression, we note a non-significant effect.

Control variables "rural population", "population aged 65 and over", and "under-five mortality rate" are the only variables that have a significant effect on public social protection expenditure.

In model C, where public expenditure on social protection is explained through non-resource tax revenues, there is a positive and significant effect of the main explanatory variable. For a 1% increase in non-resource tax revenue as a percentage of GDP, there are 0,09 percentage points increase in public social protection expenditure as a percentage of GDP, all other things being equal. It can be concluded that it is this type of tax revenues that should be favored the most as part of the financial sustainability of social protection programs.

As in previous regression models, "rural population", "population aged 65 and over", and "under-five child mortality rates" variables have a significant effect on public spending on social protection.

Discussion of the results

The results of the model above have similarities and some differences with those of the studies highlighted in the literature review. They bring a novelty in the sense that they come from an econometric analysis on a continuous period of 10 years on developing countries. Moreover, they show that non-resource tax revenues have a significant effect on the financing of social protection.

In Model A, there is a positive effect of tax revenues on the financing of social protection as in the UNU WIDER study, however, it is insignificant unlike the result found by Murshed et al. (2017). This could be explained by a different measure adopted by these authors as they include social contributions, donations and other types of resources in addition to taxes.

Model C found a positive and significant effect of non-resource tax revenues. This corroborates results from Anton et al. (2016), Handley (2009) and Muñoz et al. (2003), highlighting the role of VAT in the financing of social protection.

In Models A and B, the "rural population" variable has a positive and significant effect on the financing of social protection. This result is similar to the one found in the study by J. Pan and GG (2012) concerning the determinants of public health expenditures in the Chinese provinces since the authors observed a negative and significant effect of the urban population on the explained variable.

Finally, as in the J. Pan et al. (2012), the "population aged 65 and over" variable has a positive effect on the financing of social protection in the three models. The variable has a more significant effect in this study than in J. Pan et al. (2012).

Problem of a possible reverse causality

In this article, the direction of causality studied is the effect of tax revenues on public social protection spending used as a proxy for the financing of social protection. However, the direction of causality can be reversed because public spending on social protection can also have an impact on tax revenues. Indeed, depending on the level of the total costs of social protection coverage, the funding required to cover it will vary. This may result in a variation in the tax revenues earmarked for this purpose. Hence, it can generate a problem of endogeneity. To be able to solve this problem, a lagged variable t-1, t-2, t-3 of the main explanatory variable was used. This method was preferred to the instrumental variables method because of the difficulty of finding a rigorous instrument, such as to have a direct effect on tax revenues but not on public expenditure on social protection. Models A.1, A.2, A.3 respectively represent the regression of public expenditures on social protection on the lagged tax revenue variable at t-1, t-2, t-3; Models B.1, B.2, B.3 Public social protection expenditures on the lagged resource tax revenue variable at t-1, t-2, t-3 and models C.1, C.2, C.3 public expenditures on social protection on the lagged variable non-resource tax revenue at t-1, t-2, t-3.

In doing so, the new results (see Table 1 below) show a positive but not significant effect for all the different tax revenues variants delayed at t-1 and t-2 and for the variable "resource tax revenues" Delayed at t-3. The total tax revenue and non-resource tax revenue at t-3 variables have a positive and significant effect.

<u>Table 1</u>: Summary Table of all regressions carried out in the study

Data from WB-IMF-WHO-ILO-CEPAL-ICTD-UNDP-ISSA-Mansour data.NB::1%;**:5%,***:10%.*

Variables	A	B	C	A.1	A.2	A.3	B.1	B.2	B.3	C.1	C.2	C.3
TR (%GDP)	0,2											
Res TR(%GDP)		0,12										
Non Res TR(%GDP)			**0,09****									
TR t-1				0.12								
TR t-2					0.04							
TR t-3						**0.16*****						
Res TR t-1							-0.07					
Res TR t-2								0.06				
Res TR t-3									-0.09			
Non Res TR t-1										0.08		
Non Res TR t-2											0.14	
Non Res.TR t-3												**0.28****
CPI score	0,47	0.63	-0,29	0.48	0.75	0.59	0.71***	0.84***	-0.09	0.48	0.65	0.60
CPIscore*TR/Res TR/Non Res TR	-0,05	-0,05	-0.04									
Rur pop(% totale)	-0,2*	-0,18*	-0,21*	-.003	0.001	-0.04	0.05	0.01	0.03	0.01	-0.02	0.02
Pop 65+	0,6*	0,53**	0,54**	0.67*	0.63*	0.64*	0.66***	0.62*	0.31	0.71*	0.57*	0.52**
ODA	$-5e^{-10}$	$-3e^{-10}$	$-4e^{-10}$	-3^{e-10}	-2^{e-10}	$-3^{e.-10}$	$-4\ e^{-10}$	-3^{e-10}	$-4\ e^{-10}$	-3^{e-10}	-3^{e-10}	$-4\ e^{-10}$
U5MR	-0,03*	- 0,02***	-0,03**	-0.04	-0.03	-0.02	-0.05**	-0.03	-0.03	-0.04	-0.03	-0.02
Constant	9.79**	6.90*	11,64*	0.35	0.22	0.22	-0.51	-0.25	-1.17	0.35	0.14	-1.27*
F-test(model)-pvalue=0	19,53	16.44	22.75	8.35	8.73	8.17	7.36	6.71	7.24	7.76	8.01	8.96
F-test (fixed effect) "	7.54	7.66	8.59	7.98	6.18	5.95	6.90	6.10	5.96	8.09	6.90	7.73
R^2 Within	0,27	0,29	0,29	0.32	0.30	0.31	0.29	0.30	0.32	0.32	0.31	0.36
N	182	183	182	133	123	112	132	120	112	136	124	116

Thus, for a 1% increase in total tax revenue as a percentage of GDP, there are 0,16 percentage points increase in public spending on social protection as a percentage of GDP, all other things being equal. For a 1% increase in nonresource tax revenues as a percentage of GDP, there are 0,28 percentage points increase in public spending on social protection as a percentage of GDP, all things being equal. In the two models, another variable that has a significant effect is the variable "population aged 65 and over". For a 1% increase in this variable, there are 0,64 percentage points increase in public expenditure on social protection as a percentage of GDP, all other things being equal in the model and taking into account the lagged variable of the total tax receipts at t-3. For the last model, for a 1% increase in “population aged 65 years and older”, there are 0,52 percentage points increase in public spending on social protection as a percentage of GDP, all other things being equal. It can be deduced from this modeling that the non-resource tax revenue variable contributes the most to the financing of social protection, as already indicated above.

Conclusion

Social protection plays an important role in reducing poverty, which makes it necessary for developing countries in order to ensure the financial sustainability of social protection programs. The purpose of this article was to see if there is an empirical causal relationship between public social protection expenditures as a percentage of GDP (proxy for social protection financing) and tax revenues in African and Latin American countries. For this purpose, a panel econometric study on 30 countries over 10 years (2000-2010) was carried out. For the continuous studied period, the study is a valuable addition to the scarce existing literature on the financing of social protection in developing countries. It also contributes to literature through a disaggregated analysis of the effect of tax revenues on the financing of social protection.

The results show that aggregated tax revenues have a positive but not significant effect on public spending on social protection (proxy for social protection funding). By disaggregating total tax revenues into resource and non-resource tax revenues, we found that the latter has a significant positive effect. For a 1% increase in non-resource tax revenues as a percentage of GDP, there are 0,09 percentage points increase in public social protection expenditures expressed as a percentage of GDP, all other things being equal. Both results suggest that African and Latin American governments should allocate a larger share of tax revenues to social protection funding and they should also manage resources available for this purpose more efficiently. More emphasis should be placed on tax revenues that are not derived from the exploitation of natural resources, because they are less volatile and therefore a source of sustainable funding for social protection.

The results of the econometric study also show significant effects of the variables "rural population", "population aged 65 and over", and "mortality rates of children under 5 years of age". Complementary measures should therefore be implemented, such as urbanization of the population, efficient care of the population over the age of 65, and the improvement of the health status for children under 5 years of age and of the rest of the population to maximize the contribution of tax revenues to financial sustainability.

The study has some limitations. The first is the difficulty of finding available data for the entire 2000-2010 period for all the countries studied. This challenge was partially overcome by using different databases. The second limitation concerns the existence of a possible reverse causality due to the fact that public spending on social protection can in turn have an effect on tax revenues. This is why a lagged variable "total tax revenue / resource / non-resource at t-1, t-2, t-3" was introduced to avoid this problem.

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Parametric index insurance in developing countries: a reflection on the estimation of the risk

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Abstract: Index insurance is a development in the context of increasingly common global weather anomalies: increased frequency of extreme precipitation, intensification of extreme droughts or cyclonic phenomena. These factors present too much risk of bankruptcy for farmers. Faced with uncertainty, traditional weather insurance has drawbacks. First, the problem of asymmetry: only the insured can accurately know the impact of the climatic event on results. Then there is the problem of anti-selection: it is the farmers the most exposed to climate risks who want to protect themselves. Our article aims to analyse different insurance products, including parametric index insurance products, in order to offer some reflections on the determination of the insurance premium.

Keywords: Sustainable development, developing countries, agriculture, climate index insurance, Monte Carlo Simulation

Introduction

The development of index insurance is taking place in the context of increasing common global weather anomalies, such as extreme precipitations, intensification of extreme droughts or cyclonic phenomena. In the case France, it is estimated that, during a drought year there is a decrease of 18% in the yield for wheat crops during a drought year and a decrease of 23% in the return of maize crops (Sarraudy & Le Plat, 2017).

At the same time, traditional weather insurance has disadvantages, such as frequently long delays in compensation, and the fact that the insured must prove that the damage is caused by climatic conditions. The proof is the declaration and the expert assessment and requires two visits, one after the disaster and one after harvest. Hence different factors can lead to a great risk of bankruptcy for farmers.

The introduction of index insurance allows focusing on the baseline risk. The insurance is linked to an index: rain, temperature or humidity, and it involves a flat-rate and contractual amount paid out, in contrast to compensation for loss already suffered in conventional insurance. One advantage is the simplified declaration and automatic compensation, whenever a threshold is exceeded as defined in the contract.

The areas of application of index insurance are numerous and include, for instance:

- The industrial sector: construction companies protect themselves against operating loss due to adverse weather conditions;
- The transportation sector: delay or cancellation of flights, closure of highways;
- Other sectors such as the retail sector, tourism, ski resorts.

With index insurance, compensation is based solely on the change in an index without reference to damage.

In our article, we first present the concept of the cover. Next we explain the methodology of weather insurance products and risk measurement, by the use of the damage and the payment function. For this we use the work carried out by Riteng and Nguyen (Ritleng & Nguyen, 2014) on insurance against the risk of torrential rain. Lastly, we set out the simulation for the annual premium index against torrential rains. We hence compare the choices of different distributions and their consequences.

Literature review

In this section, we present the challenge of climate risk management for developing countries. Firstly, we describe the concept of the cover. Secondly, we address the issue of climate derivatives through the thesis of Olivier Roustant (Roustant, 2003). Then, we describe the classic methods of agricultural insurance and index insurance. Finally, we give some examples of the application of index insurance in the world.

Context

In developed countries, the agricultural sector benefits massively from risk transfer strategies. In developing countries, less than 10% of farmers benefit from coverage of risks and index-linked insurance arouses great expectations for ease of compensation. The World Bank launched in 2011 the program "Global Index Insurance Facility" to promote index insurance; many ongoing projects are supported by the International Finance Corporation (IFC), a World Bank Group entity. IFC then entrusted PlaNet Guarantee with the implementation of a regional strategy entitled Sahel Harvest Insurance (ARS), to develop agricultural index insurance in five countries in West Africa: Senegal, Mali, Burkina Faso, Benin and Cote d'Ivoire.

The food safety issue is important in the current context: take the example of sub-Saharan Africa, after decades of decline in per capita food production, agricultural and economic growth exceeded population growth in many countries. The Organization for Economic Cooperation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO) expect a "strong growth in agricultural production" in sub-Saharan Africa from now until 2027, with a 30% increase in overall agricultural production and a 25% increase in meat production. According to the report OECD-FAO Agricultural Outlook 2018-2027, this growth will be accompanied by "expanding acreage to corn, soybeans and sugar cane", but is insufficient to ensure food security. The same report indicates that sub-Saharan Africa will see a "general increase in productivity" with the use "of fertilizers, pesticides, improved seeds and mechanization and irrigation technologies." All the same, this growth will not guarantee food security in the region because of "increasing consumption needs" due to population growth. Figure 1 shows the population history of sub-Saharan Africa and projections to 2095. It is estimated that the population of sub-Saharan Africa will reach 2.1 billion people in 2050, compared to 770 million in 2005 (World Bank 2019). Despite rapid migration of populations from the rural zones to cities, it is equally probable that the total number of the rural population will continue to increase (AGRA 2017).

Figure 1: Population projection for sub-Saharan Africa: 1950-2095. Data from www.worldpopulationreview.com

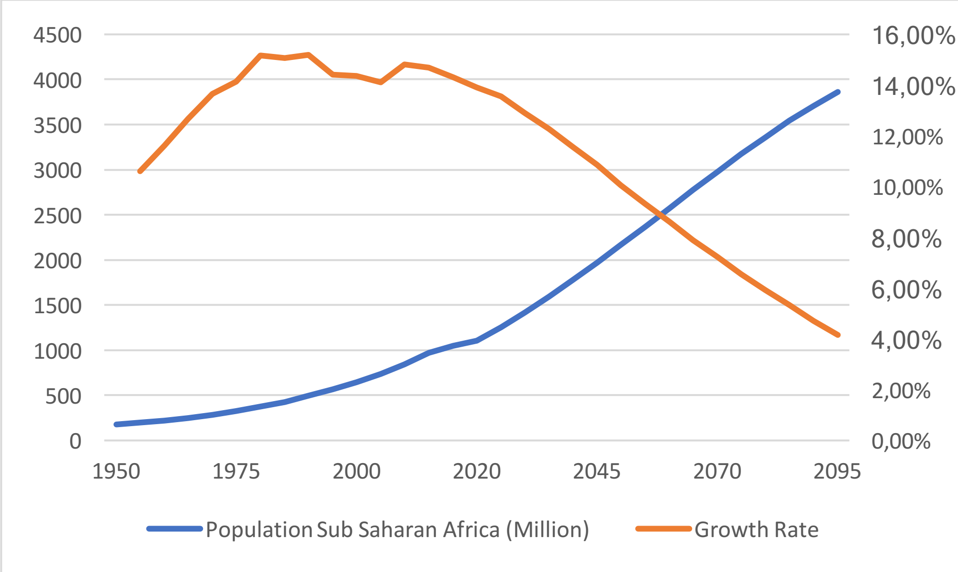

Figure 1-legend: years on the X-axis, million people on the first Y-axis, Population Growth Rate on the second Y-axis

The trap of the food crisis that threatens sub-Saharan Africa is mainly due to lack of investment in agriculture. Less than a quarter of the total potential area of sub-Saharan Africa's pluvial arable land is used. According to FAO estimates, an additional area of more than 700 million hectares could also be arable. The yields associated with high yielding varieties earnings were much lower in sub-Saharan Africa than in other regions, notably due to low inputs, markets and products.

This resulted in a low use of improved seeds, irrigation, fertilizers, and pesticides (Kidinda et al., 2015). In 2000, fertilizer use was only 13kg per hectare in sub-Saharan Africa, compared to 73kg in the Middle East and North Africa and 190kg in the East Asia and the Pacific regions. Cereal yields have grown at very low rates and are still around 1.2 tons per hectare in the region, compared to an average of about 3 tons per hectare in all developing countries (FAO, 2009).

Spending on agricultural research and development in African countries for the period of 1981 to 2000 increased by only 0.6% per year on average and even decreased in the 1990s. Considerable investments in infrastructure and technology will be necessary, as well as appropriate protective measures to prevent possible negative impacts on the environment (AGRA, 2017).

Methods of coverage and weather insurance

The introduction of index insurance allows a focus on the baseline risk. The insurance is linked to an index such as rain, temperature or humidity; it is a flat-rate contractual amount in contrast to the loss actually suffered in conventional insurance. It has the advantage of a simplified declaration and automatic compensation, whenever the threshold is exceeded as defined in the contract.

Traditionally, researchers classify three categories of agricultural risk management strategies (Cordier, 2006), (Roguet & Rieu, 2006):

- Risk avoidance, consisting in the reduction of production and investment de facto limiting the extent of probable losses.
- Risk prevention, consisting in the magnitude of reduction techniques of a disaster.
- Risk treatment.

Risk treatment strategy is the most prevalent. It comprises actions downstream of the damage to limit the impacts. This strategy is classified into three categories:

- Assume the risk, implying that the farmer assumes all the risk by providing savings to cushion losses;
- The safety net, assuming intervention by the government or the community;
- The transfer of risk, involving, against payment of a premium, its sale to a third party that can be the agricultural sector, the market (futures, derivatives) or an insurer.

In developed countries, the agricultural sector benefits greatly from risk transfer strategies. In developing countries, where less than 10% of farmers benefit from coverage of risks, index-linked insurance arouses great expectations for ease of compensation (Diop, 2016).

Conventional insurance, called traditional, forms the bulk of the insurance offer in the agricultural world. The principle of compensation is based on the estimate of damages suffered by the insured. With index insurance, compensation is based solely on the change in an index without reference to damage. For example, an insurance contract may specify a level of rain of less than 150 millimeters in a region, within a limited time horizon. Agricultural index-based insurance can be classified into three categories (Diop, 2016):

- (A) Climate index insurance: the compensation process in this case is based on the change in an index linked to meteorological factors believed to be correlated to the development cycles of agricultural crops;
- (B) Satellite index insurance, where unlike in the case of the climate index insurance, indices are based on factors observable by satellite imagery, such as evapotranspiration or the vegetation index normalized difference (NDVI);
- (C) Index insurance, which is based on an average yield by area and involves determining an average yield per area to be used as benchmark.

An index insurance product is not a conventional insurance product. In a simplified way, we can consider weather insurance products in two categories: insurance products for catastrophic climate risks (Ritleng & Nguyen, 2014) and financial products for non-catastrophic weather risk (Roustant, 2003). Regarding agricultural products, one of the common points between these two types of insurance products is the asymmetry problem: only the insured can accurately know the impact of the climate event on results.

In general, regardless of the type of product, studies on insurance products follow 3 steps:

1) Choice of index (temperature, rain, wind and others);
2) Definition of the distribution of probability of the index;
3) Pricing of the insurance product.

There are over a hundred programs related to index insurance in over 40 countries (Diop, 2016; Sarraudy & Le Plat, 2017). Faced with the impossibility of quantifying the losses following bad weather conditions, the solution is to calculate payments based on the extent of climate risks and not by the amount of financial losses due to climate (Roustant 2003, p.6). This is a parametric coverage instead of indemnity coverage. Specifically, these financial products constructed from climate indices, come in the form of futures and options. Climate risks are not dependent on the financial market, therefore weather derivatives are relatively uncorrelated to the financial market (Dury & Xiao, 2018). This is why speculators and investors are interested in these products.

Methodology

To cope with climatic hazards, non-profit insurance products have been proposed. In 2007, 16 Caribbean countries, in association with the World Bank, created for the first time in the world a multi-country insurance pool: Caribbean Catastrophe Risk Insurance Facility (CCRIF), the first system of insurance employing the parametric coverage mechanism. In contrast to conventional insurance, compensation is not paid back based on actual damage but according to the measure of a parametric index defined in the contract. In their work in 2014, Nguyen and Riteng studied a parametric insurance product against the risk of torrential rain in Jamaica. The product, named XSR[*], is offered by Swiss Re[1] at the request of CCRIF. This is an extreme rain coverage product. When extreme rains are detected based on an index aggregating rainfall over the whole country, the compensation process is triggered.

Methodology and risk measurement

The main advantage of the parametric insurance is based on the absence of information asymmetry. The insurer and the insured have the same information as measured by the meteorological variable. It is possible that the measured variable does not fully reflect the actual damage. Baseline risk is defined as the difference between the economic cost of real damage "on the ground" and the compensation paid by insurance. However, thanks to the transparency of this type of product, the level of reinsurance and securitization of parametric products is much better than that of conventional insurance (Riteng, Nguyen, 2014, 8).

Concerning indicators, the Caribbean Catastrophe Risk Insurance Facility offers three types of products in 16 Caribbean countries:

- Coverage against hurricanes using wind speed as the index;
- Coverage against earthquakes using the Richter scale magnitude as the index; and
- Coverage (XSR) against torrential rains, using an index of aggregate rainfall over different geographical areas.

The damage function and the payment function

In general, the parametric index should reflect the real damage caused by the insured event, therefore, we must first establish the damage function that links the actual economic losses to parametric indices. The parametric index (example of coverage against Hurricane, Riteng and Nguyen, 2014, 10) is given by the formula below, as for the options we have presented above, a threshold is set beforehand:

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[1] Swiss Re (Swiss Reinsurance Company) is an insurance and reinsurance company founded in Zurich in 1863. In sales, it is the second global reinsurance company Munich Re

* The part about the rain modeling is in (Riteng and Nguyen, 2014, 34 – 65).

$$I_{event} = \sum_{i=1}^{n} \quad \times max\ (v_i - v_{threshold,0})^{\beta} \qquad (1)$$

where n is the number of measuring stations,

w_i is the weight of the region (i)

α and β are scale parameters.

Once the damage function has been established, the amount of compensation is determined by the payment function. This feature connects the parametric index with the payment. If the index is below a lower limit called the Attachment Point, the insured receives no compensation. If the index is greater than an upper limit called the Exhaustion point the insured receives the maximum amount of coverage, called the Coverage Limit. The configuration of the payment function is similar to coverage by option: take the example of electricity where the daily indices, known as degree-days (DD), are used to measure climate risk. They measure the temperature difference at a threshold level corresponding to the ambient temperature. Indeed, given temperature, the consumption is minimal:

$$DD = (18 - T_t)^+ = max\ (18 - T_t; 0)$$

where T_t is the temperature at date t, measured in Celsius degrees. The measurement of the temperature risk over a season is computed as follows:

$$DD_{saison} = \sum_{saison} \quad (18 - \ T_t)^+$$

Since the damage is not easily observable, the solution is to use a function that links the measurement of risk to the consequences: the damage function.

Monte Carlo Simulation

Because of applications in agriculture, hydrology and ecology, rainfall was studied further. Statistically, rainfall is more difficult to model than temperature, because it assumes knowledge of distribution of two random variables: the occurrence time of rain and the amount, of rainfall. There is also the problem of spatial discontinuity. In practical terms, various index insurance products are offered by private or public bodies with the help of insurance institutions such as Swiss Re or Allianz Re. However, the attachment of the insurance premium remains an issue of great significance. We chose Jamaica as an example. In this case, the premium is determined by the parameters of the contract defined by the country, which corresponds to the coverage amount limit - Coverage Limit, Attachment and Exhaustion. For each torrential rainfall event, a parametric index is calculated, and the amount of compensation paid to Jamaica is deducted thanks to the payment function below.

Coverage Amount: methodology Riteng and Nguyen (2014)

In the example of the Hurricane CCRIF product, quantiles were chosen such that

P (Index <Attachment) = 96.7% and P (Index <Exhaustion) = 99.3%.

This corresponds to levels of respective returns of 30 events and 150 events. We can notice that the total limit of cover was 57 million in 2012 for the Hurricane contract.

We now consider the pure premium which is the amount of annual insurance premium borne by the insurer; it is the sum of reimbursement after each claim during a year. Riteng and Nguyen (2014, 67) gave the formula of pure premium. Let N be the number of annual events for which the CCRIF must compensate Jamaica. The annual pure premium is written:

$$premium = E\left(\sum_{n=1}^{N} \quad payment_n\right) \qquad (2)$$

$premium = E(N) * E\big(g(X > 250)\big)$ (3)where X is the aggregate rainfall over 5 days.

$E(N)$ can be estimated by identifying historical events over the last 15 years. The premium calculation can be summed up by the calculation $E\ [g\ (X|X\ >\ 250)]$. The law of the random variable $g\ (X|X\ >\ 250)$ being not explicitly known, Riteng and Nguyen (2014) used Monte Carlo simulations to calculate its expectation $E\ [g\ (X|X\ >\ 250)]$. Local premium depends essentially on the conditional random variable $(X|X > 250)$ where X is the aggregated rainfall over the cell in question. In each cell, the law of $(X|X > 250)$ is estimated by the passing the threshold model $(X|X > 250)$. Riteng and Nguyen (2014) have simulated 10,000 times the variable following a Pareto distribution: shape parameter $k = \xi_0$ and scale parameter $\sigma_0\ +\ \xi_0 \times (250 - u_0)$. This provides an estimate of $E[g(X\ >\ 250)]$ per cell. To initialize the calculations, Riteng and Nguyen (2014) have used initially a coverage limit of one million dollars per region. Convergence is stabilizing from 10,000 simulations and the results of simulations is \$1,290,180.

Monte Carlo method

In a Monte Carlo simulation, every amount that has to be estimated has to be written into the form of a mathematical expectation $M = E(Y)$ where Y is a random variable. We approach the random variable by means of a sequence of independent identically distributed random variables $(Z_1, Z_2, \dots, Z_n)$, mutually independent and identically distributed, designated by the acronym i.i.d., and integrable, with finite expectation $E(|Z_i|) < +\infty$, that we can simulate. The random variable Y is approximated by Y_n defined by:

$$Y_n = \frac{1}{n}\sum_{i=1}^{n} \quad Z_i$$

when $n \to +\infty$ and by applying the law of large numbers. For this, we use the Khinchin theorem which proves the convergence "in probability" of the empirical mean $Y_n = \underline{Z_n}$, for all $\varepsilon > 0$:

$$lim_{n\to+\infty}\ P\left(\left\{\left|\underline{Z_n}\ - E(Y)\right| > \varepsilon\right\}\right) = 0$$

This unbiased estimator of the expected value, the empirical mean, converges in probability toward $E(Y)$ This approach provides, by the Monte Carlo method, simulations of M.

Annual premium index simulation against torrential rains

Using the payment function of insurance (Ritleng & Nguyen, 2014), we can set the lower limit and the upper limit of an annual premium. In order to give an idea of the annual premium, we have a year of 365 days; For each day, if the possibility of aggregate rainfall more than 250 mm is greater than 96.7%, the level of exhaustion is 1,000,000 €. Figure 2 below gives the shape of the convergence of annual premiums, and the value at convergence which is around 7,257,033.24€ for 1,000 simulations.

Board 1: Input parameters to initialize the simulation of the annual premium

Attachment	0.967
Exhaustion	0.993
Maxprime	1,000,000 €

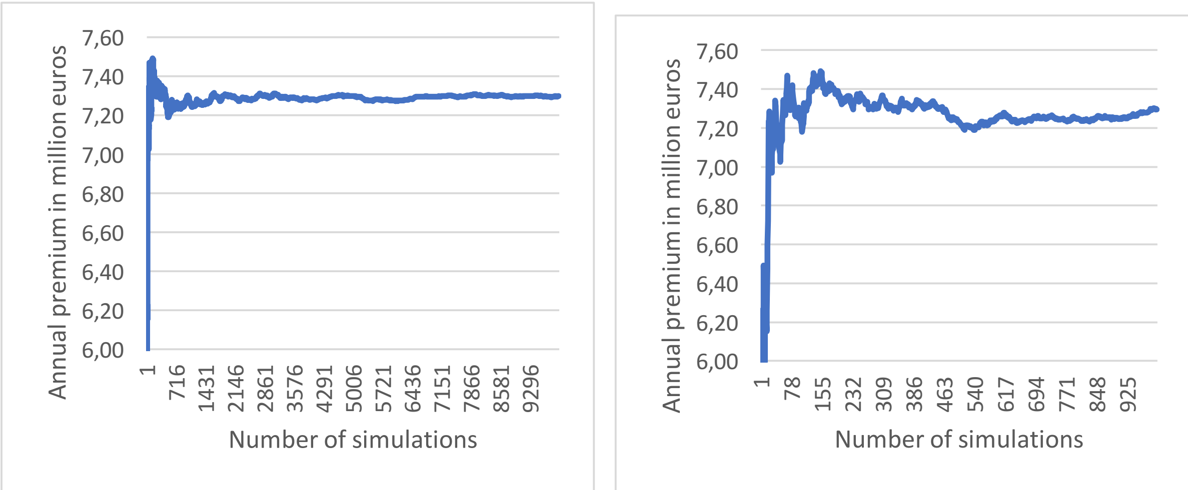

Figure 2-Legend: number of simulations on X-axis and annual premium in million euros on the Y-axis

We recognize that convergence is stabilizing from 500 simulations, as shown in the previous figure. When we increase to 10,000 the number of simulations, the result stabilizes at €7,287,432.7. When performing a simulation by varying the threshold (Exhaustion), we see, in Figure 3, the convergence from 500 simulation steps, however, when one pushes the threshold, the cost of the annual premium gradually decreases. In Figure 3, the trigger thresholds correspond to "exhaustion" the input parameter given in Board 1 above to initialize the simulation of the annual premium.

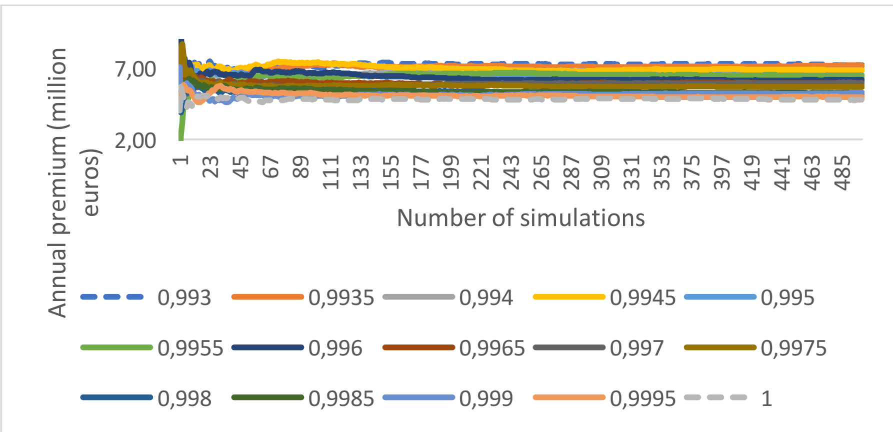

Figure 3-legend: number of simulations on X-axis and annual premium in euros on the Y-axis

Figure 4 hereafter shows the simulation of annual premiums by varying the threshold settings of exhaustion and reimbursement ceilings, between € 1 million to € 2 million. It is noted that the annual bonus reaches the maximum when the reimbursement ceiling is set at € 2,000,000 and the threshold is 99.3%, the annual cost would be € 14,404,235, against € 6,733,519 for a reimbursement ceiling of € 1 million.

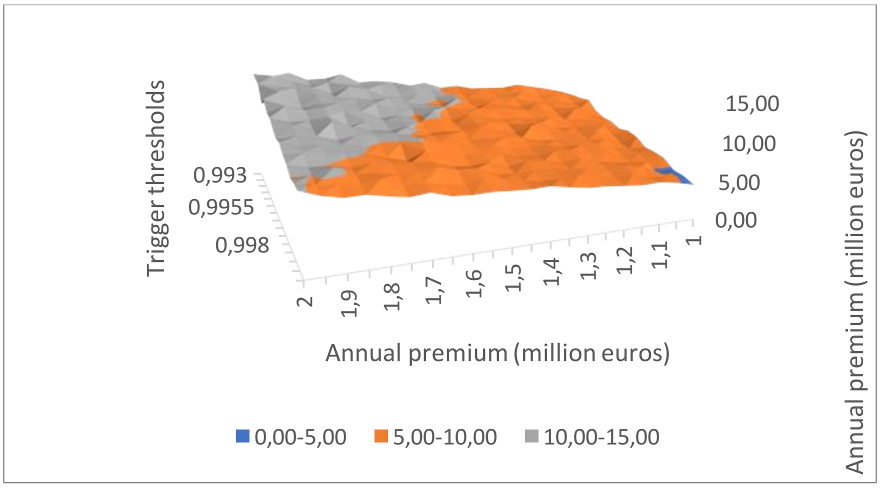

Figure 4 -legend: trigger thresholds on X-axis, annual premium in million euros on the Y-axis, maxprime (in million euros) on the Z-axis

The Figure 5 below shows the simulation based on the distribution by the Normal distribution versus the distribution by the Uniform Law.

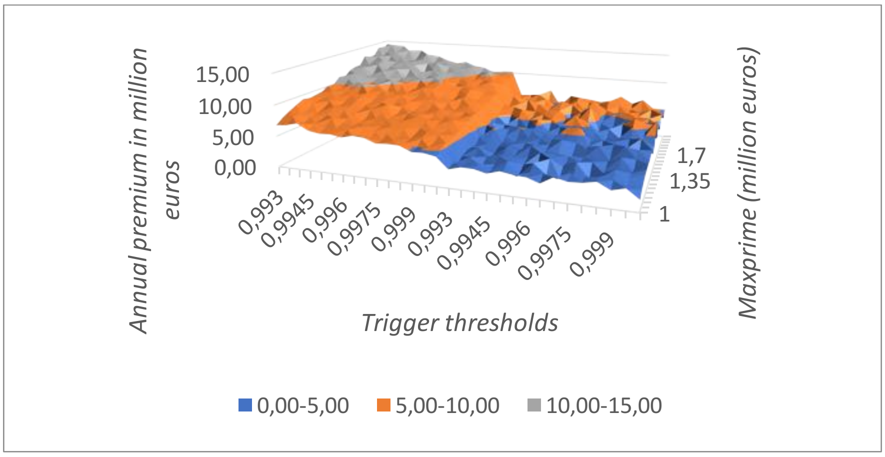

Figure 5 -legend: trigger thresholds on X-axis with Uniform Distribution/versus Normal Distribution, annual premium in million euros on the Y-axis, maxprime (in million euros) on the Z-axis and represented with the colour code

We find that the level of annual premiums decreases rapidly over the simulation performed beforehand, since rare events, at trigger point, are less frequent with the normal distribution; this indicates a decrease in the total cost of the insurance premium. The average cost of the annual premium, according to the distribution of the normal distribution, varies between € 3,999,247 and € 4,510,316. However, we note that the estimates under the normal distribution are less homogeneous than those of the Uniform law, because unlike the Uniform law, the standard normal distribution function does not increase in a linear function. Consequently, the definition of insurance premium depends greatly on the distribution law of events like rainstorms, droughts or hurricane.

Conclusion

Our article aims to analyse different insurance products, including parametric index insurance products in order to offer some reflections on the determination of the insurance premium. Climate change is a major issue which impacts society and economies. For the insurance industry, climate change poses a great risk to classic insurance, especially for agricultural insurance. In fact, increasing natural disasters lead to an increase in insurance payments. In this context, traditional weather insurance has disadvantages. Parametric index insurance offers an alternative to classic agricultural insurance management. Simulations have been used to set the annual cost of an index insurance contract, based on the objective of the insurer. The insurance contract can be offered to individuals or organizations that manage climate risk management - NGOs, government institutions and others. The choice of maximum repayment criteria is defined in terms of the socio-economic situation of the region. The difficulty lies in estimating the modeling of torrential rain, since the estimation of rare events, represented with a Pareto distribution, greatly influences the total annual cost of the insurance premium. Lastly, we have compared the estimates under the Gaussian and the Uniform distribution: the first ones with a normal distribution are less homogeneous than those of the Uniform distribution, as the standard normal distribution function does not increase in a linear function. In this context, further research on the choice of the most fitting distribution can be made in the near future.

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Sustainable socio-economic development design test for developing countries

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__Abstract__: In this research, we use econometric modeling of panel data in order to design a simplified socio-economic development model based on the durability of explanatory factors of territorial attractiveness and socio-economic development. After the empirical verification of the relations of cause and effect, "the impact of the Human Development Index (HDI) and political stability and the absence of violence and terrorism on the attractiveness and competitiveness of tourism in a territory", and "the impact of financial inclusion on the unemployment rate as an essential component of socio-economic development" are clearly apparent. In the light of our estimated variable effects model, the index of political stability and human development (including health, education and standard of living) have a positive effect on the number of tourist arrivals in the Mediterranean. Based on the results of the fixed effects model estimation, the two financial inclusion variables selected, namely, domestic credit to the private sector and the number of commercial bank branches (per 100,000 adults) have a negative effect on the unemployment rate in the different geographical areas of the world.

__Keywords__: Financial inclusion, territorial attractiveness, human development, political stability, absence of violence/terrorism, socio-economic development, econometric modeling of panel data.

Introduction

The current debate on "the economic development model of the countries of North Africa" aims to incite the political leaders and the intellectual elites to rethink the current models, which do not benefit the young people. In this study, we try to develop a simplified socio-economic development model after an econometric verification of the causal relationships on two main aspects. On the one hand, we look at the relationship between the financial inclusion of young people and the improvement of the level of human development and political stability and absence of violence / terrorism; and, on the other hand, between the latter and the attractiveness, tourism, as well as in terms of the territorial foreign direct investment (FDI). Foreign direct investment is a source of foreign exchange and jobs, and thus has a positive impact on the level of human development and political stability. The values of the average unemployment rate are calculated in this study over the period of 2005-2015 for seven geographical areas of the world: North America, East Asia and the Pacific, Europe and Central Asia, Middle East and North Africa (MENA), Sub-Saharan Africa, Latin America and the Caribbean, South Asia (Appendix-Table A1). The area of "Middle East and North Africa", followed by those of "Europe and Central Asia" and "Sub-Saharan Africa", have the highest unemployment rates, namely : 10.86%, 8.56% and 7.63% respectively (See Appendix-Table A1). The double-digit unemployment rate recorded in the MENA region represents the crucial cause of the revolutions and political instability in certain countries in this region, such as: Tunisia, Egypt, Libya, Syria and Yemen. It supports findings in the literature suggesting that a better financial inclusion policy dedicated to young graduates can lower the unemployment rate, reduce poverty (Neaime and Gaysset, 2018) and guarantee political stability, which is a prerequisite for tourist attractiveness in terms of territorial FDI.

We use econometric modeling of panel data, a very important tool that has the advantage of combining temporal data and data in instantaneous section while simultaneously studying several individuals (companies, countries, consumers, etc.). This is done in order to try to design a simplified socio-economic development model after empirical verification of the following cause and effect relationships:

- "the impact of the HDI (human development index) and political stability and the absence of violence and terrorism on the tourist attractiveness and competitiveness of a territory";

-and "the impact of financial inclusion on the unemployment rate as an essential component of socio-economic development".

The objective of this research on tourist attractiveness then consists in examining two explanatory factors of tourist attractiveness: human development, and political stability combined with the absence of violence and terrorism in a country (Ritchie & Crouch, 2003; Dwyer & Kim, 2003; Cohen et al., 2014; World Economic Forum, 2017; Montargot and Ouchen, 2018). The study uses the sample of seven countries in the Mediterranean basin, ranked among the 50 best tourist destinations in the world (World Tourism Organization (unwto.org)): France, Spain, Italy, Egypt, Morocco, Croatia and Tunisia. The panel structure used in this research makes it possible to explain, over the period between 2005 to 2015, the number of tourist arrivals by the selected factors. We also judge the predictive quality of our model through a comparison between its forecasts, i.e. the estimated numbers of tourist arrivals for the seven countries in our sample and the numbers of tourist arrivals actually observed in 2016. Moreover, the objective of this research is also aimed at empirically verifying the positive impact of certain variables of financial inclusion on economic and social development. The seven world geographical areas chosen in this study explain our dependent variable "unemployment rate" by a single equation in a global model through variables of financial inclusion, namely: "domestic credit to the private sector" and "number of commercial bank branches (per 100,000 adults)". We judge the predictive quality of our model through a comparison between its forecasts, i.e. the estimated unemployment rates for the seven areas of our sample and the unemployment rate actually observed in 2016. A literature review on the concepts of tourism attractiveness and competitiveness, and financial inclusion (section 1) as well as the methodology used (section 2) will be presented in section 1 and section 2, respectively. The results obtained and concluding remarks will be presented in section 3.

Conceptual framework

The HDI and "political stability and the absence of violence / terrorism" as explanatory factors for the tourist attractiveness and competitiveness of a territory

The economic activity generated by tourism offers real potential for diversification and a considerable source of foreign exchange, income and jobs (Wang and Hsu, 2010). Attracting tourists is therefore a major issue, which appears to be dependent on several factors that researchers have tried to identify through models. The work of Sequeira and Nunes (2008), Eilat and Einav (2004), Rittichainuwat and Chakraborty (2009) and Fuchs and Reichel (2011) highlight the negative and significant impact of violence, terrorism, unstable tourism policies and disease. The meta-analysis of the literature by Cohen et al. (2014) concludes that the perceptions of tourists often focus on risk and security, terrorism and illness and the search for sensations. Similarly, according to models of tourist attractiveness and competitiveness (Ritchie and Zins, 1978; Kim, 1998; Gallarza et al., 2002; Enright and Newton, 2004, Cracolici and Nijkamp, 2008, Jin et al. , 2012 and the World Economic Forum's (2017) travel and tourism competitiveness index, it can be inferred that the reception infrastructure, social and cultural characteristics, attitude of the local population towards tourists, safety and security, health and hygiene, education, training and the availability of qualified workers are explanatory dimensions for the attractiveness and competitiveness of tourism for a destination. The dimensions advanced above are present in the explanatory variables used, namely: the HDI and the index of political stability and absence of terrorism / violence, to explain the number of tourist arrivals by a model of panel data from Mediterranean countries (Montargot and Ouchen, 2018).

Financial inclusion as a trigger for socio-economic development: the case of the impact of financial inclusion on the unemployment rate as an essential component of socio-economic development

According to the definition of the World Bank, financial inclusion is the possibility for individuals and businesses to access at low cost a whole range of financial products and services useful and adapted to their needs (transactions, payments, savings, credit and insurance) offered by reliable and responsible providers (World Bank, 2014). Development theory takes stock of the impact of financial inclusion on economic development. The available models illustrate how financial exclusion and, in particular, lack of access to finance can lead to poverty, income inequality and lower growth (Banerjee and Newman, 1993; Galor and Zeira, 1993). To promote savings and capital accumulation and ensures optimal allocation of capital, financial development can help accelerate growth and reduce poverty (Beck and al., 2011). The results of empirical studies on the impact of financial inclusion on economic development and poverty vary depending on the type of financial service in question. Access to savings and payment services has a positive and significant impact on variables in the real economy, such as: savings, productive investment, consumption, investment in preventive health, productivity, and income (Ashraf, Karlan and Yin, 2006; Robinson and Dupas, 2013). Access to insurance has a positive impact on investment and economic growth (Ward and Zurbruegg, 2000; Cai et al., 2010; Shapiro, 2012). Access to credit encourages entrepreneurship and the growth of businesses, especially small and young businesses, and reduces poverty and unemployment (Banerjee and Duflo, 2007; Beck et al., 2007; Burgess and Pande, 2005; World Bank Report, 2014). However, the effects of microcredit on investment are relatively small and poor households use microfinance to consume rather than to invest (Karlan and Zinman, 2010; Giné et al., 2010).

Methodological framework

In econometrics, panel data have advantages compared to other econometric methods intended for the analysis of time series adopted to highlight the substantial impact of financial inclusion on socio-economic development or to explain tourist flows, such as the Autoregressive Distributed Lag Model (ADLM) (Song et al., 2003), the Vectoriel Autoregressive (VAR) model or even the Error Correction Model (ECM) (Kulendran and Wilson , 2000; Kulendran and Witt, 2003; Lim and Mc Aleer, 2000; Ward and Zurbruegg, 2000). The panel data indeed makes it possible to combine the data in instantaneous section and the temporal data. The econometrics of panel data reduces the frequent problems in collinearity time series between explanatory variables, thanks to the possibility of introducing inter-individual differences. A balanced panel, which has the same number of observations for all individuals, or a non-balanced panel, when certain observations are missing, can be used (Bourbonnais, 2015). For N (i = 1…N) individuals and T regular time intervals (t = 1…T), the panel data model is written as follows:

$$y_{it} = a_i + b_i x_{it} + \varepsilon_{it}$$

Where:

y_{it} is the explained variable observed for individual i at period t;

x_{it} is the vector of the k explanatory variables $x'_{it} = (x_{1it}, x_{2it}, \dots, x_{kit})$;

a_i is the constant for the individual i;

b_i is the vector of the k coefficients of the k explanatory variables $b'_i = (b_{1i}, b_{2i}, \dots, b_{ki})$;

and ε_{it} is the error term.

There are generally three possible cases of panel models:

(i) the case of "total homogeneity", where the constants and coefficients of the explanatory variables are identical for all individuals and the appropriate model corresponds to a single estimated equation on the stacked observations;

(ii) the case of "total heterogeneity", where the constants and coefficients of the explanatory variables are all different for all individuals and the appropriate model corresponds to an estimate of one equation per individual (N equations);

(iii) the case of the "individual effects model", where there is heterogeneity of the constants and homogeneity of the coefficients of the explanatory variables.

In order to carry out this test, it is advisable to adopt the sequential procedure of tests of homogeneity proposed by Hsiao (1986), which was built starting from the statistics of Fisher. When the results of the homogeneity tests show that the panel presents a structure with individual effects, this structure can be modeled either by a model with fixed effects, where the individual effect is constant over time, or by a model with effects random, where the constant is random. In order to determine if the coefficients of these two specifications, fixed and random, are statistically different, we use the Hausman specification test, which is written as follows:

H_0: the random effect model is the appropriate model.

H_1: the fixed effect model is the appropriate model.

First relationship: "Impact of the HDI and political stability and the absence of violence / terrorism on the attractiveness and competitiveness of tourism in a territory"

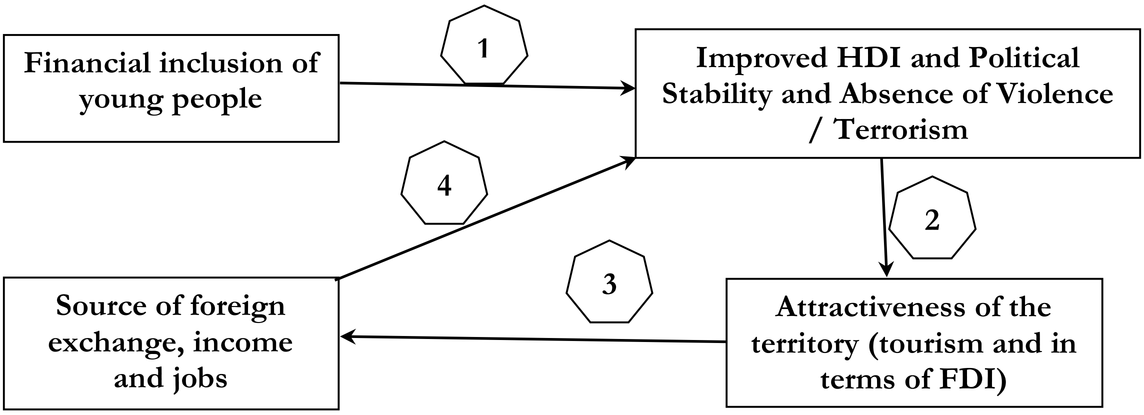
At the level of the first study, we try to explain by a balanced panel data model, for the seven Mediterranean countries, the dependent variable "the number of tourist arrivals", noted y_{it}, over the period 2005-2015, by the following two explanatory variables: the human development index for country i in year t, noted x_{1it} and the index of political stability and absence of terrorism / violence for country i in year t, noted x_{2it}. We also judge the predictive quality of our panel model estimated during the two years following the study period, i.e. in 2016, through a comparison between the values observed and those estimated by our model. the number of tourist arrivals as well as through the use of certain indicators, such as: the percentage of the Mean Absolute Error (MAE%), used by forecasters.

Second relation: "Impact of financial inclusion on the unemployment rate as an essential component of socio-economic development"

In this second study, we try to determine, by a balanced panel data model, for the seven geographic areas of our sample, the impact of certain variables of access to finance and financial services ("domestic credit to the private sector", noted x_{1it}, and the "number of commercial bank branches (per 100,000 adults) ", noted x_{2it}) on the "unemployment rate", noted y_{it}, over a study period from 2005 to 2015. We also judge the predictive quality of our model of panel estimated during the year following the study period, i.e. in 2016, through a comparison between the observed values and those estimated by our unemployment rate model as well as through the use of certain indicators used by forecasters.

Therefore, our simplified economic model designed is based on the econometric verification of the causal relationships that may exist (Figure 1), on the one hand, between the financial inclusion of young people and the improvement of the level of human development, and political stability and absence of violence / terrorism (relation n ° 1); and, on the other hand, between the latter and the attractiveness, tourism and in terms of the territorial FDI (relation n ° 2), which is a source of foreign exchange and jobs (relation n ° 3), and which thus has a positive impact on the level of human development and political stability (relation n ° 4).

Figure 1- Simplified model for the socio-economic development of developing countries



Results

Econometric modeling of the impact of the political stability and absence of violence / terrorism index and the HDI on the tourist attractiveness

Our individual effects model uses the composition of the Travel and Tourism Competitiveness Index (TTCI) of the World Economic Forum on the competitiveness of the travel and tourism sector (2013). This index mainly takes into account the following dimensions: safety and security, health and hygiene, education, training and the availability of qualified workers. These dimensions are fully incorporated into the two explanatory variables of our model, namely: the index of political stability and freedom from violence / terrorism and the index of human development. The following table summarizes the results of the estimation of the individual random effects model used:

$$y_{it} = a + a_i + b_1 x_{1it} + b_2 x_{2it} + v_{it}$$

Table 1- Results of the estimation of the individual random effects model

Country i	a	a_i	b_1	b_2
Egypt	-61824536 [-3.817212] (0.0003)	-4740539	1.13E+08 [6.214012] (0.0000)	131100.6 [3.608648] (0.0006)
Spain		17275682		
France		34371314		
Croatia		-28063679		
Morocco		-3113740		
Tunisia		-16202800		
Italy		473762.2		

F-statistic = 21.67395 and Prob (F-statistic) = 0.0000; [.] is the value of t-statistic; and (.) is the value of the critical probability (Prob (T-Statistic)).

According to the results of the estimation of the individual effects model, validated statistically and econometrically, the two explanatory variables of our model positively influence the number of tourist arrivals. The comparison between the values estimated by this model and those observed for the number of tourist arrivals (See Appendix-Figure A1) as well as the low values of the indicators used by forecasters, such as the Mean Absolute Percentage Error (MAPE), Percentage of the Mean Absolute Error (MAE%) and Percentage of the Root Mean Square Error (RMSE%), in 2016, show the good predictive quality of the model chosen (See Appendix-Table A2). These results are very relevant for political actors, who must integrate and manage the risk effect in their tourism development policy. The reduction of a country's political risk is in fact closely dependent on government actions. According to Sequeira and Nunes (2008), decision-makers in Central and South America, the Middle East, Southern and Eastern Europe must especially deal with greater political risk in their countries. According to the results of our model, a Mediterranean country that would like to increase its tourist attractiveness is called upon to ensure its political stability and absence of violence / terrorism (political violence or terrorism) as well as to improve the three dimensions of its human development index: the dimension of health; the dimension of education; and the dimension of standard of living, through investments in collective projects relating to health, education, etc.

Econometric modeling of panel data: case of the impact of financial inclusion on the economic and social development of seven geographical areas of the world

The following table summarizes the results of the estimation of the fixed individual effects model used: $y_{it} = a + a_i + b_1\, x_{1it} + b_2 x_{2it} + \varepsilon_{it}$

Table 2: Results of the estimation of the fixed effects model

Zone i	A	a_i	b_1	b_2
North America	14.82855 [8.071191] (0.0000)	8.145018	-0.046871 [-3.182794] (0.0022)	-0.245901 [-2.577017] (0.0121)
East Asia and the Pacific		-1.323579		
Europe and Central Asia		4.507986		

Middle East and North Africa		1.371921		
Sub-Saharan Africa		-3.892682		
Latin America and the Caribbean		-2.207804		
South Asia		-6.600861		

F-statistic = 82.77562 and Prob (F-statistic) = 0.0000; R-Squared = 0.91 [.] Is the value of t-statistic and (.) Is the value of critical probability (Prob (T-Statistic)).

According to the results of the estimation of the fixed effects model, validated statistically and econometrically, the two variables of financial inclusion used, namely: domestic credit to the private sector and the number of commercial bank branches (per 100,000 adults), have a negative effect on the unemployment rate in the various geographical areas of the world. In other words, financial inclusion lowers the unemployment rate. This result coincides with the results of the work of Ashraf et al. (2006), Robinson and Dupas (2013), Banerjee and Duflo (2007), and Burgess and Pande (2005). These studies highlight the role of financial inclusion in increasing investment and economic growth and in reducing poverty and the unemployment rate. Financial inclusion is therefore an engine of economic and social development. It should be noted that we also tested the predictive quality of the model, defined over the period 2005-2015, by comparing the estimated unemployment rates and the observed (actually realized) unemployment rates, during the year following our period of study, namely 2016, dates from the latest statistics available from the World Bank. Overall, the estimated values of the unemployment rate are close to those observed in 2016 for the geographic areas considered. It is the case for both the geographic areas with unemployment rates above 7%, such as South Africa, MENA and Sub-Saharan Africa, and areas with unemployment rates below 4.5%, such as South Asia and East Asia and the Pacific (See Appendix-Figure A2). Mean Absolute Percentage Error (MAPE), Percentage of the Mean Absolute Error (MAE%) and Percentage of the Root Mean Square Error (RMSE) calculated for all of the countries in our panel are relatively low in 2016 and point towards good predictive quality of the model (See Appendix-Table A3). The two variables used ("domestic credit to the private sector" and "number of commercial bank branches (per 100,000 adults)") thus largely explain the unemployment rate.

Conclusion

In our simplified economic model, we have empirically verified up to now the causal relationships that exist, on the one hand, between the financial inclusion of young people and the improvement of the level of human development, and political stability and absence of violence / terrorism; and, on the other hand, between the latter and the territorial attractiveness, tourism and FDI, which is a source of foreign exchange and jobs, and which thus has a positive impact on the level of human development and political stability (Figure 1). The tourist attractiveness of a destination and its attractiveness of FDI, both constituting a considerable source of foreign exchange, income and employment, are then dependent on the level of human development, and political stability and absence of violence / terrorism. For lasting political stability and the absence of violence / terrorism, efforts must be made to improve the level of human development, reduce poverty, create jobs and encourage economic growth. These objectives can be achieved through a robust policy of financial inclusion of young graduates and the unemployed, which would allow young entrepreneurs to start their projects easier. The financial inclusion of young people will certainly contribute to reducing the unemployment rate and poverty, and to economic growth. It is a prerequisite for the socio-economic development of the countries of North Africa.

The results of this study highlight the robustness of the main cause and effect relationships of our socio-economic development model, through the application of econometric modeling of panel data for a set of countries and geographic areas of the world. The essential contribution of this research lies in the identification of the trigger for socio-economic development, namely: the financial inclusion of young entrepreneurs with business projects. It should be noted that, just two months after the presentation of this research at the Conference "Paradigms, Models, Scenarios and Practices for strong sustainability-4-6 December 2019-Clermont-Ferrand (France)", Morocco launched in February 2020 "The Integrated Business Support and Financing Program". This measure constitutes an application of the socio-economic development model of our research which considers the financial inclusion of young graduates as the trigger for any socio-economic development for developing countries. It thus presents an illustration of the social utility of this research. Methodologically, this research is distinguished by the test of the predictive quality of the equations retained and validated on a statistical and econometric level, through the use of certain indicators used by forecasters, such as: MAE% and RMSE, during the periods following those of the econometric study. It doesn't only estimate econometric models validated on the statistical level, but it also tested their predictive qualities through the comparison between the values actually observed of the variables of our interest (the unemployment rate and the tourist attractiveness) and their values estimated by these models, during the periods following those of the empirical study. To go further, we will be able to assess, after a certain time, the results of such programs, by measuring the magnitude of their impact on the reduction of the unemployment rate and poverty, for a panel of developing countries.

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Appendix

Table A1: Average unemployment rate (over the period 2005-2015) for the seven geographical areas of the world (according to the classification of the World Bank)

Zone	Average unemployment rate (2005-2015) (in%)
North America	6,83
East Asia and the Pacific	4,40
Europe and Central Asia	8,57
Middle East and North Africa	10,87
Sub-Saharan Africa	7,64
Latin America and the Caribbean	7,61
South Asia	4,11

Source: World Bank site. See http://databank.banquemondiale.org.

Figure A1: Observed and estimated numbers of tourist arrivals in 2016

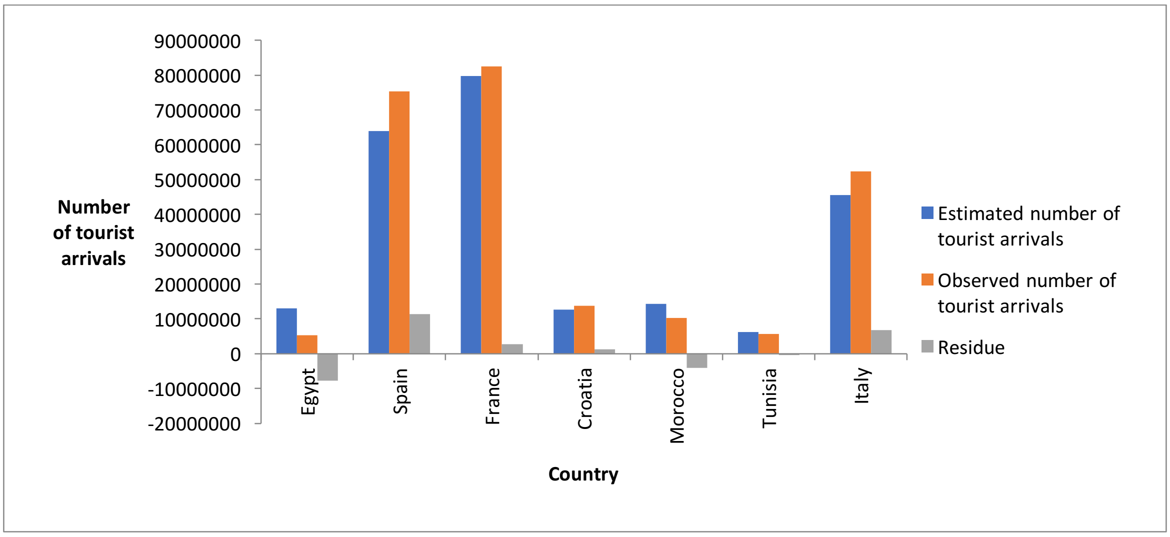

Table A2: Average percentage of absolute error MAPE, percentage of absolute error average MAE% and percentage of quadratic error average RMSE% in 2016

	2016
MAPE	0,28043
MAE%	0,12386
RMSE%	0,17461

Figure A2: Observed and estimated unemployment rates in 2016

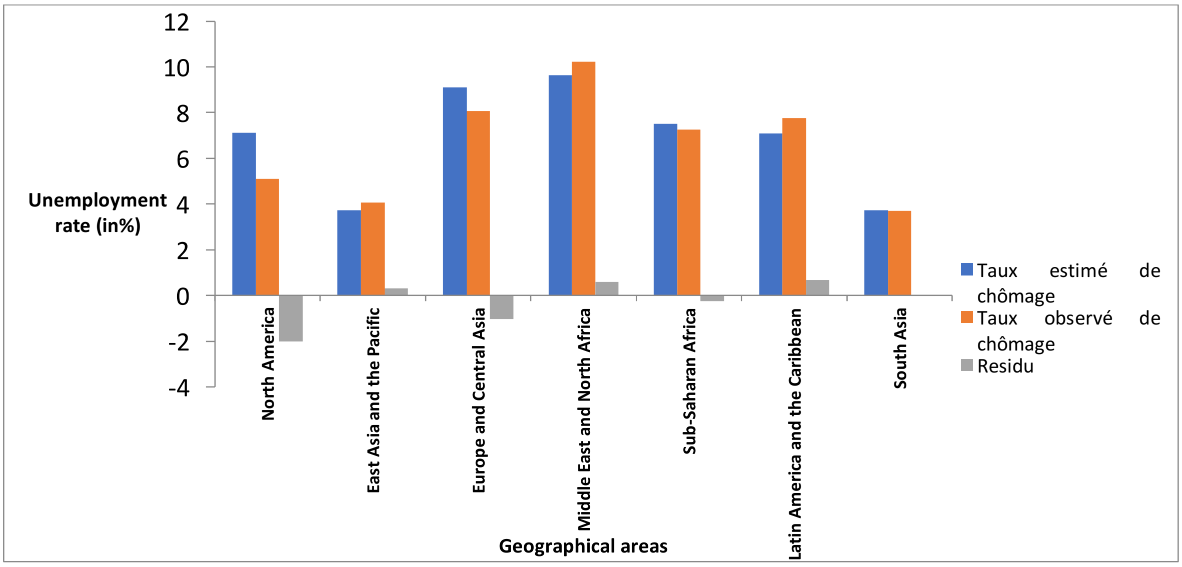

Table A3: Error in mean absolute percentage (MAPE), percentage of mean absolute error (MAE%) and percentage of mean squared error (RMSE%) in 2016 (%)

	2016
MAPE	0,00577
MAE%	0,03506
RMSE%	0,14170

Reviving Indian indigenous agricultural practices with cow (bovine) based products: An attempt towards sustainability in the chemical based environment

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Abstract: Amidst the strive for higher productivity, Indian farmers have mostly forgotten the indigenous technologies that our classical treatise behold. Studies show that cow- based products can be used for seed treatment, seed hardening, pest and disease management, and yield enhancement. Studies have shown that cow urine solution can be used for seed hardening, thus making it drought tolerant and also effective against some serious soil borne diseases like smut of ragi (Eleusine Corcana). Nevertheless, apart from helping in managing pests, cow urine also increases the yield parameters significantly when used in combination with PSB. Buttermilk, a processed cow milk product, can be used in the management of Bemesia tabacci, which is a vector of the tobacco mosaic virus (TMV). Buttermilk has an efficiency of 60% in controlling the insect pest and indirectly lessening TMV attack. It is also surprising to notice that a semisolid mixture of cow dung can be used to get rid of the cotton seed stickiness problem, which is very much prevalent in drought conditions. Policy makers in India are emphasizing on zero-budget farming as a pathway towards sustainable agriculture. This work will help policy makers to understand various benefits of cow-based indigenous products and frame policies that will not only foster zero-budget agriculture, but also pave the way towards a more sustainable development in the agricultural sector.

Keywords: Indigenous methods, Sustainable, Zero budget farming, Cow based products.

Introduction

India is primarily an agricultural country where more than 60% of the country's population depends on it for livelihood. The Green Revolution in the mid 1960s came up with the aim to feed the ever-increasing population and was followed by indiscriminate use of chemicals to get higher yield in a shorter period of time. Thus, this excessive and irrational use of chemicals has led to an increase in chemical residues in food, which has directly harmed human health. Nowadays, when humans want to seek out productivity results much faster, the farmers are also using harmful banned chemicals either to speed up the procedure or to find a shorter way to reach the goal of higher productivity. The result is that this led to a declining factor of productivity in the most fertile and productive plain of the Indian subcontinent: the Indo Gangetic Plain. This trend has forced to shift the focus from the mainstream chemical agriculture to our roots – the ancient organic agriculture, which has historically supported the Indus Valley Civilization. Thus, pondering on ancient knowledge, we cannot forget about "Astha Mutra' or eight (Astha) types of urine along with their functioning properties and composition as described in our classical treatises. Among these eight types, cow urine is one type and also the major component of Panchagavya. Nowadays, farmers and researchers are trying to retrieve the age-old practices of applying cow dung, cow urine, and their products in the form of manure and pesticides (Anonymous, 2011; Devakumar et *al*., 2014; Singh et *al*., 2014; Veeresha et *al*., 2014; Sharma et *al*., 2016; Choudhary et *al*., 2017). There are mainly small farmers in India and about 70% of the population is engaged in agriculture. Hence mechanization being difficult in small-scale holdings, using cattle as an alternative source is the only option for the farmers. Cow urine has been used comprehensively in traditional Indian agriculture for medicinal and agricultural purposes since the Vedic periods. Moreover, cow urine consists of nitrogen, sulphur, phosphate, sodium, manganese, iron, silicon, chlorine, magnesium, maleic, citric, tartaric and calcium salts, vitamins A, B, C, D, E, minerals, lactose, enzymes, creatinine, hormones and gold acids (Bhadauria, 2002). This builds up the reality that cow's urine is not a toxic effluent as 95% of its content being water, 2.5% urea and the remaining 2.5% a mixture of minerals, salts, hormones and enzymes (Arif et *al*., 2012). This shifted the focus toward the use organic sources keeping in mind not only sustainability but also food security. Furthermore, not only this will help to regain the soil health and sustain the crop production for generations to come but will also help to lessen the cost of cultivation as compared to expensive inorganic chemicals. It can also contribute to the government plans of zero budget farming.

Effect of cow urine

In Thondamuthur Village of Tamil Nadu where red soils are predominant and annual rainfall is 700mm, seed hardening of Ragi (*Eleusine coracana* Gaertn.) is practiced by farmers. Here, Ragi (Poor man's Crop) is grown under rainy conditions. To cope with the adverse climatic conditions and the soil water moisture constraints, a native technique is applied, wherein seeds of the crop are hardened using cow urine. Seed hardening, as in this case of Ragi seeds, consists of taking 100ml of fresh cow urine and mixing it with 1L of cold water (Karthikeyan et *al*., 2006). The solution to seed ratio should be 1:1 and the solution should always be kept 3-4 cm above the seed level. This allows the seed to absorb ample amounts of moisture. Before sowing, the seeds are soaked for 16hours, followed by 24 hours of shade drying. The results showed that this method is highly effective against diseases like smut (seed borne). This has also helped to increase drought resistance in plants.

Controlling pest with cow urine

In the Samamlapuram village of Coimbatore District, Tamil Nadu, red soils are also predominant, and the average annual rainfall is of 680 mm. An innovative yet ancient method is applied to control the pest by using the locally available green leaves of Neem, Pungam, Eruku and Tulsi. (Karthikeyan et *al.* 2006). Farmers first prick the young leaves from the trees and let them dry and then crush them with the help of a granite stone located in an indigenous milling tool called ural. After crushing the leaves, the farmers mix them with cow urine and ferment the resulting product for 10-15 days. The standard measure is that for each 1 kg of crushed leaves, 100 L of cow urine are used. The solution is stirred using non-metal or wooden sticks. After the fermentation process is completed in 10-15 days, the resulting solution is filtered through a cotton cloth to remove suspended material. The solution is then sprayed on the field on one and a half month old crops like brinjal (*Solanum melongena)* or okra (*Abelmoschus esculentus).*

Effect of cow urine on yield parameters for various crops

Tamaraker et *al*., (2016) reported that all post-harvest parameters of gladiolus (i.e. percentage of opened flower in the vase, the diameter of basal floret, shelf life and vase life) significantly increased when cow urine was used at 5 and 10 % concentration. Devakumar *et al.* reported that there has been a significant increase in yield when cow urine is applied with phosphate solubilizing bacteria (PSB's), as compared to Azolla and phosphate solubilizing bacteria (PSB's) mixture (Abraham and Lal, 2004; Veeresha et *al*., 2014; Qibtiyah et *al*., 2015; Tamaraker et *al*., 2016; Sharma et *al*., 2016; Choudhary et *al*., 2017). Damodar et *al*. (2010) reported that when cattle urine having concentrations of 25%,35% and 55% respectively were sprayed, the spray with 55% concentration yielded highest fruit weight, volume, number of fruits, fruit yield kg/plant and yield tons/hectare of Mango (*Mangifera indica)* (Khanal,2010). Hence, the literature thus shows that specific concentrations of cow urine can be suggested to the farmers in order to help then increase their crop yield.

Seed treatment with cow dung

Chilli seed treatment with cow dung slurry

The farmers of Viraliyur village in Coimbatore district, Tamil Nadu, use cow dung for the treatment of chilli seeds. Chilli is an important commercial crop grown in rain-fed conditions. In this village red soils are also predominant, and the average annual rainfall is of 680 mm. (Karthikeyan et al., 2006). The ratio for preparing the solution is 1:2 i.e. for every 1 kg of cow dung 2 l of fresh water is required. Notably, fresh cow dung should be used as it enhances its capability of fully mixing with water and it thus results in less wastage. For every acre of land 400mg of chilli seeds are required, which are tied in a cotton cloth or a muslin cloth and are soaked in the prepared solution for 24 hours. After soaking them, shade drying is carried out, followed by sowing. This process has increased germination in chilli seeds 5 days prior and has also made the soaking process easier. It is furthermore reported that this process is effective (80 %) in inducing the germination of seeds and control of seed borne diseases like fruit rot (Karthikeyan et *al.,* 2006). Thus, farmers from other parts of the country where chilli is grown in rain-fed conditions can adopt this technique in order to treat the seed rather than opting for chemical pesticides for seed treatment.

Cotton seed treatment with cow dung

Cottonseed treatment with cow dung is being practiced by the farmers of Periyakallipatty village. This region is characterized by red soils and receives an average annual rainfall of 680 mm. As conditions are that of dry land, farmers face the problem of stickiness of cotton seeds, which creates problems during the dibbling of the seeds. To overcome this problem, a practice of seed treatment is followed by the application of a cow dung slurry locally called *Sanipal pidithal.* (Karthikeyan et *al., 2006*). Farmers mix the cow dung with water in the ratio of 1:1/4, i.e. for every 1 kg cow dung dissolved there is 250 ml of water needed in order to produce a semisolid mixture. The semisolid mixture is then rubbed with the seeds. This treatment separates one seed from others easily during sowing. This helps in sowing along with easy establishment of seeds (Kumar, 2014). This practice was further adopted for the purpose of removing the fuzzy hairs and also to make dibbling of cotton seeds easier. Nearly 60% farmers adopt this technology as no extra cost is involved. It is both a safer and cheaper method to facilitate the sowing operation. It is moderately effective (60%) in sowing seeds.

Whitefly control with buttermilk in Bhendi (*Abelmoschus esculentus)* crops

In order to control the whitefly (*Bemesia tabacci)* in Kanoorputhur village the farmers use buttermilk. After keeping 10 L of buttermilk for fermentation for about 2 days in a closed earthen pot an aliquot of 1 L fermented solution is mixed with 9 L water and is then sprayed on 25 days old *Bhendi* crops. Whiteflies, leaf-sucking pests attacking the crop usually in the vegetative stage serves as a vector in transmitting TMV (Tobacco Mosaic Virus) (Karthikeyan et *al.,* 2006). Hence, by controlling the whitefly, transmission of viral disease is controlled, and it is also reported that 50% of *Bhendi* growers have adopted this low-cost technology. Its effectiveness is 60 % in controlling the whitefly infestation.

Conclusion

We can infer from this study that specific concentrations of cow urine can be recommended to the farmers for them to use as a catalyst for yield enhancement. Moreover, cow urine acts as a natural disinfectant, pest repellent and also forms the main component of Panchagavya, an organic crop booster prepared and sprayed by ancient Indian farmers. Being a product of ecological sanitation, urine is therefore in many ways well suited for use as fertilizer. It contains essential nutrients needed for plant growth. Furthermore, a positive effect of cow urine application has been reported in enhancing the productivity of different crops.

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Exploring mitigation interventions and SDGs links: Evidences from Indian agriculture

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Abstract: This paper explores the synergies and trade-offs between various cropland-based greenhouse gas mitigation interventions in India within the Sustainable Development Goals (SDGs) by synthesizing more than 250 abstracts and 74 full text articles and assesses those synergies and trade-offs using weighted scores with evidence and agreements levels. The mitigation interventions are clubbed into four broad categories namely, strategies that reduce emissions from paddy cultivation (PWM); integrated nitrogen use efficiency (NUE), sustainable intensification (SI) and climate smart agriculture (CSA). Most of the articles talk about social benefits (43%), followed by environmental benefits (32%) from implementing these interventions. Results show that for all the interventions synergies are higher than trade-offs clearly indicating that adopting these will have non-climate sustainable development benefits besides emission mitigation. CSA has the highest synergies with SDGs followed by SI and NUE. Though all the interventions have few trade-offs, those can be addressed through awareness programs and careful expert consultation thereby indicating the importance of capacity and institutional development (SDG 16 and 17).

Keywords: Agriculture; Mitigation; Sustainability; SDGs; India

Introduction

Greenhouse gas (GHG) emission mitigation is one of the sustainable development goals (SDG 13). Agriculture, an emerging cost-effective mitigating sector (FAO, 2017) includes both supply-side and demand-side options. For example, supply side options take into account reduction of GHG emissions per unit of output produced (Campbell et al., 2014) while demand-side actions include shifting towards less meat intensive diets (Bajzelj et al., 2014; Creutzig et al., 2018). Literature suggests pursuing these climate-mitigation options has several other non-climate impacts related to development (IPCC, 2018).

For emerging economies like India, development-related goals are prioritized and GHG emission mitigation from agriculture may not be the primary goal. But the success of GHG emission mitigation efforts in India may to a great extent lie in their ability to explore the links between climate protection and developmental priorities. The SDGs are interconnected, clearly conveying the message to policy makers that tackling them together, rather than in silos, will generate wider and more consistent impacts. Studies show scope for both positive (synergies) and negative (trade-offs) links to sustainable development goals and indicators (Roy et al., 2018; Hoegh-Guldberg et al., 2019). IPCC (2014) identifies the need for an improved understanding of the environmental and socio-economic impacts of implementing land-based mitigation options.

This paper addresses this gap in the literature by exploring and assessing the link between various supply-side, cropland-based GHG mitigation interventions in India and the SDGs. Three of the four interventions considered in this study are mentioned in Some et al. (2019): transition to less-flooded paddy water management (PWM) practices; minimizing overuse of nitrogen based fertilizer i.e. nitrogen use efficiency (NUE) and sustainable intensification (SI). The fourth intervention considered is climate smart agriculture (CSA), which is widely promoted in India (Taneja et al., 2014) as an adaptation strategy having mitigation co-benefits.

Methodology

The rapidly growing body of literature on the mitigation interventions mentioned above has been thoroughly reviewed following 'systematic review' methodology to understand the wider impacts of implementing these mitigation interventions. Assessment of the wider impacts of these interventions and SDGs has been done following the methodology of Roy et al. (2018), with some additional features discussed in section 2.2.

Systematic Review methodology

The systematic review methodology consists of five steps: building an appropriate research question; constructing search queries, using the queries to search literature in online publication databases, search engines and specialist websites; screening of the literature fetched by the online publication databases, search engines and specialist websites; recording information from the literature and finally synthesizing the information/ data recorded from the relevant literature.

i) The *research question* was first segregated into PIO (Population- Indian Agriculture, Interventions- PWM; NUE; SI; CSA and Outcome-emission mitigation) elements and then search queries were constructed.

ii) Searches were made using various combinations of the following search terms:

PWM: *"water management in paddy fields" OR "water management in rice fields" OR "water management in irrigated rice" OR "alternate wetting and drying" OR "AWD" OR "repeated soil wetting and drying" OR "multiple aeration" OR "midseason drainage" OR "single aeration" OR "irrigated rice" OR "intermittent flooding"*

NUE: *"Fertilizer use efficiency" OR "fertilizer application" OR "Nitrogen fertilizer" OR "Nitrogen input"*

SI: *"sustainable intensification" OR "Rice intensification" OR "Rice intensification practices" OR "sustainable rice intensification" OR "SRI" OR "rice intensification practices" OR "System of rice intensification"*

CSA: *"CSA" OR "Climate Smart agriculture" OR "climate-smart agriculture"*

Terms related to *Indian agriculture* were used as population and terms related to *GHG emission mitigation* have been used as the outcome.

For search queries, the Boolean operator 'AND' has been used to connect these PIO related search terms.

Searches were made in the following databases and search engines:

Online databases:

Web of Science (Core Collections) (www.webofknowledge.com)

Science Direct (www.sciencedirect.com)

Scopus (www.scopus.com)

Web-based search engines:

Google Scholar (scholar.google.com/)

Note that in Google Scholar we limit our search to the literature contained in the first 4 pages containing 10 literatures per page and for Science Direct, the first two pages containing 25 literatures per page.

iii) Article screening was done following some exclusion criteria in a three-stage hierarchical process: title, abstract and then full text.

- Title: Presence of any other country name than India, other sector names apart from agriculture.
- Abstract: Same as in title screening. Additionally, presence of studies related to quantifying Global Warming Potential (only) was excluded.
- Full text: Similar to that applied for abstract screening. Additionally, field trials or study period before 2010 were excluded.

Exercise caution at each stage **-**Any doubt about a particular study to be excluded or included has been kept for screening in the next stage

iv) The following information have been recorded based on the research objectives during full text screening

- Study area/state
- Mitigation potential of the option (if stated/measured)
- Benefits, co-benefits and cost of implementing the interventions

v) Information recorded in stage (iv) have been used for further analysis (see section 2.2 and 3.2)

SDGs link and assessment methodology

The direction (positive or negative) of the links were recorded, a weighted (impact) score (**7** points rating-scale; see Table 1) was assigned depending on the strength of the impacts. If a mitigation option was identified as having both a positive and negative impact, both were recorded. Degree of evidences and literature agreement were assigned. Number of articles was used as a parameter to measure degree of evidences. High evidence would mean more than 10 studies, medium evidence means 5 to 9 studies and low evidence means less than five studies. Literature agreement was expressed qualitatively depending upon the number of studies having similar results/views. High agreement would mean that more than 75 % of the studies analyzing the intervention have the same views/results regarding the impact of the interventions. The level of confidence was assessed depending on the degree of evidences and literature agreement and was measured using a scale of 5 stars, where 5 stars imply very high confidence and 1 star implies very low confidence).

Table 1: 7-point rating scale; Impact score

Impact Score	Name	Explanation	Example
+3	Indivisible	Inextricably linked to the achievement of another goal	Climate Smart agriculture
+2	Reinforcing	Aids the achievement of another goal	Sustainable intensification
+1	Enabling	Creates condition that further another goal	Application of agricultural biotechnology enables food security
0	Consistent	No significant positive or negative interaction	Irrigation management does not have any effect on reducing inequality
-1	Constraining	Limits options on another goal	Increasing production may constrain water access due to rising demand for irrigation
-2	Counteracting	Clashes with another goal	Increasing production to feed the growing population may counteract with forest conservation.
-3	Cancelling	Makes it impossible to reach another goal	Low commodity prices may reduce the incentive to invest in farm capital and farm labor (cancelling zero- poverty goal)

Source: Prepared using Nilsson et al. (2016)

While noting the synergies and trade-offs of implementing the mitigation interventions within the SDGs framework, the SDGs were divided into 4 impact dimensions: social-goals 1, 2, 3, 4, 5 and 10; economic-goals 7, 8, 9 and 11; environment- goals 6, 12, 13, 14and 15 and capacity & institution development- goals 16 and 17) to avoid double counting.

Results

Systematic Review descriptive statistics

The searches were performed from January to March 2019. Articles published from 2010 onwards were considered as 2010 coincides with the timing of the National Mission for Sustainable Agriculture (NMSA) in India. The search fetched a total of 654 articles. After duplicates, removal across databases and interventions (all the interventions are related to sustainable agricultural production), 602 unique articles remained. After title screening 259 studies could be included. Abstract screening left 160 articles that were considered relevant for full text screening. In all, 15 articles were not accessible and 145 articles were screened based on the full text. After full text screening, 74 articles were finally included for our study. The main reasons for exclusion at this stage were that articles reported results based on field trials conducted before 2010 or do not mention GHG emission mitigation or related words.

Figure 1: *Number of literature studies (included in this paper) published yearly, from 2010-March, 2019.*

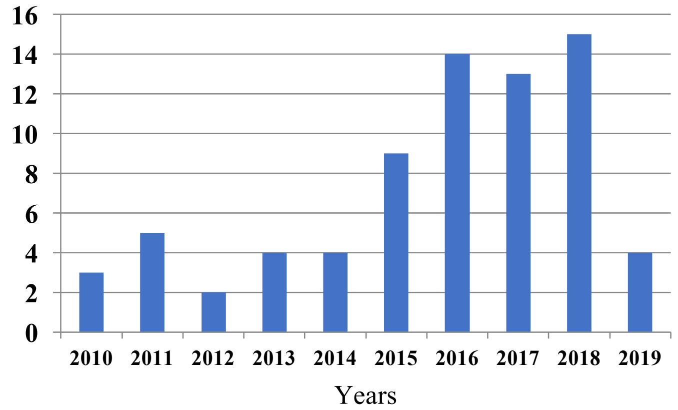
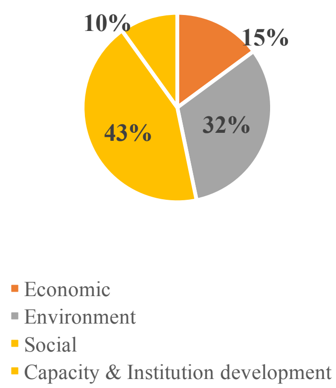


Figure 2: *Share of various impact dimensions in the literature included in this study*



More than 75% of the studies included are published between 2015 and 2019 (Figure 1). Overall, 15 studies are from North Indian states (Haryana*: n=6*, Punjab *: n=3*, New Delhi: n=*3* Uttar Pradesh*: n=2*, Uttarakand: *n=1*), 11 from South Indian states (Andhra Pradesh and Telengana : *n=2*, Tamil Nadu: : *n=9*) and 8 from the states of the East (West Bengal: *n=2*, Odisha: *n=2* and Bihar: *n=2*) and North East India (Assam: *n=1* and Tripura: *n=1*). The 6 studies that mention multiple states like Haryana-Bihar were based on CSA only. 5 studies mention Indo-Gangetic Plains as their study-area. 33 studies, mostly review papers, do not specify any geographic location. The articles included in this study are of 5 types: Field trials (n=23), literature review (n=22), primary survey (n=15), case-studies (n= 09) and model/simulation (n=5). Also, most of the studies (Figure 2) talk about social benefits (43%), followed by environmental (32%), economic (15%) and institutional (10%) associated with the intervention.

Interventions and SDGs links

The impact scores of the synergies and trade-offs between individual mitigation interventions and SDGs are provided in Annex 1. Annex 2 provides a qualitative overview of the potential synergies and tradeoffs from implementing the mitigation options. The synergies and trade-offs of individual mitigation interventions are explained below.

Transition to less-flooded paddy water management (PWM)

PWM practices like single aeration (or mid-season drainage-MSD) and multiple aeration (or alternate wetting and drying-AWD) help reduce methane emission, which arises due to flooded paddy fields during the growing season. A field trial conducted at the Tamil Nadu Rice Research Institute (TRRI), Aduthurai, Tamil Nadu from May 2017 to February 2018 shows that early AWD practice reduces methane emissions by 35.7 to 51.5% in dry season and 18.5 to 20.1% in the wet season, while full AWD practice reduces methane emissions by 52.8 to 61.4% compared with continuously flooded PWM practice (Zaw Oo et al., 2018).

Field trials conducted under the Nagarjuna Sagar Project of Krishna River Basin in the states of Andhra Pradesh and Telanganashow that AWD increases productivity by 35% during the rabi season and 74% for the kharif season (Kakumanu et al., 2018a), thereby ensuring food security {*high confidence*}. However, direct seeded rice (DSR), a practice of sowing seed directly instead of transplanting seedling, has been reported to reduce yield by 20% (Farooq, 2011) mainly due to soil sickness and plant auto-toxicity (Kaur & Singh, 2017). Field trial in Andhra Pradesh shows that AWD needs 25%-45% less irrigation water compared to normal irrigation (Kakumanu et al., 2018b) and DSR saves 6.2% of water compared to the transplanting method (Dagar et al., 2012). Therefore, these practices need less irrigation and so are more tolerant to water stress, require less energy and have better adaptive capacity to climate change {*very high confidence*} (Pathak et al., 2013).

However, in the wet season farmers face technical and practical constraints, as it is difficult to drain fields (Pathak, 2015). The capacity-building programs in the states of Telengana and Andhra Pradesh have helped in knowledge creation on water use efficiency and water conservation (Kakumanu et al., 2018a). But lack of proper financial and market-driven incentives for adoption and scaling-up of technologies are the main reasons behind non-adoption of these practices (Pathak and Aggarwal, 2012).

Nitrogen (N)-Fertilizer Use efficiency

Imbalanced use of fertilizers has led to increased nitrous oxide emission in India. Some et al. (2019) reported a 358% growth in nitrous oxide emission due to increased nitrogen fertilizer use (esp. urea) during 1980-2014. Studies suggest applying neem oil-coated urea reduces GHG emissions by 13% as compared to urea alone (Basak, 2016). Furthermore, efficient use of nitrogen fertilizer is possible by using smart technologies (e.g. optical sensors), as well as by changing the method of application (e.g. deep placement). Datta et al. (2017) conducted an experiment in Odisha and suggested that deep placement of urea briquette instead of broadcasting prilled urea may be a sustainable mitigation option in the tropical region for paddy cultivation. This method reduces nitrous oxide emissions by 26% and 14% during the dry and wet season respectively.

Optimizing N-fertilizer use improves yield (Sapkota et al., 2019) and saves energy due to reduction in application of fossil-fuel dependent synthetic fertilizer (Kritee et al., 2015) thereby increasing income. Studies reported that application of fertilizer with the help of optical sensors can increase wheat yield by 0.20–0.53 t/ha and net returns by $159/ha and can also save $110–

$438 million fertilizer cost in rice production (Basak, 2016) {*high confidence*}. CGIAR (2017) mentions that lower nitrogen-use can decrease crop yields and when yields are low, women tend to decline food consumption to ensure that young children or other family members eat more nutritious food. Moreover, to add to this problem, women tend to use less fertilizer as they have unequal access to both financial and knowledge resources. Therefore, gender equitable co-benefits at local level can be achieved through '*Gender-equitable N use efficiency strategies*' (Farnworth et al., 2017) and inclusion of women in on-farm decision-making around fertilizer purchase and application (CGIAR, 2017). A study surveyed six districts of Punjab to examine farmers' awareness regarding the usage of fertigation, which is a new technology in which fertilizers are injected into the irrigation system. The study concluded that although farmers are aware of the adverse environmental effects of excess fertilizer use, they prioritize short term benefits and use their instinct to apply N-fertilizer, as there is no penalty on overuse (Pandey & Diwan, 2018). The authors also indicated the need for governmental support in the development of organic fertilizer marketing networks and also in capacity building programs and extension services to incentivize farmers in optimizing N-fertilizer use.

Sustainable intensification (SI)

Sustainable intensification refers to increasing food production using the existing land resource in such a way that the environmental impact can be minimized and the capacity of future food production is not compromised. Studies show that SI helps in emission mitigation. For example, sustainable rice intensification (SRI) reduces GHGs emission by 40% (Gathorne-hardy et al., 2016).

Sustainable intensification reduces poverty and improves farm livelihood (Rockström et al., 2017; Berkhout et al., 2015) {*high confidence*}. For instance, sustainable rice intensification (SRI) increases yield {*very high confidence*} (Rockström et al., 2017), which can be used to earn extra income that can cover household costs such as medical expenses and school fees for the children (Styger & Uphoff, 2016). In Bihar, SRI provided a world record rice yield of 21.16 tons/ha (Kassam & Brammer, 2013). It is not only cost-saving (Ray et al., 2018; Taylor & Bhasme, 2019) but also conserves natural resources by sequestering soil organic carbon and improving soil quality (Deelstra et al., 2018). SI requires low external input and is thereby more ecologically sustainable (Kassam & Brammer, 2016). Specifically, SRI improves water use efficiency {*very high confidence*} (Taylor & Bhasme, 2019) and requires less fertilizer (Kassam & Brammer, 2016), thereby reducing water pollution through leakage of agro-chemicals (Rockström et al., 2017). It is thus also beneficial for human health (Uphoff, 2014). SRI is highly recommended in Bihar, West Bengal and the Southern states of India (Deelstra et al., 2018; Kakumanu et al., 2018a; 2018b; Ray et al., 2018; Kassam & Brammer, 2013).

Glover (2011) states that adoption or non-adoption of SRI solely depends upon the existence of subsidies (e.g. for water, power and equipment) and other incentives because initially SI may require high costs, although these costs reduce in the long run (Kakumanu et al., 2018b; Palanisami et al., 2015). Also, SI is difficult to implement in small landholdings due to high upfront cost, which reduces its scope to decrease poverty (Bhattacharyya et al., 2015; Zhou, 2010) in the short run. In Telengana and Andhra Pradesh, SI reinforces gender and caste inequalities {*medium confidence*}. For instance, SI reduces labor demand by 45% with the maximum share of decline in female employment (Gathorne-hardy et al., 2016) and it also needs skilled labor but due to its shortage all laborious tasks are given to the female workforce as they charge less (Taylor & Bhasme, 2019). Recently, many farmers are opting out of the SRI practice mainly due to high initial cost and physical difficulties in using tiny seedlings along with the risk of seedling loss due to pest attack (Berkhout et al., 2015). This creates the need for extension programs as they can act as guarantees against the risks associated with adopting SI (Taylor & Bhasme, 2019; Styger & Uphoff, 2016).

Climate Smart Agriculture (CSA)

Climate smart agriculture is a range of technological, institutional and policy interventions that aid in achieving three objectives: increasing agricultural productivity, increasing adaptive capacity and decreasing greenhouse gas emissions. A study based on Punjab reveals that CSA reduces GHG emission intensity by 34% (Groot et al., 2019). Srinivasarao et al. (2016) states that CSA practices like intermittent flooding irrigation, incorporation of green manure and straw into the soil can reduce methane emission by 12%, while soil-test-based fertilizer application and integrated nutrient management can mitigate GHGs emission by 16%.

Climate Smart Agriculture practices such as rice-shrimp cultivation, agroforestry, use of Green Seeker or land-laser-leveling (LLL) technologies and water management, ensure better livelihood security by increasing farm income and boosting employment opportunities (Sikka et al., 2018) {*very high confidence*}. It also practices increased yield (Chan et al., 2017; Yadav et al., 2017) and is profitable. Practices like conservational agriculture sustain soil health (Parihar et al., 2018) {*very high confidence*}. They save water and increase water productivity by 37% (Groot et al., 2019) {*very high confidence*}. Integrated cropping system practices, like shrimp-rice cultivation contribute to enhanced agro-biodiversity (Bunting et al., 2017). Climate Smart Agriculture practices improve energy use-efficiency by 58% and energy productivity by 56% compared to traditional practices in the Indo-Gangetic Plains (IGP) (Groot et al., 2019) {*very high confidence*}. However, subsidies on electricity and free use of water in India prevent farmers to use water and fuel saving technologies efficiently (Groot et al., 2019).

Climate Smart Agriculture - practices are not widely adopted due to high transaction cost (Westermann et al., 2015), high upfront costs of machinery and lack of site-specific scale-appropriate machinery in some locations, and the traditional mindset on crop establishment and farm management of the farmers (Groot et al., 2019; Kakraliya et al., 2018; Sapkota et al., 2015). A study (Khatri-Chhetri et al., 2016) based on primary survey of small farm holders, conducted by the International Maize and Wheat Improvement Center (CIMMYT) in 2013, in the Climate-Smart Villages (CSVs) of Haryana and Bihar pointed out that government extension agents have limited knowledge about the tools and techniques available for implementation of site-specific nutrient management in the smallholder production systems, which hindered adoption of CSA practices. Therefore, it is important to assimilate field-specific data, use data technologies and tools and convey data driven agronomic knowledge to farmers and government extension agents {*high confidence*}. Making CSA a success requires a paradigm shift in the data-driven technology generation process in NARS (National Agricultural Research System) in India (Rao, 2018). International organizations and the Indian Government have shown keen interest in financing and scaling out CSA practices in India (Westermann et al., 2015). Recently, NICRA (National Innovations on Climate Resilient Agriculture) has demonstrated different CSA practices in the vulnerable districts of India to enhance the resilience of agriculture to climate change and realize better agricultural production with improve rural livelihoods (Sikka et al., 2018).

Conclusions

Implementing SDG 13 through climate mitigation options has various synergies and trade-offs with other SDGs. This paper explores these synergies and trade-offs for four different croplands based greenhouse gas mitigation interventions. These interventions reduce emission through water management in paddy cultivation (PWM); integrated nitrogen use efficiency (NUE), sustainable intensification (SI) and climate smart agriculture (CSA). The findings suggest that synergies clearly outweigh trade-offs for all the interventions. Few synergies are valid across all the interventions. For instance, in the case of energy saving, PWM and SI are energy saving due to effective irrigation management, NUE is energy saving due to reduction in application of fossil-fuel dependent synthetic fertilizer and CSA is energy saving because of the practice of zero-tillage which requires less energy than conventional tillage. All interventions have improved water-use efficiency benefit due to efficient irrigation management. In addition to intervention-specific benefits, improved agricultural productivity benefits are common across all interventions.

However, no single intervention is completely devoid of trade-offs. These trade-offs can be addressed through careful expert consultation and implementation. For example, limited knowledge among government extension agents regarding the tools and techniques available for implementation of SI and CSA in small landholdings makes it difficult to scale-up SI and CSA because the average size of landholding in India is only 1.08 hectares. Moreover, lack of awareness among the farmers regarding the economic and environmental benefits of these mitigation interventions is also a challenge. Therefore, promotions of appropriate policies, incentives and awareness programs for the farmers through government–private–civil society partnership are crucial for scaling up all these mitigation interventions

Overall, CSA delivers the highest synergies. Government of India has been advocating CSA as a resource-efficient and income-generating technology. But the government extension agents are not always fully aware of location-specific knowledge and information, thereby impeding the capacity building process of the farmers. In order to scale-up CSA, awareness programs for the farmers as well as the extension agents should be highly prioritized. On the other hand, SI practices relates to maximum trade-offs because implementation of SI requires high cost in the short run, which is not an attractive or, in some cases, affordable prospect for the farmers. Furthermore, interventions like PWM provides better results in eastern Indo-Gangetic Plains than in the northwestern part while SI (rice) has been highly recommended in eastern and southern states. Therefore, examining region-specific nuances is also important. This work sets the stage for discussion among academics and policy makers in India on the fact that agricultural mitigation options undeniably provide developmental co-benefits and adopting them will help in achieving sustainability in agriculture, while paving the path towards broader goal of sustainable development.

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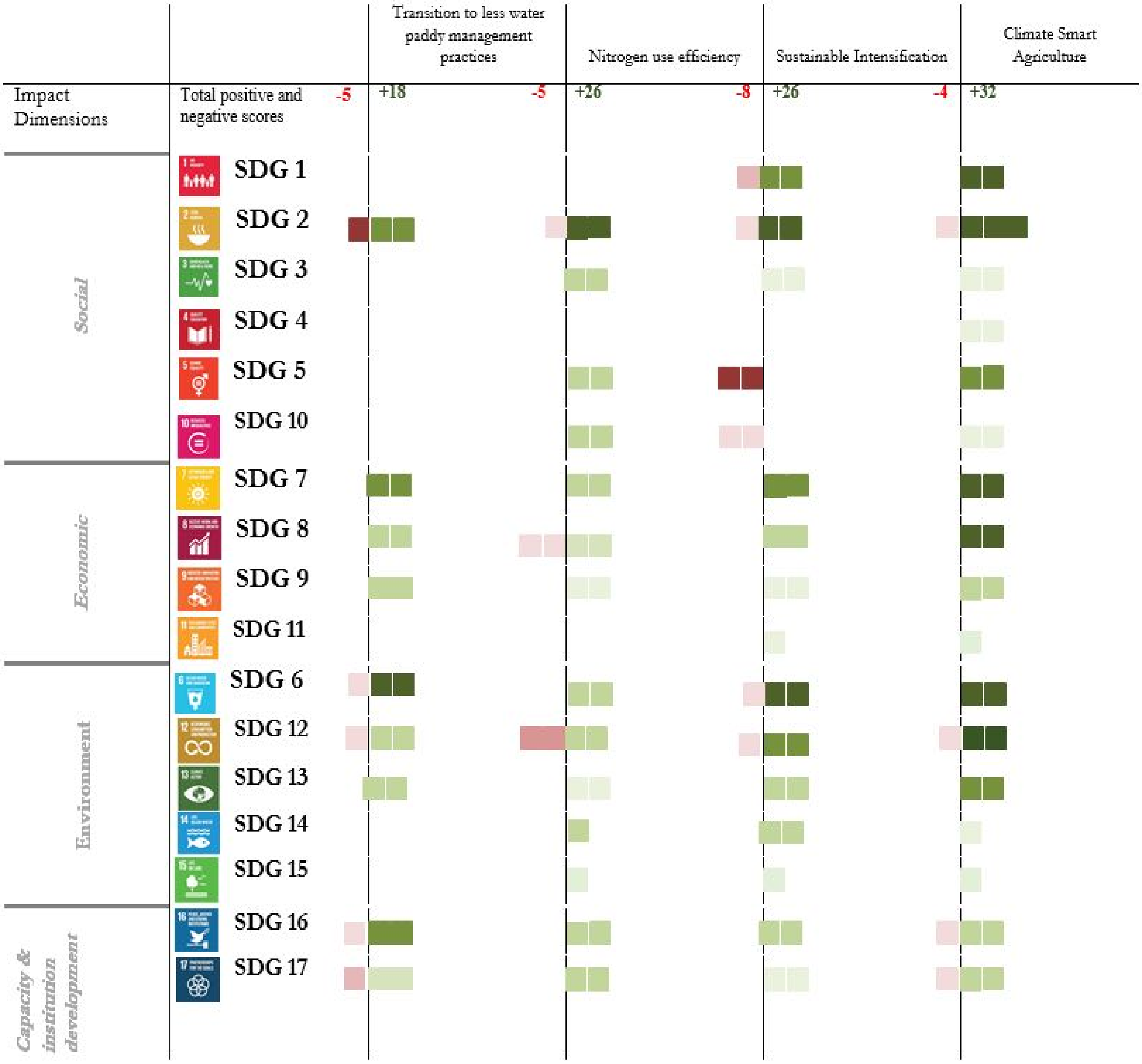
<u>Annex 1</u>: SDG chart - showing synergies and trade-offs (using Table 1) between individual mitigation interventions and SDGs impact dimensions.



Synergies (positive interaction) are denoted by green

Trade-offs (negative interaction) are denoted by brown

The shades denote level of confidence

Very high confidence

(Robust evidence and

high agreement) → ← Very low confidence

(Low evidence and low agreement)

Annex 2: Synergies (+) and trade-offs (-) between cropland-based mitigation interventions and SDGs. Uncertain impact is denoted by ±.

Level of evidence and agreement are given in braces; Abbreviations for evidence: l = limited, m = medium, h = high; for agreement: l = low, m = medium, h = high.

Mitigation Interventions	SDGs (Social)					
	SDG 1	**SDG 2**	**SDG 3**	**SDG 4**	**SDG 5**	**SDG 10**
PWM		+ AWD and MSD increase agricultural productivity & income (h/m) -DSR reduces yield (m/h) + Sustainable food production(h/h)				
NUE		+increase agricultural productivity (h/h) + Sustainable food production(h/h)	+Reduce illnesses from chemicals(l/h)		+Women empowerment through *"Gender-equitable N use efficiency strategies"* (l/l)	Women empowerment through *"Gender-equitable N use efficiency strategies"*
SI/SRI	+Improves livelihood (m/h)	+Increases agricultural productivity & income (h/h) +Sustainable food production(h/h) +Maintain the genetic diversity of seeds and cultivated plants (l/l) +Increase investment in agricultural research & extension services (l/l) -Difficult to implement in small landholding (l/l) -Initial cost is high (m/h)	+Reduce illnesses from chemicals(l/l)		-Reduces female employment thereby reinforces inequality(l/h)	- Reinforces class-inequality as benefits are distributed depending on class and caste (l/l)

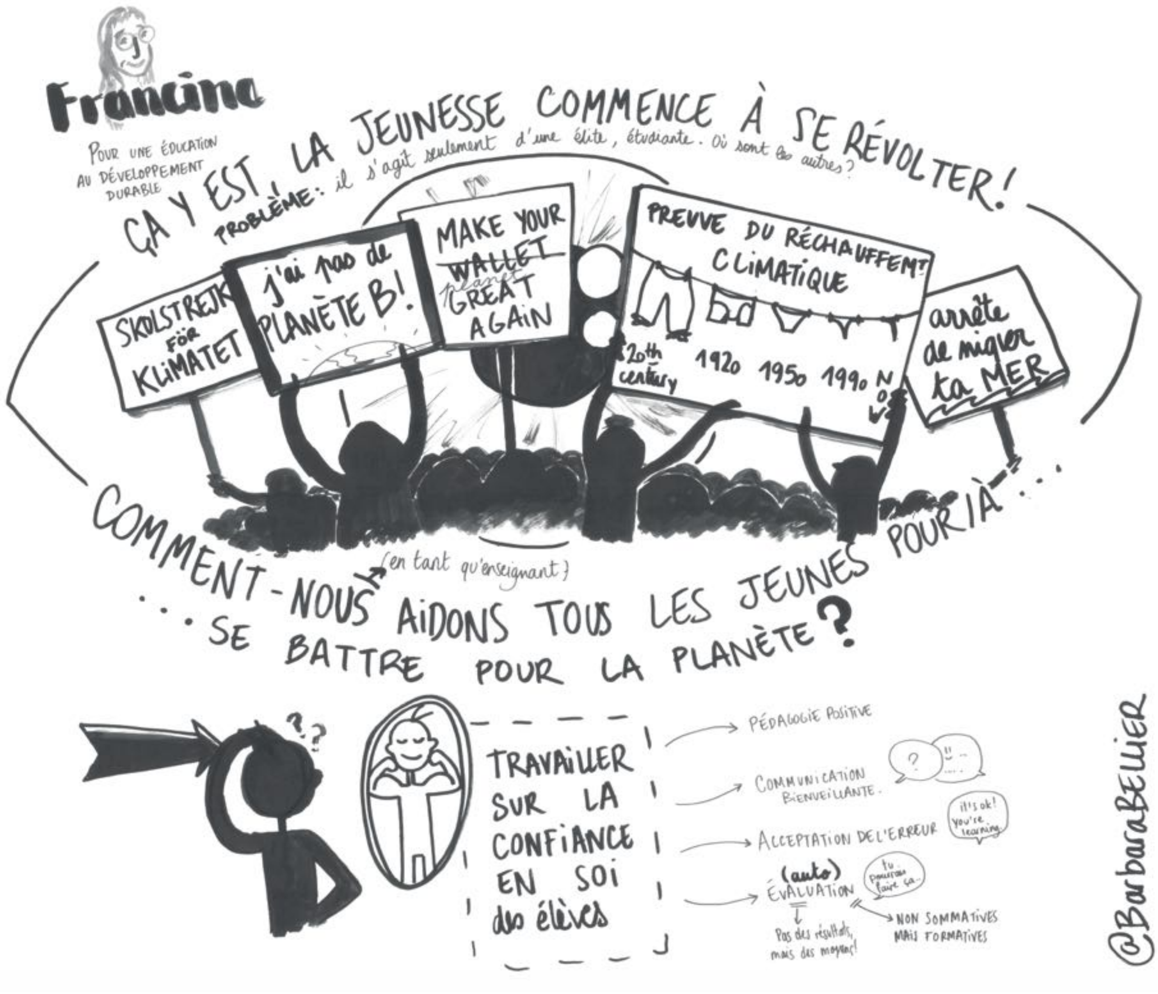
CSA	+Improves livelihood and reduces risk (h/h)	+Agricultural productivity & income(h/h) +Sustainable food production (h/h) +Maintain the genetic diversity of seeds and cultivated plants (m/h) +Increase investment in rural infrastructure, agricultural research & extension services (l/l) - high initial cost and knowledge intensiveness (h/h) -Difficult to implement in small landholding (l/h)	+Reduce illnesses from chemicals(l/l)	+Ensure education for sustainable development (l/l)	+ Trains local women and improves their job opportunities (m/h)	+ Ensures equality through Inclusion of marginalized groups by training and capacity building (l/l)

Mitigation Interventions	SDGs (Economic)				SDGs (Capacity & institution development)	
	SDG 7	**SDG 8**	**SDG 9**	**SDG 11**	**SDG 16**	**SDG 17**
PWM	+Saves energy(m/h)	+Sustainable production(l/l)	+Develop sustainable and resilient infrastructure (l/l) +Supports research and innovation (l/l)		+ Promotes appropriate policy, incentives and awareness mechanisms(m/h) -Lack of proper incentives lead to non-adoption of these practices (l/l)	+ Capacity building of farmers (l/m)
NUE	+Saves energy(l/h)	+Sustainable production(l/h)			+ Promotes appropriate policy, incentives and awareness mechanisms(m/h)	+ Enhance policy coherence(l/h) +Promotes partnership(l/l)
SI/SRI	+Saves energy(m/h)	+Sustainable production(l/h) ± Creates jobs (l/l)	+ Supports research and innovation (l/l)	+Reduces air pollution (l/l)	+ Promotes appropriate policy, incentives and awareness mechanisms(m/h)	+ Capacity building of farmer(l/l)
CSA	+Saves energy(h/h) +Promotes clean energy through fossil fuel substitute (biomass) (l/h)	+Enhance economic productivity through diversification(m/h) + Creates jobs(m/h) + Sustainable production(m/h) +Strengthen domestic financial institutions(m/h)	+ Increases access to financial services and markets (l/h) + Supports research and innovation (l/l)	+Reduces air pollution(l/l)	+Promotes appropriate policy, incentives and awareness mechanisms(m/h) -Limited knowledge among Government extension agents is a challenge(l/l)	+ Capacity building of farmer(m/h) + Enhance policy coherence(m/h) - Limited knowledge among Government extension agents is a challenge(l/l)

Mitigation Interventions	SDGs (Environment)				
	SDG 6	**SDG 12**	**SDG 13**	**SDG 14**	**SDG 15**
PWM	+Increase water-use efficiency(h/h) -Farmers face practical constraints like they may not be able to drain fields during wet season(l/l)	+Sustainable production(l/h) -Lack of awareness act as a constraint in adoption of low emission technologies(l/l)	+Promotes capacity for effective climate change-related planning(l/l)		
NUE	+Increase water-use efficiency(m/h) +Eliminate chemical dumping; improves water-quality(m/h)	+Sustainable production(m/h) -Lack of awareness and no penalty for overuse act as a constraint in adoption of low emission technologies. (l/h)	+ Integrates climate change measures into national policies(l/l)	+Reduce marine pollution(l/h)	+ Reduces freshwater eco-toxicity, terrestrial acidification, terrestrial eco-toxicity and water depletion (l/h)
SI/SRI	+Increase water-use efficiency(h/h) +Eliminate chemical dumping; improves water-quality(l/h) -Controlling water during wet season is a challenge(l/l)	+Sustainable production(m/h) -Lack of awareness act as a constraint in adoption of low emission technologies(l/l)	+ Increases resilience(l/h)	+Reduce marine pollution(l/h)	+ Restore degraded land and soil(l/l) +Biodiversity conservation(l/h)
CSA	+Increase water-use efficiency(h/h) +Eliminate chemical dumping; improves water-quality(l/h) +Integrates water resource management(l/l)	+Sustainable production(h/h) -Subsidy on electricity and free use of water prevents farmers to use water and fuel saving technologies(l/l)	+Increases resilience(m/h) + Integrates climate change measures into national policies(l/h) +Promotes capacity for effective climate change-related planning(l/h)	+Reduce marine pollution(m/h)	+ Restore degraded land and soil(l/h) +Biodiversity conservation (m/h)

PART 5

EDUCATION FOR STRONG SUSTAINABILITY



Sustainable Development Goals and Education in Pakistan: the new challenges for 2030

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Jean Monnet Excellence Center on Sustainability (ERASME)

Abstract: There is a causal link between Education for sustainable development (ESD) and Sustainable Development Goals (SDGs). This study explores this causality in the context of developing countries with a case study on Pakistan. Education for Sustainable Development and SDGs are inclusively targeting the improvement of people's quality of life through quality education, as defined in SDG4. Implementation of SDGs in Pakistan is very important because of its dynamic nature, which can be a learning exercise for the literature in ESD and SDGs. Pakistan is not ranking high in the Human Development Index (HDI) and the Multidimensional Poverty Index (MPI). Pakistan, Kenya and Bangladesh have the same MPI but inequality in Pakistan is twice that in Kenya and once that in Bangladesh. The Human Development Index and other indexes are reviewed in order to understand the link between SDG-1 and SDG-4 in order to achieve objectives of not only country but global agenda as well. This effort highlights the importance and link between different SDGs, policies, quality education and ESD. It is concluded that living standard of people of Pakistan can be improved by improving the quality education with the objectives of education for sustainable development and prioritizing the SDGs keeping the local context of the country in mind.

Key Words: Education for Sustainable Development, Health, Quality Education, Pakistan, Poverty, SDGs

Introduction

While education for sustainable development (ESD) through UNESCO's programs has spread widely in both the North and the South, national programs have not always made ESD a priority in education policy. Teacher education remains a key variable for the implementation of ESD, and in the absence of a real willingness of teacher education institutions to integrate ESD into teacher training program, little real progress has been made.

This is the case in Pakistan, which has seen the implementation of scattered initiatives such as the UNESCO Associated Schools Network (ASPnet), courses on ESD as part of master's program (Educational Sciences), and the spontaneous participation of a few universities such as the University of Punjab in the International Network of Teacher Training Institutions. More than 60 ASPnet schools have developed peace and sustainable development education programs to share contextualized knowledge on respect and cultural diversity with teachers, students, parents, and the community at large. A pedagogical initiative on ESD was proposed by the Institute of Education, Lahore College for Women University (Kalsoom & Khanam, 2017). The objective of this program was to raise awareness among student teachers of the concepts of Sustainable Development (SD) and Education for Sustainable Development in order to strengthen their awareness of the notion of sustainability. As part of this initiative, undergraduate student training to become teachers carried out 11 weeks of local fieldwork. This work included field surveys on sustainability issues, such as the effect of the socio-economic context on education, the challenges faced by female students in higher education, environmental awareness of pre-service teachers and the culture of teacher training institutions.

Although there are individual or institutional efforts related to the implementation of ESD in teacher education, ESD is only tentatively entering Pakistan's education policy. The analysis of various documents such as education policy (Government of Pakistan, 2009), provincial education sector plans (Government of Balochistan, 2013; Government of Punjab, 2013-2017), the B. Ed. Honors curriculum (Higher Education Commission, 2012) or national professional standards for teachers (Ministry of Education, 2009), do not reveal education for sustainable development as a national priority. This virtual absence of ESD in national systems contrasts with initiatives on other topics. For example, environmental education, economics, human rights and citizenship have been included in the B. Ed. curriculum. Civic responsibility, social cohesion and tolerance are mentioned in national education policy, the education sector plan and national professional standards.

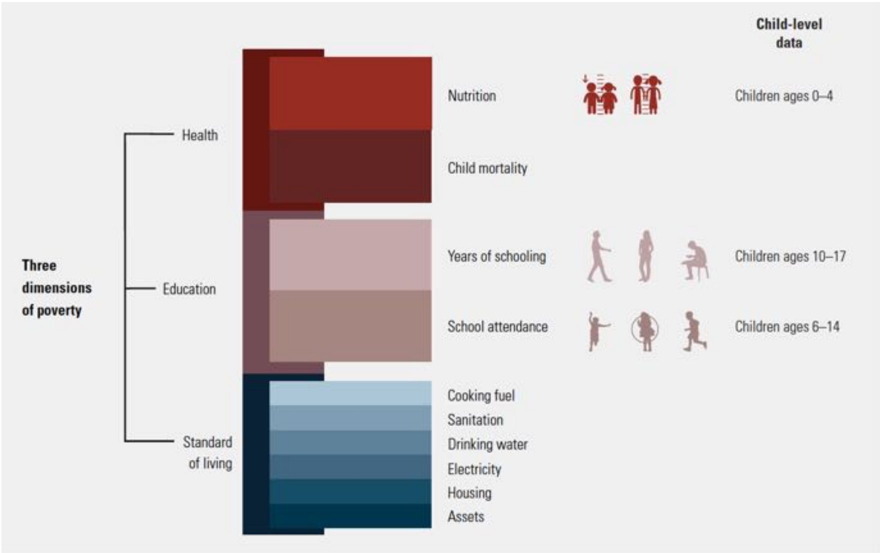
According to Kalsoom, Qureshi and Khanam (2018), this low emphasis on ESD has generated two types of problems: (i) the knowledge of students training to become teachers of sustainability issues and their attitudes and behaviors towards sustainability fall short of expectations; (ii) a lack of research on ESD-related issues. Kalsoom, Qureshi and Khanam (2018) analyzed a database of ESD-related research-based articles written by Pakistani authors. The databases consulted were Springer, Taylor and Francis, as well as 4 national education journals. They found more than 2,500 articles on ESD, but none of them empirical studies. The authors also analyzed 353 articles that were published in national journals from 2004 to 2016 and concluded that no articles had been published on ESD. Pakistani researchers would appear to have little or no exposure to research related to the concepts of sustainable development and education for sustainable development.

This paper addresses education for sustainable development in the case of Pakistan on the basis of two premises. Firstly, it argues that the implementation of education for sustainable development is inextricably linked to issues of health, environment and child nutrition. Thus, the implementation of SDGs may well enable Pakistan to improve the quality of its education. Secondly, it assumes that there is a close link between SDG 4 "Education quality" and SDG 1 "Poverty". The Multidimensional Poverty Index (MPI), based on government social statistics and calculated according to 15 factors, showed that 39% of Pakistanis were poor (UNDP, 2018), the majority in rural areas. This poverty is relatively deep: on average, poor Pakistanis are deprived of basic goods and services in 50.9% of the surveyed areas. A positive loop would seem to show that an improvement in the quality of education can reduce poverty, but also that any reduction in poverty improves the quality of the country's education (Diemer, Faheem, 2020).

Education for sustainable development in developing countries

Education for sustainable development, and the skills implied, is based on three major aspects, which are relevant for most developing countries: health (associated with sanitation, access to water, and access to health services), the environment (associated with population density in urban areas and waste), and food (provision of school canteens). These societal challenges are integrated in the United Nations' recommendations: "*Investments in the health and nutrition of young children will translate into an investment in equality and sustainability throughout life*" (UNDP, 2019), into the basic curriculum of many national programs and the SDGs, thus introducing a final issue, education (itself reflected in SDG 4).

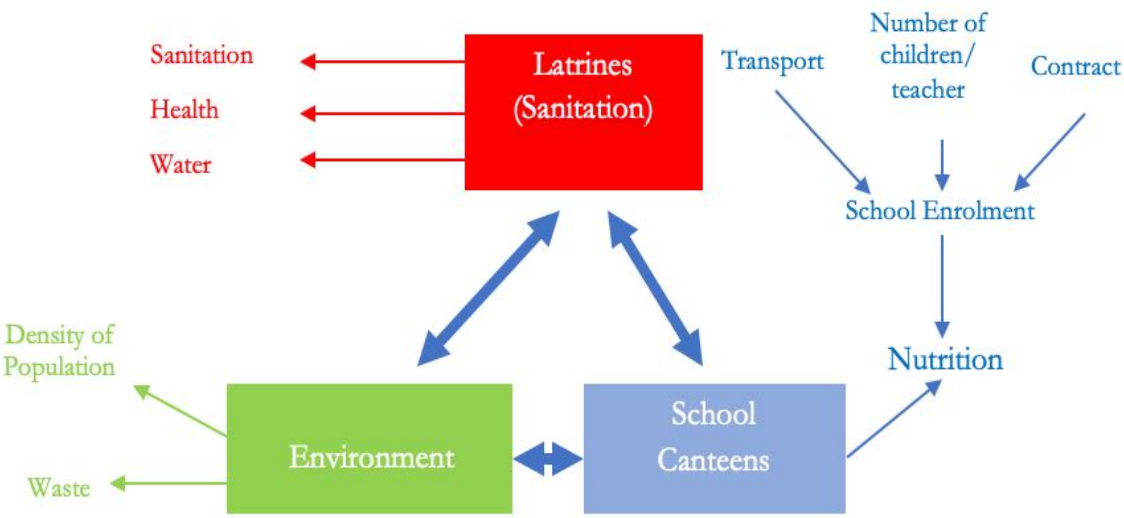
Figure 1: Health, Environment and Nutrition in the three dimensions of the poverty



Source: Oxford Poverty and Human Development Initiative (2018)

However, the education issue cannot be limited to a simple analysis of curricula; in many developing countries, the quality of education is conditioned by the social, political, religious, and economic context. Transportation and access to school can take time for both children and teachers. There are inequalities between urban and rural areas. The number of children per class can be as high as 80 in primary school. Despite official texts in developing countries that set the number of students at 35 or 50, reality overwhelms the texts and makes it difficult to successfully implement any of the pedagogical innovations (e. g. critical pedagogy, mindfulness, project pedagogy) associated with education for sustainable development.

Figure 2: ESD, SDG and Socio-political context

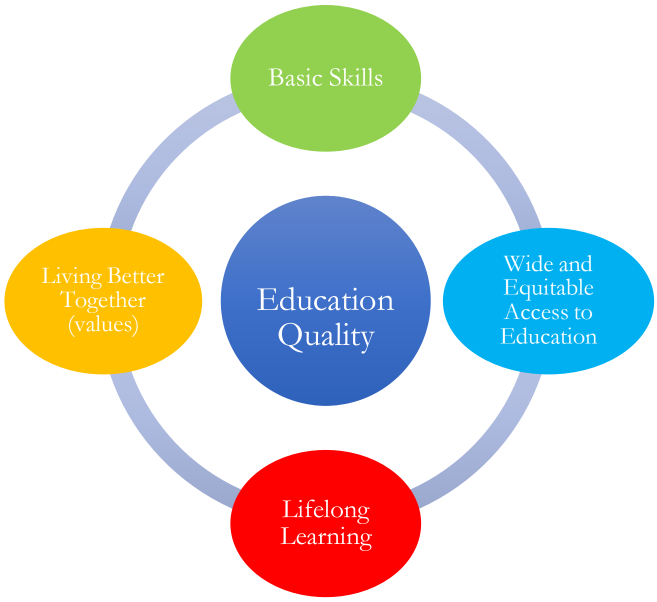


Source: Diemer (2015)

Finally, teacher contracts are not homogeneous and uniform. There is a large number of contracts and therefore a significant range of skills: from the civil servant teachers - who have received teacher training and have been able to benefit from a few hours of training in education for sustainable development - to the contract teachers paid by the village, who have had to forge a culture of education for sustainable development themselves.

Sustainable Development Goal 4 aims to ensure that all people have access to quality education and lifelong learning opportunities[1]. This objective focuses on the acquisition of basic and higher-level skills at all stages of education and development; broader and more equitable access to quality education at all levels, as well as to technical and vocational education and training, plus the knowledge, skills and values required to live in a productive society. This SDG is a reminder that there are numerous situations which prevent children from going to school: children may live in rural areas, may be affected by poverty, or may have parents with little or no education (SDG Report, 2016).

Figure 3 : SDG 4, Quality Education

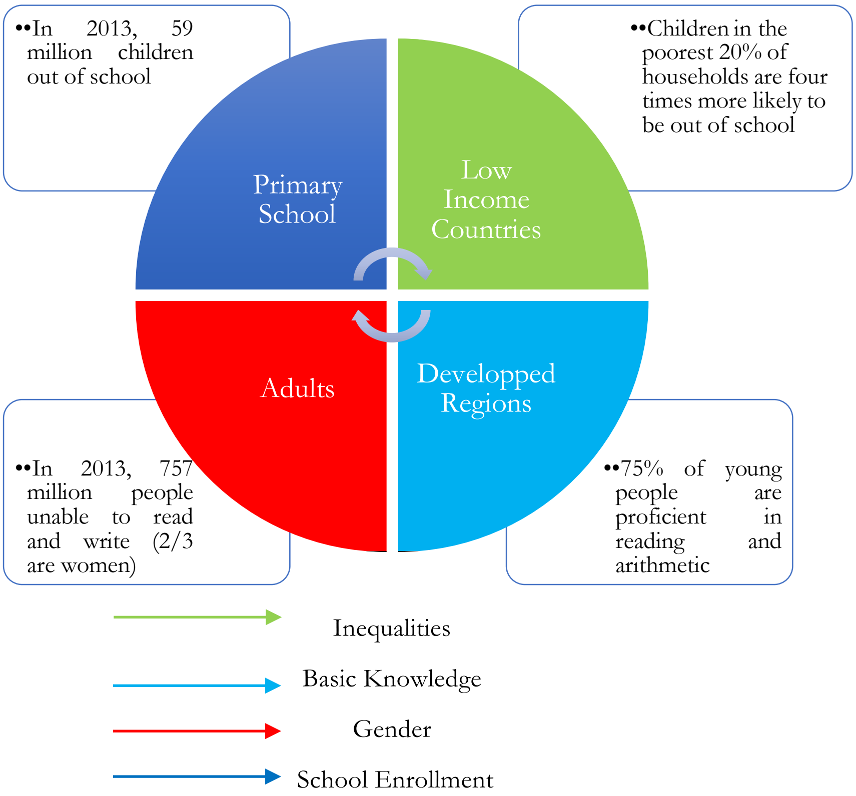


Source: Diemer (2017)

However, and this may be where the expectations and outcomes of SDG 4 need to be qualified, the fact that the quality of education may influence several other SDG targets somewhat obscures the reality of the facts. Indeed, education quality is influenced by the socio-economic context. Thus, the success of primary school depends on enrolment and access to the education system; in low-income countries, an improvement in education first requires the eradication of poverty; in developed countries efforts on basic knowledge must increase; and adult education (e.g. lifelong learning), should not be prevented by gender issues.

[1] United Nations specified that the reasons for lack of quality education are due to lack of adequately trained teachers, poor conditions of schools and equity issues related to opportunities provided to rural children. For quality education to be provided to the children of impoverished families, investment is needed in educational scholarships, teacher training workshops, school building and improvement of water and electricity access to schools (https://www.un.org/sustainabledevelopment/education/).

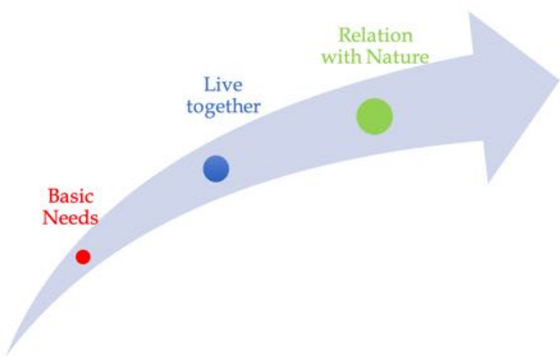
Figure 4: Targets of SDG 4



Source: Diemer (2017)

Inequalities, gender, schooling, and basic knowledge are the target variables of SDG 4, and are expressions of the systemic nature of sustainable development (inequalities corresponding to SDG 10 and gender to SDG 5). This link between SDG 4 and complex and systemic thinking allows us to reaffirm the strong link between education quality and education for sustainable development. In a way, SDG 4 and ESD are positioned at the crossroads of a triptych composed of basic needs, relationship with nature, and living together (see Fig.5).

Figure 5: Challenges of SDG 4 and ESD



The implementation of SDG1 and SDG4 in Pakistan

By adopting a universalist position, the United Nations has made poverty a global issue. The SDGs apply to both North and South countries, but sufficient and necessary conditions must be created to ensure that such targets do not melt like snow in the sun. Indeed, beyond the occasional statements, "*We are determined to eradicate poverty and hunger everywhere in the world by 2030; to combat inequalities within and between countries; to build peaceful and just societies, where everyone has a place; to protect human rights and promote gender equality and the empowerment of women and girls; to protect the planet and its natural resources in a sustainable manner*" (United Nations, 2015), sustainable development programs should be integrated into the national strategies of individual states. Pakistan is mainly characterized by a large population (220.9 million inhabitants) and a high birth rate (28.5 per 1000 according United Nations Population Division). It has a very low literacy rate, 58% (NEMIS-AEPAM, 2016); 30% of the population lives below the poverty line; the gross national income per capita is less than $1,500 US (current $); and the country's HDI is 0.538. Poverty and illiteracy are a combination of harmful factors that drive the majority of young people and children to extremism, violence, or criminal activities. The deteriorating environment, the decrease in air quality, urbanization, contaminated water, terrorism, regional/provincial conflicts, food security, inflation, social and economic inequalities, access to education, debt, security issues, soil fertility, deforestation, and corruption underpin the long list of challenges facing Pakistan today. These challenges have made Pakistan a very vulnerable country, dependent on humanitarian aid from major international institutions and/or NGOs.

Tableau 1: Indexes for Pakistan Source: *UNDP (2019)*

	HDI	*HDI Adjusted to Inequalities*		*GDI*[2]	*GII*[3]		*Multidimensional Poverty Index*		
	Value	Value	Global Lost %	Value	Value	Rank	Value	%	Intensity of deprivation
Pakistan	0.560	0.386	31,1	0.747	0.547	136	0.198	38,3	51,7

There is no doubt that education plays an important role in achieving the objectives of well-being and life satisfaction, which are symbols of a society working towards sustainable development. Although there is a controversial debate on the type of education necessary and sufficient to achieve the SDGs, all stakeholders agree that multifaceted education is needed, including education for sustainable development, and not conventional education. In a country like Pakistan, which has not been able to achieve the goal of universal primary education over the past decade, the challenge is significant and impedes the prospects for achieving SDG 4. According to the 2015 Education for All report, 6.7 million children are still not at school, 62% of whom are girls. Access to schooling is a prerequisite for the implementation of ESD, so it is essential to ensure that as many children as possible go to school and stay in school up to the middle level.

In what follows, we have chosen to focus on the link between SDG 1 (no poverty) and SDG 4, but this perspective would be insufficient and biased if we did not revisit the Millenium Development Goals (MDGs), and in particular MDG 2 "Achieve universal primary education". Millenium Development Goal 2 aimed to achieve 100% primary school enrolment, 100%

[2] GDI (Genre Development Index)

[3] GII (Genre Inequalities Index)

completion of grades 1-5 and a literacy rate of 88% (Pakistan report, 2013). The Pakistan results were disappointing. Primary school enrolment and completion rates increased until the mid-2000s, then slowed to 57% and then reduced to 50% in 2011/2012. The literacy rate reached 58%, however, this overall figure conceals wide disparities between men (70%) and women (47%). In 2013, a national action plan was launched to accelerate progress towards MDG 2 so that the target can be reached by 2015. Unfortunately, this action plan could not be implemented despite many initiatives to encourage school enrolment. The TAWANA (Healthy) project provided edible oil, pulses and rice to families to increase the school enrolment rate of children in rural areas. Girls received small allowances to encourage them to enroll and stay in school up to secondary level. From 2008 to 2015, incentives were given to students by providing them with free textbooks from the first to the tenth grade. The National Assembly of Pakistan has established a working group of elected members to review progress towards the MDGs. All these efforts have not been successful, and thus Pakistan has not achieved the MDGs (32% of children aged 5-9 years were still not at school in 2015).

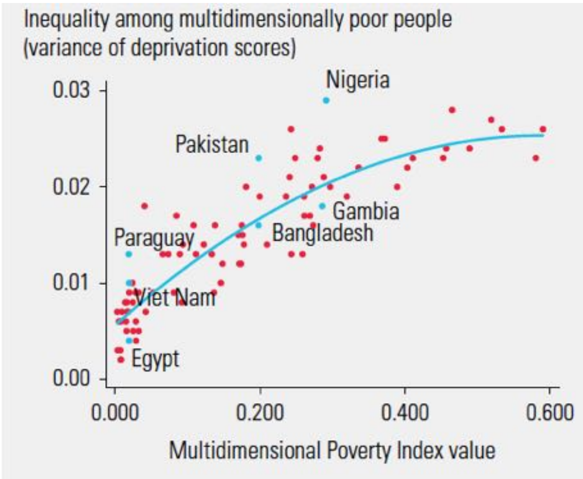
In the official documents of the Pakistani government (national MDG report 2011 and 2013), there was mention of an inclusive, coherent, and collaborative strategy to achieve ambitious goals. This was part of an action plan, the Millennium Acceleration Framework (MAF), developed by the United Nations Development Programme (UNDP) to accelerate progress on the MDGs, particularly for countries that did not achieve the 2015 targets. While all successive Pakistan governments have sought to achieve the MDGs under international pressure, no single administration has actually defined a list of priorities or taken concrete measures. Many reasons have been given by Pakistan governments to explain these failures: the military coup of October 1999, which changed the current regime and reduced efforts in the education system; the 2005 earthquake, which caused population displacements and disrupted the deployment of education policy; the post-2005 situation characterized by an increase in terrorist attacks and military operations in the north-western part of the country; the major floods of 2010; and the 2015 earthquake in the western province of Baluchistan. In addition to these natural disasters and human conflicts, internal problems such as corruption, ineffectiveness of ministerial services, lack of monitoring mechanisms, accountability issues, political interference in educational institutions, deficits in the number of teachers, and unavailability of basic facilities (water, electricity, toilets) in schools should also be highlighted. Last but not least, the country's extreme poverty played a significant role in the failure to implement the MDG on education.

Poverty is a well-known phenomenon in Pakistan. According to the commonly used index, based solely on consumption, 29.5% of Pakistanis are below the poverty line, estimated at 3,030 rupees (25 euros) per adult per month. Since 2016, the Pakistani government has published its multidimensional poverty index – MPI, which takes into account the standard of living but also access to education and health. Of the total population of Pakistanis 39% are poor, the majority in rural areas. This poverty is relatively deep: on average, poor Pakistanis are deprived of basic goods and services in 50.9% of the areas surveyed for the MPI. A correlation seems exist between MPI and Inequality among Multidimensionally Poor People (IMPP), which is the difference in the intensity of poverty experienced by each poor people, measured using the variance[4]. Clearly, IMPP

[4] Which is calculated by subtracting each multi-dimensionally poor person deprivation score from the average intensity, squaring the difference, summing the squared differences, and dividing the sum by the number of multi-

tends to increase with MPI value. Pakistan has a high MPI value (0.198) and high inequality level (IMPP is about 0.023). In the last United Nations' report, "*the measurement of inequality among multidimensionally poor people summarizes the distribution of their deprivation scores within intensity. Variance adds an additional piece of information: it signals when average intensity is high heterogeneous*" (2019, p. 13). This is the case for Pakistan.

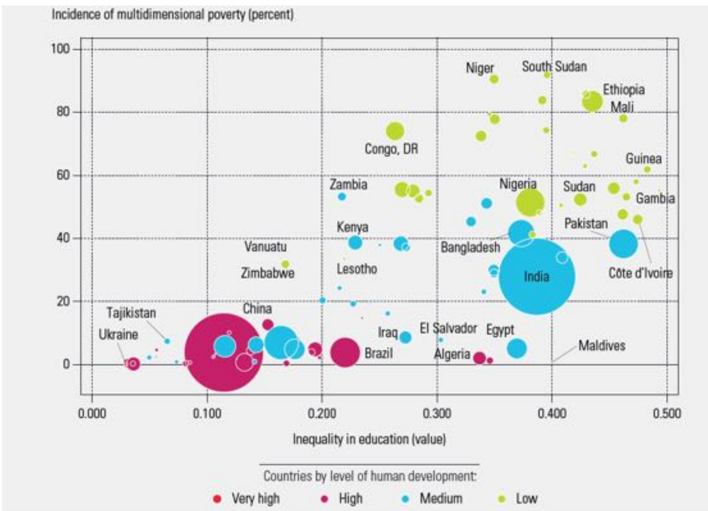
Figure 6: Correlation between MPI and IMPP



Source: Alkire, Santos (2019)

The correlation between inequality in the education dimension of the Human Development Index (HDI) and the Multidimensional Poverty Index (MPI) are not so strong for Pakistan. For example, Pakistan, Kenya and Bangladesh have the same MPI but inequality in Pakistan is twice that in Kenya and once that in Bangladesh (see Fig.7).

Figure 7: Multidimensional Poverty and Inequality in Education



Source: UNDP (2019)

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dimensionally poor people. While Variance provides useful insights, it is important to emphasize that the primary objective of SDG 1 is to end poverty – not merely to reduce inequality among poor people.

The triangle MDG - SDG - Poverty illustrates Pakistan's past and present situation. The close relationship between SDG 1 and SDG 4 reflects a well-known causality in developing countries, with poverty forcing large numbers of children to work in order to support and contribute to family income. Pakistan has a clearly visible poverty, despite a very flourishing economy: GDP growth rate of 5.3% in 2016/2017, and a GDP close to 300 billion dollars. Some economists at the Karachi Centre for Social Policy and Development (SPDC) (Sabir, 2016) see it as a threshold effect, as growth is not yet strong enough to reduce poverty. Figures in the order of 6% to 8% are put forward as being high enough to bring about a significant reduction in poverty. In other words, the salvation of education and the optimistic prospects for achieving the targets of SDG 4 are conditioned not by the Pakistani government's desire to improve its education system but by an objective of economic growth.

Table 2: Multidimensional Poverty Index value and its components harmonized for Pakistan

MDI				**People who are multidimensionally poor and deprived in each indicator**									
Value	%	Population	Intensity Of deprivation	Nutrition	Child mortality	Years of school	School attendance	Cooking Fuel	Sanitation	Drinking Water	Electricity	Housing	Assets
0.198	38,3	76 976 000	51,7	27	5,9	24,8	24,3	31,2	21,7	7,9	7,1	30,6	12,2

Source: UNDP (2019, p. 20)

Given the above-mentioned facts and the review of the SDGs, it would seem to be very difficult for Pakistan to prioritize ESD goals or synchronize its 2025 vision with that of the SDGs. The educational agenda is on the priority list (SDG 4), however no comprehensive mechanism or reference framework has been proposed to implement such a program and achieve the targets within a reasonable timeframe, although some policy documents were developed. Most of the targets in SDG 4 are internal challenges. In 2015, the Pakistan government proposed an inclusive strategy, aimed at learning from the past and forging a challenging agenda, calling for (1) the formation of national and provincial working groups on the SDGs to obtain provincial input on national priority setting, (2) the establishment of dedicated SDG offices within the Ministry of Planning and Development to allow stakeholder consultation at the federal and provincial levels, (3) consultations and commitments at national level with all key stakeholders, including the business and media sectors, (4) strengthening national data sources through innovative and creative information technologies at all levels. For a sustainable development program to be effective and bring about change for society, it must be based on the following four basic elements: (i) an ambitious vision for the future firmly rooted in human rights and universally accepted values and principles, including those set out in the Universal Declaration of Human Rights and the Millennium Declaration, (ii) a set of concise targets to achieve priorities, (iii) a global partnership for development to mobilize means of implementation, (iv) a participatory monitoring framework to integrate all stakeholders in decision-making.

In Pakistan, the challenges posed by SDGs 1 and 4 can only be met through a three-pronged approach: coordinating and engaging all stakeholders (including private sector and nongovernmental organizations) in a policy of poverty eradication through education; identifying and prioritizing the essential social development program tailored for each province; and redeploying and allocating appropriate resources through rigorous monitoring and control mechanisms. While poverty is not inevitable, it can very quickly become so if the country's population no longer have reasons to hope for change.

Conclusion

Sustainable Development Goals are an opportunity for developing countries such as Pakistan to improve the living standard of their people through quality education and ESD objectives. This international agenda deliberately engages countries to prioritize issues according to their local country context to achieve local as well as global objectives. Sustainable Development Goal 1 - Poverty is one of the critical challenges for Pakistan, which can be addressed through implementing SDGs especially quality education in order to improve HDI indicators by catering causes linked to poverty. These findings can enhance and contribute in future policy decisions in order to link SDGs with the country vision for future plans and programmes. 2030 Challenges will be more serious if they are not addressed in present.

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Service Learning for the Achievement of the Education for Sustainable Development: Analysis of educational contexts and case studies in Japan and Malaysia

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Abstract: To respond to the requirement of the sustainable development agenda, Malaysian and Japanese universities started the service learning projects as their own curriculums. The purpose of service learning is to enhance the Education for Sustainable Development and Global Citizenship Education. However, the process of the service learning is problematic in many respects, especially in the relationship between universities and communities. Usually, educators of the service learning choose and set the educational purpose and the community that students visit. Indeed, it is important to identify the needs of communities, but also crucial to consider communities' everyday lives and feelings, with respect to, for instance, happiness or well-being. Service learning is meant to allow students to both convey university knowledge to a community, and to live together with a community. We investigated the service learning programs in Malaysia and Japan from the perspective of cultural studies and philosophy and found that different ways of communicating with communities lead to various results in the service learning.

Keywords: Education for Sustainable Development, Service learning, Local community, Happiness, Affect

Introduction

With the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs) that were adopted in 2015, the Japanese Ministry of Foreign Affairs released an SDGs Action Plan. In its 2017 revision of the Guidelines for the Course of Study, The Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT) defined Japan's school education goal as nurturing "*creators of a sustainable society*" (MEXT 2013). This change has required to reconfirm the importance of citizenship education in Japan and urged Japanese universities to create a new curriculum. In the Japanese educational contexts, education for sustainable development (ESD) is linked to active learning. It is because the MEXT insists that active learning allows learners to acquire competencies of "creators of a sustainable society". Service learning is considered as an exemplary approach to active learning. Therefore, many Japanese universities have adopted service learning since 2000.

With regard to the question on building a sustainable society, the Brundtland report was not meant to see a conflict between environmental protection and economic development, but to link them. The problem, however, is that achieving goals in the global village is sometimes opposed to achieving goals in the local community. For example, the prioritization of economic growth and environmental issues in the global village may threaten specific local cultures, which are neglected due to globalization. On the contrary, local community interests may distract attention from global issues. Zygmunt Bauman insists in the separation of global power from local politics. For him, the famous slogan "Think globally, act locally" does not mean that we can solve the global problems by acting locally, this interpretation is adopted by the MEXT (MEXT 2013), but it means that even if we think globally, we can only act locally. If we only act locally, we cannot tackle the global problems. Bauman says that "*there are no local solutions to globally originated and globally invigorated problems*"

(Bauman 2006, p.128). He points out the scission between the local and the global. It is not an easy task to be a "creator of a sustainable society", because, according to Bauman, a creator of a sustainable local society is not that of a sustainable global society.

In this paper, we do not try to treat it, but we now mention the importance of interdisciplinary approaches for solving global problems. There are the various global issues which are difficult to resolve, such as poverty, healthcare, gender, racism and environmental protection. They are directly related to the helpless and hopeless situations of local communities. According to Suchs, we should regard the global phenomenon as complex systems: "*In addition to being a normative (ethical) concept, sustainable development is also a science of complex systems. A system is a group of interacting components that together with the rules for their interaction constitute an interconnected whole […] A small change in the cell's chemistry can lead to its death; small change in the physical environment may cause large and cascading changes to the relative abundance of the species in that environment.*" (Suchs 2015, 7). The failure of politics or business can cause financial panic on a worldwide scale. We can also say that the failure of a single cultural process can be caused by a global financial panic, and moreover, the local cultural issues can turn to other severer global issues. As previously mentioned, in order to achieve a sustainable society, we should be able to analyze the global issues by means of interdisciplinary approaches, including economics, ecology, politics, philosophy, cultural studies, etc.

This paper focusses on the concepts of Education for Sustainable Development and Global Citizenship Education (GCED) and their applications. In fact, we have not had enough concrete and theoretical discussions on sustainability: what should be sustainable for our society or global community? What does it mean to be "creators of a sustainable society"? What is a true problem for local communities? Education would not be justifiable without more explicit goals for the plan. We still need to make efforts to clearly define ESD. Moreover, when it comes to education, not only its goals but also its political and cultural effects matter. Every education system needs to constantly be reconsidered and redesigned, as long as it can lead to social, economic, and even cultural inequalities. In this paper, we reconsider the concept of ESD from the perspective of cultural studies and philosophy, and then analyze cases of service learning in Japan and Malaysia to clarify some problems from the perspectives of both students and the local community. With regard to the educational purpose, it is necessary to examine the educational effects of such activities. With regard to the interests of local community, in several observations, we also show the cases that Edward Said (1978) called "Orientalism": our service can be a kind of violence by which service objects are forced to play a role to satisfy our philanthropic desire. In order to test these, we use the concept of 'affect' which refers to the bodily capacities to make a transition beyond expectations. The capacities to affect and to be affected can make a difference to a relationship between self and others. Finally, the paper attempts to present how those theories or criticisms turn into practices.

Education and Sustainable development

The Range of ESD

Before we consider the issues about the 'creators' and local communities, this chapter aims to make clear why ESD should be adopted for service learning. The concept of sustainable development is to solve global issues including economic and environmental problems. And from our perspective, it should also generate a sense of happiness or well-being for every community.

In 2019, Angel Gurria, OCED Secretary-General, noted the importance of the economy of well-being. She wrote that "the SDGs have given an important push to measuring progress 'beyond GDP', although there is significant room for improvement here……the OECD is taking action to help tackle these challenges, and to help countries build "economies of well-being" through its new Framework for Policy Action on Inclusive Growth (Gurria, 2019). Therefore, the categories of happiness or well-being have widely attracted much attention. Moreover, Scotland, Iceland and New Zealand established the group called the Wellbeing Economy Governments in 2018. In this regard, Iceland's prime minister pointed out that the importance of calling for "*an alternative future based on well-being and inclusive growth*" (BBC News, 2019). These actions have closely connected with globalization and the technological innovation. The global economic system, often represented by global capitalism, seemed the best way for each country to achieve economic growth, accumulate wealth and reduce poverty. Indeed, the United Nations' Decade of Development in 1960s was able to project successful economic growth to a certain extent. However, economic growth does not necessarily correspond to the improvement of people's well-being. While globalization accelerated the flow of the markets, it also brought environmental damage and jeopardized the well-being of local communities. As a result, the economic disparity between developed countries and developing countries has been increasing. Thus, it was necessary to consider not only economic situation, but also cultural aspects such as individual well-being, equality, and locality. Sustainable development should be one of the solutions to such problems, which are produced by global capitalism.

In the Brundtland Commission, sustainable development was determined as the development that would meet the needs of all generations without the desire of global capitalism (World Commission on Environment and Development, 1987). "All generations" include future generations, which are not born yet. The Brundtland Commission also claimed that in order to implement sustainable development, we had to pursuit a sense of well-being and happiness. Brundtland defined sustainable development as a holistic measure that would ensure all our well-being, environmental security and social inclusion.

Rio Earth Summit in 1992 following the Brundtland Commission set up Agenda 21 to tackle climate change, biodiversity, social inequalities and so on. According to Sustainable Development webpage, "the Commission on Sustainable Development (CSD) was created in December 1992 to ensure effective follow-up of UNCED (United Nations Conference on Environment and Development), to monitor and report on implementation of the agreements at the local, national, regional and international levels" (United Nations, 1992). At the same time, Agenda 21 included educational statements well known as Education for Sustainable Development in chapter 36, 'Promoting Education, Public Awareness and Training': "*Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues*" (United Nations, 1992). While sustainable development required to connect the local, national, regional, and international levels, it also tried to implement those agreements at individual level through ESD.

Now that education is recognized as one of the most important aspects for sustainability, it is expected to contribute to the enhancement of individual and social well-being. The connection between individual and society is essential for making the foundation of sustainable society. Soubbotina explained: "*Investing in education is not only an important way to build a country's human capital and move it closer to the knowledge economy, thus improving its prospects for economic growth and higher living* *standards. For every individual, education also has a value in its own right because education broadens people's horizons and helps them to live healthier, more financially secure, and more fulfilling lives*". (Soubbtina 2004, 52)

Education allows people to enter more sophisticated lifestyles and to get ideas for technological innovations. Indeed, the knowledge about economy and environment for sustainability may help people make the right decisions when it comes to accessing their health care, enhancing their cultural value and improving their quality of life. Therefore, education became the first place of transforming individuals and society.

It is required to think that an individual has always responsibilities of a social transformation as the member of the society because every choice of each individual can affect the society. Furthermore, a problem in one area cannot be solved solely by the local community, because one community issue can be affected by factors located in a wider geographical area. Sustainable Development seems to include a certain cosmopolitanism according to which any countries have the responsibility of the global issues that would affect every country, including poverty, environmental issues, etc. Of course, there is a discussion about which country has the responsibility to what extent. The practice of this cosmopolitanism would always produce a politically sensitive discussion, because it tends to provoke a conflict between the cosmopolitanism and the realism according to which each nation maximizes their national interest. But this cosmopolitanism itself must be sustained by the fact that any community cannot be sustainable without sustainability of the globe. This cosmopolitanism is closely associated with the Global Citizenship Education or the Education for Sustainable Development or the service learning. As it is pointed out by Cress, "*as citizens, it is our obligation to contribute to the improvement of our nation. Moreover, many would argue that as citizens of the wealthiest nation in the world, it is our responsibility to be good global citizens.*" (2013, 12-13) However, being a good global citizen does not imply taking responsibility for shortcomings in developing countries, but for shortcomings in our community: our community is now the globe. We tackle the global issues, because these issues are our 'own'. Being a good global citizen is not to be philanthropist to help others, but to create a new identity as a global citizen and create a new sense of community as the globe across the national borders.

Active Learning in Japan

In order to respond to the requirement of ESD, one of educational policies promoted by Japan's government is to foster "Global *Jinzai* (Global Human Resources)". The "Global Human Resources" means individuals who can survive in the internationalized labor market and successfully face global competition among high-skilled workers. According to the MEXT, the "Global Human Resources" has "generic skills". Therefore, the education in Japanese schools should aim to let students learn generic skills. The MEXT believes that active learning is a teaching and learning method that suits this aim. According to its definition in the report of Japan's Central Council for Education (*Chuo-kyoiku-shingikai*) issued in August 2012, *Toward a qualitative transformation of university education to build a new future*, active learning is "*unlike one-way lecture-style education by teachers, a generic term for teaching and learning methods that incorporate the involvement of learners in their active learning process*", and it aims "*to develop generic skills including cognitive, ethical, social competences, liberal arts, knowledge and experience*" (MEXT, 2012). It is remarkable that this report emphasizes the importance of developing generic skills rather than deepening the understanding of the subject. In Japan, active learning is promoted by the MEXT because it is considered a teaching and learning method for developing the generic skills, that are necessary for the "Global Human Resources".

Japan's ESD is also influenced by this concept of generic skills. *The Guide for the Promotion of ESD* states that generic skills are needed to be able to make an action for building a sustainable society ((MEXT 2018, p.9). The concept of generic skills is now influential in Japan's school education. The concept of "Global Human Resources" insists that we can be competitive in the global labor market, if we develop our general skills. It presupposes that we are in global competition, and we learn skills to win over others in the global labor market. On the contrary, the ESD and GCED (Global Citizenship Education) are essentially based on the idea that we live together in one community. The ESD and GCED are essentially value educations and transformative pedagogies and allow learners to feel their citizenship in their community. Therefore, we can find a certain contradiction between the concepts of "Global Human Resources" and ESD. However, we can also say that this confusion helped to promote ESD and GCED in Japan's school education.

Service Learning

Since 2000, many Japanese universities and other educational organizations have started to adopt service learning as part of integrating active learning into their curriculums. When universities adopt service learning as part of their curriculums, it is crucial to consider how to connect specific goals with community service through students' learning activities. According to Sara Berman, service learning has a dual role purpose: on one hand, the academic goals and on the other hand, authentic volunteer projects (Berman 2006, xxi). The learning aspect is important as long as it is done in the curriculums of the universities that provide expert knowledge. What is always important and difficult in service learning is how to treat and evaluate this double focus, professional knowledge and actual service experience as one project. To succeed in service learning projects, both teachers and students need a deep understanding of global citizenship and flexible ideas to solve a community's problem. It is completely different from volunteer work or internship activity. The dual focus can be seen as an ideal method to develop a creator of sustainability. Berman continues, "*Service learning strengthens students in many different ways. Students who learn to do for others rather than 'being done for' by others become more self-confident and develop more self-esteem. They feel that they are useful members of the community who can identify problems, propose solutions, act independently in implementing solutions, and open themselves to new experiences and roles as they do so.*" (Berman 2006, xxii-xxiii).

Students learn the process by which they become members of the community and fulfill their responsibilities for problem solving. In other words, this is not just about answering the one-way needs of the community, but it involves a deeper understanding of the community's historical, sociological, cultural, economic and political context. Learning what to do to a community's needs is part of the process of becoming members of the community. In this way, it is expected in service learning that a student thinks the community's issues as their own problems. Next, specialized knowledge is used for analyzing them in order to implement appropriate solutions and therefore, the community can also learn from the student's professional and academic knowledge.

How do students exactly carry their knowledges into communities? Asia-Pacific University-Community Engagement Network (APUCEN), that helps us to do our research in Malaysia, characterizes its own projects as 'knowledge transfer'. Knowledge Transfer literally means that as universities, they offer their expertise to communities. The leaflet that APUCEN published states, "*Revisiting the roles of universities, vis-à-vis the ways and kinds of knowledge being produced, is vital to building a sustainable future. If universities are to achieve their mission to develop and apply knowledge with society in mind,* *then their core functions have to build not only on an academic base but also upon an intellectual civil base that can offer solutions to societal problems. Universities play integral roles in contributing to the sustainability, well-being, and economic vitality of the communities while becoming catalysts for positive change and development at the national and regional levels.*" (APUCEN, 2013)

APUCEN insists that knowledges of universities can help local communities solve their various issues and that it is the most effective contribution that universities have.

Service learning is a type of education through which not only do students improve their sense of the citizenship, but a community learns ways to solve their own problems. In the context of ESD, however, members of the community must reconstruct their lifestyles in order to achieve sustainability. Indeed, improving economic and environmental issues can help them develop their local places. Nevertheless, we still need to think the fact that service learning urges communities to transform their socio-cultural lives and even their feelings, because solutions require their readiness to change lifestyles in the first place. Since this is most difficult aspect of service learning, it is required to discuss the meaning of transforming a local community's life.

Well-beings and Happiness in Local Community

Economic growth and Happiness

What does it mean to transform local communities through university engagement and education? The service learning programs demand students and teachers to understand the situation of each community, such as economic, politic and cultural condition. Based on these specifications, students work to propose a customized solution. On the other hand, the educators, tend to set the educational contents and goals for student as the top priority. These educational goals do not necessarily fit the needs of community. Academic knowledge demands its universality, and therefore, university's education, that provides academic knowledge, tends to set its goals from the universal perspective, that is the global perspective. Thus, this knowledge can be unrelated to the crucial needs of local communities. Certainly, service learning can be justified if it brings benefits to students in their learning process. But, if that is solely the case, service cannot be justified, because local people and their issues would be nothing but their study tools. In this situation, local people only play the role of studied subjects. The service that students practice in their service learning on can be justified only if it serves to the happiness and well-being of local people.

It is not easy to identify the happiness and well-being of local people. The widely accepted answer is that happiness is their achievement of liberty. In this sense, it is sure that their feeling of happiness is closely connected to their economic condition as their 'primary goods' if we use the term of the philosopher Rawls (Rawls, 1999). According to *World Happiness Report* in 2019, "*the effects of happiness equality are often larger and more systematic than those of income inequality. For example, social trust, often found to be lower where income inequality is greater, is even more closely connected to the inequality of subjective well-being*" (Helliwell et al., 2019, 19). The relationship between happiness or well-being and the economic situation has to be investigated carefully. It is easy for universities to take economic issues as the purpose of service learning, but without achieving feelings of happiness, the project cannot be successful. On the other hand, Richard Layard states that "*there is a paradox at the heart of our lives. Most people want more income and strive for it. Yet as Western societies have got richer, their people have become no happier*" (2005, 3). The improvement of the economic condition does not necessarily lead to the happiness. Not only economic or environmental solutions, but also social and cultural dimensions should be considered. Now, we consider that happiness is associated with cultural contexts, and we introduce cultural studies based on this consideration.

Happiness and Affect

In *the Promise of Happiness*, Sara Ahmed notes that "*cultural and psychoanalytic approaches can explore how ordinary attachments to the very idea of the good life are also sites of ambivalence, involving the confusion rather than separation of good and bad feelings. Reading happiness would then become a matter of reading the grammar of this ambivalence*" (Ahmed 2010, 6). We understand affect as what produces this confusion of feelings. In this chapter, we examine the affects as what would cause happiness, based on 'the ethics of happiness' proposed by Kim Yerang (2019).

Happiness and well-being are not the environment of human beings but mind conditions. When people see local communities' mind conditions from their perspectives, there is a risk of seeing them as docile bodies represented as vulnerable members. 'The ethics of happiness' aims to shift vivid happiness outside the 'happiness *dispositif*', which is constructed by the discourse including religion, education, family, schools, and government. As Sara Ahmed noted in *the Happy Objects*, if happiness has a power to solve local issues, "then we can consider how feelings participate in making things good. To explore happiness using the language of affect is to consider the slide between affective and moral economies" (Ahmed 2010, p.30). We need to discuss not what is happiness itself but what happiness can do, because happiness is not personal matters but the phenomenon between a body and another body. What is important here is where the happiness lead us to rather than what happiness gives us.

First, we need to consider how 'affect' affects people. According to Melissa Gregg, affect is just movement that passes a body to a body. "*Affect, at its most anthropomorphic, is the name we give to those forces- visceral forces beneath, alongside, or generally other than conscious knowing, vital forces insisting beyond emotion-that can serve to drive us toward movement, toward thought and extension, that can likewise suspend us (as in neutral) across a barely registering accretion of force-relations, or that can even leave us overwhelmed by the world's apparent intractability*" (2010, 1).

Affect is not involved with any discourses and the intention of a body itself, in other words, it does not work on the processes of signification but it involves the processes of body's movements or transitions. Brian Massumi, who introduced the affect theory into cultural studies, says in *Parables for the Virtual* that it coincides with its own transformation, transition and variation (Massumi 2002, 4). The bodily transition is related to every transformation of people's lives because it is related to the process of producing differences. The differences have the power to change situations outside of discourses, which is to say that the bodily transition is an exceedingly abstract movement. With Deleuze's theory in mind, Massumi says: "*It doesn't preexist and has nothing fundamentally to do with mediation. If ideology must be understood as mediating, then this real-abstract is not ideological. Here, abstract means: never present in position, only ever in passing. This is an abstractness pertaining to the transitional immediacy of a real relation- that of a body to its own indeterminacy*." (2002, 5).

Indeterminacy and abstractness of a body gives us an opportunity to make a difference because it happens outside of the mediation. Massumi calls this the movement-vision. The movement-vision is "*a multiply partial other perspective included in a fractured movement-in-itself: change*" (Massumi 2002, 51). Moreover, to enter the space of movement-vision, we must see ourselves as others. This transformation of bodies literally changes the bodies in between self and others on a subject-object axis. It is an unpredictable phenomenon but there is a possibility that we can make a new identity from unmediated impulse and this also has the potential for being the global citizen because the global citizen needs to exist between global and local spheres.

Affect is not a personal phenomenon. It allows a local community to create a new lifestyle while maintaining their cultures. As Yeran (2019, 37) mentioned, vulnerability and pain can rather transform into strong political ethics. In the movement-vision, subject is constantly changing, and we never be able to determine what it is. Sustainability of happiness is needed for the community. Since ethics is related to the will of the individual to do something good, now we need to consider not what should we do in the global rule but what we can do in constantly changing local situations through sensing the needs of local members. In this way, service learning needs to build up the idea and the design to use the power of affect, in order to lead subjects to achieve their happiness goals. Rather than happiness by innovation, it is more important how productivity of happiness or well-being can change the society.

Practicing Service Learning in Malaysia and Japan

Clean Streets with the 3R (Reduce, Reuse & Recycle)

In this section, we demonstrate the Malaysia and Japan cases of service learning and investigate the cases from the angle of cultural studies and philosophy.

In March 2018, our research team visited Malaysia, and observed some of the community engagement activities of universities: The Dried Catfish Project and The Oyster Project (at the Universiti Sains Malaysia), The Stingless Bee Project and the Peace Learning Centre (at Rohingya school), and a community engagement activity of Universiti Utara Malaysia: Clean Streets with the 3R. The professor of accounting from Universiti Utara Malaysia, Hazeline Ayoup, was in charge of the "Clean Streets with the 3R" project. Her students of accounting participated in this project activities. The project held an enlightenment event that was opened to local community people in Kedah. This event began by a JICA (Japan International Cooperation Agency) volunteer's lecture. In his lecture, he explained how to use raw garbage as fertilizer, and participants tried to practice it. After that, participants were divided into some groups, and each group cleaned up the area that was allocated. At the end of the event, there was a lottery for participants.

This event gave students an opportunity to deepen their understanding of their discipline by taking action based on their academic knowledge for the sustainability of their community. In this event, students provided with the concept of 3R applied to garbage disposal, understood the importance on cleaning up the area. Thereby, they also got an opportunity to deepen their understanding of the current situation of the community: since there is no public service for garbage collection, residents burn garbage by themselves without scientific knowledge. The burning of garbage poses a high risk of being exposed to toxic gases. This event also gave students an opportunity to understand the lack of residents' awareness and the structural problems of this area that has no social infrastructure and lacks even electricity. From the perspective of accounting, external diseconomies such as health damage and environmental pollution should be internalized. The aim of the project was for the students to realize the importance of the concept of 3R and of a technique of raw garbage disposal for improving the community's circumstances.

From the perspective of social and cultural affect, it was expected that this event was a transformative pedagogy for students and gave them an opportunity to feel a connection with residents or feel themselves as members of the local community. The social emotional learning, however, was limited in this event. It is because it was evident that residents did not participate actively in the event. Although some residents came to the event, no local resident participated in the raw garbage collection activity, as they left the lecture room after JICA volunteer's lecture. Only students stayed to experience raw garbage disposal. Certainly, some local children participated in the group activities for cleaning up their area. However, even they did it because they could receive some reward by doing it. It means that their participation was not based on their understanding of the importance on cleaning up the area. It seems that many local people participated in the event for the lottery. The coordinator of the program was quoted saying: "*We cannot collect them without lottery*." While the local problem is clear, it is difficult to make local residents truly aware of it. The event was definitely not matched by the needs of local people. This case allows us to realize that it is important to make connection and communication and affect between students and local people. Otherwise, the achievement of happiness and well-being of local people would be more difficult. Students need to understand the local community's feeling from the perspective of that very local community. One of the service-learning projects in Japan's universities also prove this point. *New Horizon of volunteer education – principles and practices of service learning* shows comments from participants in a service-learning program on cleaning up their local area held by Ritsumeikan University. One of the students said that "*I absolutely feel that it's difficult to create positive societal transformation in a lack of communication between local communities*" (Sakurai 2009, 115-116). Provided that students have a sense of community, they can create a remedy for a local issue, because only the experience between professionals and community life offers them a sense of community's happiness. Without this sense, the program does not succeed. It is necessary to keep in mind that goals in a program should be related to their happiness, not a raffle. We can insist that this gap between students and communities is unintendedly produced by the 'happiness *dispositif*'.

The Peace Learning Centre (Rohingya school)

Another example of a 'happiness *dispositif*' was observed in the Peace Leaning Centre program at the Kyoto University of Foreign Studies. The Peace Learning Centre located in Penang is supported by professors from the School of Social Sciences at the Universiti Sains Malaysia and their students. They teach Rohingya refugee children English and other basic subjects.

Prof. Kageura is in charge of a service-learning program for his department of Global Studies at the Kyoto University of Foreign Studies in Japan, and this program was implemented in October 2019 for the first time. The activities in the Peace Learning Centre were a part of the program. His students spent three hours with children on each day throughout a week. The teachers in the Centre allowed Kageura's students to do their project freely and without any reference to this Centre's curriculum. They also tried to teach children Japanese, which was the students' idea. While it was a good opportunity for children to learn Japanese and the Japanese culture, Rohingya refugee children have some more urgent matters that are needed in order to survive in the Malaysian society and this is the reason why they need to learn English. Thus, although learning Japanese could be an enjoyable experience for the children, it is doubtful that the activity will really be helpful for them. This can be seen as another case of 'happy *dispositif*', in that there is a difference in the happiness mindset between Japanese students and the refugee children. In this service leaning program, unlike the clean streets program with the 3R where Malaysian students participated the activity in the specific countryside in Malaysia, Japanese students needed to go overseas and experience a completely different culture. Japanese students, therefore, had to learn the Malaysian culture, the religion, and the history of Rohingya refugee. When considering the process of implementing the program, it appears that the students could not overcome their preconceptions. The reason is that they could not come up with what was really in need for the community.

There was affect between the students and Rohingya refugee children to a certain extent, but the problem was that there was no affect between the students and Peace Learning Centre's teachers. We can expect that this project would be a more efficient transformative pedagogy if the students can spend more time to communicate closely with Peace Leaning Centre teachers. Therefore, students should change their understanding about the community's needs, what can bring happiness to a community and afterwards they may realize how a sense of happiness can transform the community itself.

Oyster Project

The professor of marine biology from Universiti Sains Malaysia, Shau-Hwai Aileen Tan, is in charge of this project for oyster culture. The project has two activity locations: at the Centre For Marine & Coastal Studies (CEMACS) in the Universiti Sains Malaysia and in a coastal community in Kedah. The mass production of oyster seeds is possible in CEMACS and oyster seeds are nurtured. They are sent to a coastal community in Kedah, where they are grown. Mangrove protection is also included in this project. Professor Tan has sent oyster seeds to the local community and has helped this local community with training and guidance on the basic method of culturing oysters. She has also directed undergraduate and postgraduate students of marine biology to all these sites for research. In March 2018 and May 2019, we visited the coastal communities in Kedah and in May and October 2019, we visited CEMACS. When we visited Kedah, we were able to observe oyster farming and the activities on the mangrove planting area.

According to Prof. Tan (TEDxBayanLepas 2019), it took two years for her to gain the trust of local communities, after which she started the project. Prof. Tan found that local people changed throughout this project: they became more open-minded. Although they cannot speak English at all, local people have become more active in accepting foreign visitors. When we visited their community, we could not communicate with them without Universiti Sains Malaysia students' translation. However, the community leader willingly presented their community and the oyster farming activity to us. He had the confidence to carry out the project and he seemed to understand the project as his own job. This is the most significant process in a service learning program. He has not changed because of his knowledge that was given by the university, but because of his own sense of happiness in working for the community. We can certainly find that there is affect between local people and the university people, and this transformed all the concerned people involved in the project. The program is still ongoing but if the local people can handle the project themselves with a sense of happiness, it can be assumed that the project has a positive effect on the community.

Conclusion

It is important for local communities to solve their economic and environmental issues. But, at the same time, social or cultural aspects should also be considered. We repeatedly use the term 'community' in this paper. However, there is always an unintentional trap in terms like 'for local areas' or 'for communities'. Individuals do not exist for 'local areas' but living in a specific area should mean each individual is enriching their lives (Kawabata, 2018, p.19). In order to achieve sustainability, universities have to run the service learning projects with multiple perspectives, because sustainability is to be associated with people's lives or feelings. Once Jean-Jacques Rousseau writes i*n the Social Contract* that "*as long as several men in assembly regard themselves as a single body, they have only a single will which is concerned with their common preservation and general well-being……Finally, when the State, on the eve of ruin, maintains only a vain, illusory and formal existence, when in every heart the social bond is broken, and the meanest interest brazenly lays hold of the sacred name of "public good", the general will becomes mute: all men, guided by secret motives, no more give their views as citizens than if the State had never been……Dose it follow from this that the general will is exterminated or corrupted? Not at all… he wills the general good in his own interest, as strongly as anyone else.*" (1762).

These words provide a basis for the citizenship. The general will is the will of each and every individual, and their achievement is self-fulfillment, which brings happiness. Rousseau (1750) also states that "what good is it looking for our happiness in the opinion of others if we can find it in ourselves? Let us leave to others the care of instructing people about their duties and limit ourselves to carrying out our own well". Citizenship thus brings happiness.

If we follow the theories of cultural studies, affect would cause feeling for this citizenship. Citizenship education would not be feasible without affect between local people and students. Service-learning programs should have a chance for affect between local people and students. But in reality, it is difficult to realize such educations. This is what we see in some cases in Malaysia and Japan. The service learning should not be just 'knowledge transfer', activities to convey ideas or knowledge of universities into communities. It should allow students to co-create happiness with community people, as citizens of this community. What can generate affect between local people and students should be taken into consideration for service learning.

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Evaluation of a political socialization strategy within family communities, from a governance and sustainability approach, with an educational nature.

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Abstract: This study analyses the governance and sustainability role of political socialization with an educational nature within family communities, as a potential factor for change in behavior, preferences and consumption decision-making, intended to protect natural resources. Our conclusion points toward two main drivers: the incorporation of knowledge and values, as well as the development of competences inherent to implementation of an environmental management system within families. The two drivers can act as specific instruments of the proposed strategy for political socialization and thus explain varying degrees of willingness in relation to saving on energy consumption, potable water and waste generation. These are connected to changes in behavior, preferences and consumption decisions intended for the protection and rational management of natural resources, as well as for the internalization of environmental externalities.

Keywords: political socialization, consumption decision-making, environmental management system, family, governance

Introduction

It is considered within the domestic setting that political socialization consists of internalizing beliefs, values, ideas, behaviors and attitudes that constitute the political heritage of individuals. In most of the literature, the emphasized factors are linked to the perception construction of the way political power is made and the way the world is organized around the citizen. Nevertheless, this paper's approach to the issue regards the family as one of its major agents, as it is an influential institution which instills rules, behavior of economic and social values in their members.

It might be said that some of the main public problems originated in the difficulty to identify borders amongst education, public policies and daily life itself. Besides, they are constantly presented to us as relatively independent and differentiated subjects for academic purposes. Then, most of us are somewhat predisposed not to incorporate such concepts into our citizens' life.

Generally, when arriving at a gas station we do not reflect on the general condition that would get the maximum consumption efficiency from our vehicle. We just want our tank to be filled up, in the hope that the amount of fuel will be enough to obtain the best possible mileage. When walking through a supermarket's aisle we seldom look at products' labels.

The above paragraph shows some examples of daily life where a lack of incentives (public policies) to enable a change in civic behavior (education) can be identified. Most alarming is the persistence of the belief that appropriate education is only obtained in classrooms, and that public policies that are needed to solve serious community problems are the sole responsibility of governments. This situation worsens if we take into account that the combined effects of the influence media and governments' have on the way society perceives reality.

The dominant economic system during the last decades and its consequences have been identified as the main reasons justifying the emergence of a new concept of development. The core components of such a system are: rampant consumerism conceived to never be satisfied, the capitalist-neoliberal concept of development based almost entirely on consumption, intrusive mass-media intervention strategies at the individual level, and modern circulation of money and information, which causes an unprecedented volatility in the global capital. As a result, individuals have been led to a virtually nonexistent participation in the most important element of community life: decision-making. "*If it is not environmental educators' job to cultivate that kind of understanding, whose job is it, then?";* or, in that very sense, who are environmental educators, really?

In order to make education efforts effective and relevant, they must be incorporated to trends and rules of societies. First and foremost, nuances and relations of the different elements interacting to form our collective states of mind must be identified. It is all about shaping citizens' understanding regarding environmental matters, so that they are able to assess complex information and make informed decisions about issues that are hard to visualize. This can be done by incorporating the ability relevant to achieve the necessary changes in attitudes and behaviors, thus clearing the path to sustainable development.

With the aim of creating a deep connection with what is learnt, what is taught must provide (or have) real support to citizens' life. Solutions most come not only from classrooms, but also from homes and communities.

Then, the issue of environmental education must be put forward as a public policy challenge from the perspective of politics and environmental law, as well as from the sustainability angle.

The study approaches the problems in the fields of political socialization in the family and public policies, as well as in the way knowledge is generated from the implementation of such processes.

Problems that give rise to research questions

According to INEGI (National Accounts System of Mexico): Financial and ecological accounts of Mexico, costs of what is known as *the rest of sectors* (trade, information and mass-media, financial services and insurance, corporate, healthcare services, sports services, hotels and restaurants) as well as those of the institutional sector *homes*, increased to $459,846,644,000 Mexican pesos in 2016, but in the latter case they represent 58.4% of this economic sector as well as 49.9% of the total costs of depletion and degradation of the country's natural resources.

The accumulated loss of purchasing power in the last 30 years, measured on the basis of the basic food basket, amounts to 80.08%. According to the analyses performed throughout several years by the National Autonomous University of Mexico (UNAM), a lack of recovery has been detected.

In 2017, amongst the 35 member countries of the OECD, Mexico recorded the highest inflation regarding energy and the second highest inflation regarding food. In that year, the price of energy products in this country increased by 15.8% compared to that of 2016, which represents more than twice the 6.9% average recorded by the OECD associates.

Regarding the observation of home-related national surveys (National Survey of Homes [ENH] and National Survey of Political Culture and Civic Practices [ENCUP]), the notion of political socialization was absent.

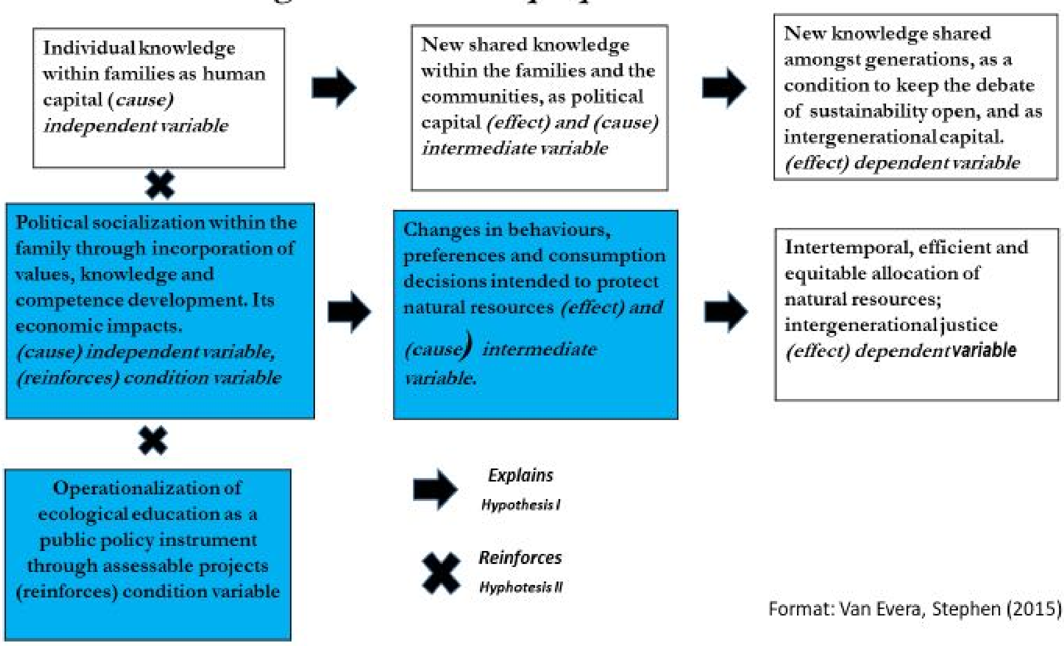
Proposal and theoretical framework

The proposed theoretical scheme is built on the basis of a cause-and-effect link *between potential changes in consumption behavior and incorporation of values and knowledge acquired during the exercise (ethical practice) of political socialization within the family*. *In particular, special attention is paid* when these processes are reinforced by the establishment of projects capable of operationalizing a public policy instrument. It also indicates that such changes in preferences, behaviors and decisions would explain, at the same time, *a prospective intertemporal, efficient and equitable allocation of natural resources*, as well as the proper conditions to establish justice in terms of intergenerational equity.

Aimed to a politics of knowledge, another chain scheme is proposed amongst new knowledge shared in families and communities (as political capital), and the individual insights of its members (as human capital), even more so when these processes are reinforced by the *incorporation of values and knowledge acquired during the exercise (ethical practice) of political socialization within the family* (Fig.1)

Then, research on concepts leading to abolishing barriers between the concepts of education, public policies and daily life, as well as to favor their integration into the fields defining sustainable development, is required. Given that this type of development is allowed by economic, environmental and social factors, concerns have arisen over the reason why they are presented to us as relatively independent and differentiated entities for academic purposes, as well as over our predisposition not to incorporate them appropriately into our citizens' life.

Fig. 1. Theoretical proposition



These are important issues, but they are too extensive to be covered in the same paper. Nevertheless, some questions can be posed stemming from the identification of problems originating from such issues. As for the assessment, it is the stage of the public policies cycle that makes it possible to decide whether to continue applying them and, if so, whether with or without changes. *Can the role of political socialization (within families) be reinforced as a factor for change in consumption preferences and behaviors towards decision-making intended to protect natural resources through projects suitable for* *assessment according to their economic impact? (research question number 1) If so, is it possible to operationalize ecological education as an environmental policy instrument? (research question number 2)*

Considering that both transition processes of members' individual competences and joint actions required to achieve a social optimum take place within the family: *¿Can political family socialization (education) be established as a factor for change in consumption preferences and behaviors toward decision-making intended to protect natural resources through incorporation of knowledge and values, as well as development of competences? (research question number 3)*

Finally, in the light of the intergenerational nature of family structure, it is fair to ask: *Would the previously mentioned changes and new decisions lead to an intertemporal, equitable and efficient allocation of such resources? (research question number 4).*

Once justification giving origin to this research project have been contextualized and questions expected to outline its course have been posed, the respective study object can be established: *political socialization (education) within the family, as a factor for change in behaviors, preferences and consumption decision-making intended to protect natural resources from a governance and sustainability approach.*

Since this way to address the study problems put forward has been just slightly explored, the theoretical apparatus of this research comprises very diverse fields of science. Therefore, the path to identify a methodological instrument capable of providing insight *in a first exploration* of interim answers to the questions already posed is analyzed.

When identifying a possible theory of social change (from norms and values linked to social structures) implicit in every public policy, enquiries are made about whether it can be implemented by means of changes in behavior patterns, preferences and *consumption decisions intended for protection and more rational use of natural resources*, as well as for internalization of environmental externalities.

Methodological instruments

Design

Some methodological stances are the starting point leading to the initial research project. The first of them has an *explanatory nature (positivist).* A theoretical framework of cause-and-effect about observed phenomena has been proposed from it. It centers around the *rational choice stance* on the subject of decision-making for consumption. It focuses specifically on the analysis of the way groups of individuals (families) respond to challenges concerning political institutions (rules of the game), public policies (processes for solving public problems) and other inherent phenomena.

The second methodological stance is a *critical* one (under the qualitative paradigm). It lies either in emancipation or empowerment, its main objective being to help research participants to identify and understand the causes of their circumstances and then empower them to produce the change they deem necessary.

Similarly, this initial research incorporates a *postmodern (postpositivist) approach*, which highlights the importance that must be attached to time, situation and purpose of social actors, on top of the event or behavior themselves. This methodological stance gives rise to a study case. In this regard, researcher Myriam Cardozo Brum (2006) highlights the fact that social sciences have moved from the study of macro processes with quantitative methodologies to the social construction of meanings in local communities under a qualitative paradigm. The author stresses that the latter emphasizes the analysis of differences, the study of individual (micro) matters, their causes and the emotions actors attach to their participatory experience. *This includes the* social, cultural and political dimensions in which they develop, as well as the life of groups in society, their actions and interrelations.

Moreover, such an approach points out that, as a part of the intuition with which a theoretical proposal framework is constructed, one of the most important tasks of a researcher consists of interpreting a phenomenon itself before research on it can be carried out.

The initial project design is determined by a logical structure, which provides certainty that collected data are enough and appropriate to answer a research question thoroughly and with no ambiguities. Such design has an exploratory nature (scope), as a small sample is to be used in it. This sample will be essentially employed to obtain a greater perception of the phenomenon under a case study, as well as to generate additional ideas concerning research problems, variables and other related matters. The reason why this alternative has been chosen is that exploratory studies are often employed as a first step in multiple-part research projects.

Data collection in this exploratory stage implies a combination of strategies that comprise both quantitative and qualitative elements. It is indicated that such data come from primary sources. This design includes the elaboration of a baseline in order to assess the willingness to implement an environmental management family system within communities in Merida, Yucatan. The implementation of such a system implies a political engagement of the whole family, led by parents (senior management) in order to carry out a set of actions aimed at improving their environmental performance; in this case, energy and water consumption as well as reduction of urban solid waste generation are considered (Fig. 2). This type of system has been chosen because of the analogy existing in the sphere of economic resources use, between either a business or a government organization and a family organization.

Furthermore, its implementation in subsequent stages of the research project requires simple training provided by expert advisers to family communities through guidance documents connected to Sustainability Related Management System Standards - such as the ones designed both by the Secretariat of the Environment and Natural Resources [*Secretaría del Medio Ambiente y Recursos Naturales*] and by the U.S. Environmental Protection Agency. Through this baseline (ex ante evaluation) the information necessary to draw comparisons with the results of subsequent stages of the research is generated. The information also serves to test -as though it were about an explicit or implicit hypothesis- whether the proposed strategy for political socialization within the family (either as a policy or a particular action programme) has been capable of producing the expected effects. This will entail making sure that such effects have been produced and the policy has been their only cause, thus dismissing the impacts of other possible intervening variables.

Process for gathering information

Information for this stage of the initial research has been gathered through a set of interviews along with a questionnaire **(**APPENDIX I), both carried out prior to the incorporation of the political socialization strategy. It is worth noting that the questionnaire's design is supported by the study of general predictors versus specific predictors of the environmental behaviors under assessment, by comparing the concerning effects of such behaviors' immediate precedents. These are comprised by the model developed in the field of social psychology by Icek Azjen and Martin

Fishbein (1991), *Theory of Planned Behavior* (TPB), which means: intentions, attitudes, subjective norms and behavioral control perceived by the individual. Questions are grouped as follows: those exploring social situations and political perceptions in families (items 1 to 4), those concerning differentiated willingness intended to modify energy consumption and other environmental behaviors (items 5 to 11), and finally those (items 12 to 21) regarding willingness aimed both at implementing an environmental management family system (EMS) and sharing information related to current consumption (Fig. 3) and APPENDIX I. The questionnaire (APPENDIX I) has been designed to determine what people know and think, *as well as the way they are willing to act*. Questions have been arranged in a logical sequence and have been formulated in the clearest possible way for people from all professional and educational backgrounds and ages. Prior to obtaining the sample, relevant modifications were made for a better understanding both of every item and of pertinent explanations. To this end, knowledge and experience of interviewers (who were required to complete the questionnaire) were taken advantage of, concerning some of the elements that constitute political socialization within family communities.

In this regard, the questionnaire has been structured with the aim of gathering information useful to answer each study question by means of the respective case hypothesis testing, as well as to keep potential mistakes to a minimum. Besides, individual answers have been developed according to the data analysis plan with respect to codification, tabulation, and interpretation. The questionnaire was arranged in such a way that respondents would feel motivated to answer all the questions, beginning with the wider and easier to answer ones and continuing with those more focused questions. Answering the latter often demands a significant effort from the respondents. It was intended to prevent respondents from interpreting the questionnaire as a very difficult task, otherwise they would often ignore questions. When possible, the so-called *funnel sequence* for questionnaire design was adopted.

Good case studies include some uniform and generalizable features, as well as others that seem to be relatively unique to the study case. Case hypotheses 1 to 5 refer to differentiated perceptions about: the best environment for learning how to make a great change in politics and to design a family policy from home. Moreover, they refer to different degrees of willingness to implement an environmental management family system. Hypotheses 6 to 10 concern different degrees of willingness to modify consumption of electricity, fuel, LP gas and potable water, as well as solid waste disposal, concerning implementation of an environmental management family system.

Case hypotheses 11 to 15 relate to different degrees of willingness to modify such consumption concerning enhancement of an environmental management family system through incorporation of suitable assessment projects. Finally, case hypothesis 16 conjectures about different preferences regarding time return to reinvest saving profits in consumption, and the willingness to implement (or not) an environmental management family system (Fig. 3).

The case study for this initial research has the following cornerstones: political-family communities in Constituency V of Merida City, Yucatán; tests concerning differences amongst groups resulting from preferences for implementing (or not) an environmental management family system; analyses (debates) concerning willingness intended to: a) f*ace family problems (energy consumption)* with an own policy; b) *express a family energy policy*; c) negotiate and agree to look for solutions (*setting up of goals with regard to saving*) within the family; and d) implement a strategy (with a *specific instrument*) for achieving all this.

Statistics

From a statistical point of view, the case study population consisted of about 41,314 families. The sample size of 317 families was determined in accordance to the following factors:

- A confidence level of 95%, which determines the critical value for standardized normal distribution Z=1.96
- An acceptable sampling error of 5.5%
- A population proportion of 50%, which produces the largest possible sample size

The sampling framework was taken from both the electoral register and the INE's (National Electoral Institute) nominal list of voters, as well as from the publication titled "Geografía Electoral. Distrito V" (Electoral Geography. Constituency V) by Instituto Electoral y de Participación Ciudadana de Yucatán (Electoral and Citizen Participation Institute of Yucatan). A stratified sample was established according to the number of families comprised in each of the 51 electoral sections of constituency V. The sample was obtained between June and November 2016 by 18 interviewers, 13 women and 5 men. As for the survey questionnaire, it was answered by 122 men and 8 women, as the responsible people for financial management at home.

Information analysis plan (data)

Data were compiled in a spreadsheet, separately for each of the questionnaire's item. With the aim of carrying out contingency tests concerning hypotheses, family communities were classified into 5 socioeconomic levels, according to the assessed value of the plot where their homes were located, which was used as a parameter to measure household wealth value. The concerning tabulation was made with the filtered data in the spreadsheet, according to the tests of independence to be carried out amongst categorical variables (Fig. 3).

The survey variables (data variables in Fig. 2) used for measuring economic impacts stem both from potential willingness or unwillingness to implement an environmental management system (independent variable) expressed in questionnaire item 11, and from the different degrees of willingness (percentage) to achieve certain savings goals (intermediate variable), expressed in questionnaire items 5 to 9. (APPENDIX I)

In order to make comparisons of categorical answers' counts, cross-classification tables have been developed. They show occurrence frequency of success and failure concerning each variable (contingency tables).

Case hypotheses testing was performed (numbers 6 to 10) with the relation amongst these variables, through application of chi-square statistics as an independence test between two categorical variables (concerning difference amongst groups) (Fig.3). The null hypothesis proposes that both categorical variables are independent, that is to say, there is no relation between them, whereas the alternative hypothesis indicates that both variables are dependent, or more exactly, that there is a relation between them. In the event of null hypothesis rejection, comparisons were made of all pairs of variables using the Marascuilo procedure to determine whether or not there was significant differences amongst them.

For measuring economic impacts, relations were established between potential *willingness or potential unwillingness* to incorporate a project -by sharing initial information- in order to reinforce implementation of an environmental management system (*conditional variable*), expressed in questionnaire items *12 to 21,* and differentiated percentage willingness for achieving certain savings goals *(intermediate variable)*, expressed in questionnaire items *5 to 9* (APPENDIX I). The relation between such variables was used to perform tests of case hypothesis -items 11 to 15- through application of chi-square statistics as a test for independence between two categorical variables (Fig. 3). The null hypothesis puts forward that both categorical variables are independent, that is to say, there is no relation between them, whereas the alternative hypothesis indicates that both variables are dependent, in other words, there is a relation between them.

In the event of null hypothesis rejection, comparisons were made of all pairs of variables using the Marascuilo procedure and it was determined whether or not there existed significant differences amongst them. Validity evidence of the instrument is linked to its content, essentially because of the following elements: 1) Questionnaire design is supported by comparative effects of immediate antecedents of environmental behaviors, which are included in the Theory of Planned Behavior (TPB) model, specifically: intentions, attitudes, subjective norms and behavioral control perceived by the individual; 2) Studies on general predictors vs specific predictors (in five of the environmental protection domains) of the environmental behaviors they evaluate. These studies were conducted by N. Carmi et al. (2014) , for the Tel-Hai College in Israel during 2012 and 2013; 3) Other research works where representation of content domain components (67%) of measured variables is observable.

Results

It can be stated that results concerning case hypotheses 11, 13, 14 and 15 provide sufficient elements to obtain - with regard to evaluable projects on electricity, LP gas, potable water and solid waste respectively - a negative answer to research questions 1 and 2. Nevertheless, results concerning case hypothesis 12 provide sufficient elements to obtain - with regard to evaluable projects on fuels - a positive answer to research questions 1 and 2. It can be observed that results of hypotheses tests 6, 7, 8, 9 and 10 provide sufficient elements to obtain, with regard to the case study, a positive answer to research question 3. It can be asserted that results concerning hypothesis 16 provide sufficient elements to obtain, with regard to both the study case and long-term preference, a negative answer to research question 4. However, as far as the study case and medium-term preference are concerned, such results provide elements to obtain a positive answer.

Conclusion

It can be concluded that the incorporation of evaluable projects into the specific instrument of the proposed strategy for political socialization, does not lead to enhanced degrees of willingness with regard to energy consumption, saving on potable water consumption and modification of waste generation. This conclusion should be interpreted in connection with a change in behaviors, preferences and consumption decisions intended for protection and rational management of natural resources, as well as for internalization of environmental externalities (linked to research questions 1 and 2). Yet, considering what was observed, the subject of energy consumption in the field of fuel for vehicles poses an exception. The incorporation of knowledge and values, as well as the development of competences inherent to implementation of an environmental management system within families as a specific instrument of the proposed strategy for political socialization, explain different degrees of willingness in relation to saving on energy consumption, potable water and waste generation. This conclusion should also be interpreted in connection with changes in behaviour, preferences and consumption decisions intended for protection and rational management of natural resources, as well as for internalization of environmental externalities (linked to research question 3). Moreover, it is concluded that, although there is a willingness to change preferences and behaviors towards consumption decision-making intended to protect natural resources, intertemporal allocation of financial resources released from such changes does not seem to be equitable and efficient, that is to say, it is unsustainable. A causal factor for this trend is the fact that preference for short-term and medium-term has been manifested (linked to research question 4).

In conclusion, it is proposed in this work to delve into *a path allowing to move from environmental education to political socialization and go back*. This path would look like a process of re-discovery in changing behaviors and preferences, as well as in the improvement of general decision making; that is to say, of the common elements between education and politics.

Figure 2: Matrix of operationalization of variables

VARIABLES OF THE THEORETICAL PROPOSITION FRAMEWORK	CONCEPTUAL DEFINITION	OPERATIONAL DEFINITION		CASE VARIABLES (TYPES)	SOURCE OF DATA COLLECTION
		Factors	Indicators		
Implementation of political socialization strategy within the family (EMS) (independent).	It refers to the incorporation process of values and knowledge, as well as to competence development.	Willingness **to pool values, knowledge and competences. It is inherent to** the implementation **process of** an environmental management family system (EMS).	Implement EMS. Do not implement EMS.	Categorical, nominal. Independent (It contains the stimulus or experimental treatment).	Questionnaire, 1st and 2nd parts. Items 3, 4 and 11.
Consumption saving (change). Waste reduction and generation (intermediate variable).	It refers to the process of change in behaviours, preferences and consumption decisions	Willingness to save (change) on consumption and to reduce waste generation.	<= 5% <= 10% <= 15% >15% Regarding current consumption	Categorical, nominal Dependent.	Questionnaire, 2nd part. Items 5 to 9.
Ecological education as a public policy instrument (elements allowing to clarify it and measure it as a [diffuse] concept). (Conditional variable).	Implementation of projects suitable for assessment according to their economic impact (reinforces implementation of EMS	Willingness to share initial (current) information about consumption. It is **necessary as a first step to formulate ecological education projects** vii **(measurement of the policy instrument).**	Share current information. Do not share current information	Categorical, nominal. Independent. (It contains the stimulus or experimental treatment). .	Questionnaire, 3rd part. Items 12 to 21.
Intertemporal, efficient and equitable allocation of natural resources (dependent variable).	It refers to an optimal distribution of resources during time frames, after making compensations amongst each time frame's groups.	Temporary preference on return **(allocation as a compensation to a future group)** of benefits derived from saving **(regarding the current group)** according to the type of good or service.	Preference for short-term. Preference for medium-term. Preference for long-term	Categorical, nominal. Dependent.	Questionnaire. Item 10.

Figure 3: Correlation amongst Categorical Variables

Research hypotheses tests	Case hypotheses tests	Questionnaire **ITEMS** (APPENDIX I)	X^2 Test (outcome value)	Critical value	Null hypothesis (H0): ***there is no relation*** amongst variables.
Context tests for hypothesis	H1	3	22.1089	9.4877	Rejected
	H2	4	6.5186	9.4877	NOT rejected
	H3	3 and 4	9.7371	9.4877	Rejected
	H4	11	20.9501	9.4877	Rejected
	H5	3 and 11	1.5439	9.4877	NOT rejected
Hypothesis I, between ***independent variable and dependent variable*** (item I.6)	H6	5 and 11	12.7239	7.8147	Rejected
	H7	6 and 11	13.4853	7.8147	Rejected
	H8	7 and 11	15.7477	7.8147	Rejected
	H9	8 and 11	21.1695	7.8147	Rejected
	H10	9 and 11	19.2790	7.8147	Rejected
	H16	10	15.0805	7.8147	Rejected
Hypothesis II, between ***conditional variable and independent variable***	H11	12 (17) and 11	6.7608	7.8147	NOT rejected
	H12	13 (18) and 11	10.5480	7.8147	Rejected
	H13	14 (19) and 11	5.9080	7.8147	NOT rejected
	H14	15 (20) and 11	6.4544	7.8147	NOT rejected
	H15	16 (21) and 11	3.4291	7.8147	NOT rejected

Test for independence between two categorical variables, through an X^2 test. Decision rule: Reject Ho if $X^2 > X^2u$ (critical value). Significance level (α) = 0.05

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APPENDIX I. QUESTIONNAIRE.

"ENVIRONMENTAL INITIATIVE FOR FAMILY SAVING"

This short survey is intended to start a project about household saving (energy, water and solid waste generation).

The project consists in implementing a simple environmental management system, introduced to your home by YOURSELVES, with the support of our institution's instructors and of qualified personnel specialised in energy saving and environmental protection (INCENTIVE OR STIMULUS).

ITEMS:

1.- How many people are there in your family?

a) 2 b) 3 c) 4 d) 5 or more

2.- Approximately what percentage of the family income do you spend on household electricity bills?

a) 5 % b) 10 % c) 15 % d) Other_

3.- Which of the following do you deem the best environment so as to learn to make a great political change happen in Mexico?

a) Firms b) Schools and universities c) The family d) The neighborhood

Considering that a family policy is a way (an instrument) to confront its daily problems and needs, with the participation of all its members, as a process to express everyone values, preferences, interests and commitments, aimed to find solution strategies.

4.- Do you think people can learn to design family policies from within home?

a) Yes b) No

Based on your CURRENT household expenditure:

5.- Regarding electricity, which of the following household saving targets would you be willing to achieve? (Remember that bills are issued bimonthly)

a) 5 % b) 10 % c) 15 % d) Other ___

6.- Regarding family cars fuel, which of the following household saving targets would you be willing to achieve?

a) 5 % b) 10 % c) 15 % d) Other __

7.- Regarding kitchen and boiler LP gas, which of the following household saving targets would you be willing to achieve?

a) 5 % b) 10 % c) 15 % d) Other ___

8.- Regarding general-purpose potable water, which of the following household saving targets would you be willing to achieve?

a) 5 % b) 10 % c) 15 % d) Other ___

9.- Regarding reduction of solid waste generation, which of the following household saving targets would you be willing to achieve?

a) 5 % b) 10 % c) 15 % d) Other ___

10.- How would you better invest your new savings?

a) Other household needs b) A forest precious-tree plantation c) A fund for my child's higher education

11.- In order to achieve these goals, would your family be willing to implement an environmental management system? (INCENTIVE OR STIMULUS)

Consider that during the project's life it will be necessary to share information about monthly and bimonthly control both of energy consumption and waste generation. In order to implement this family system and achieve our objectives, we also need some INITIAL information. Would you be willing to share it with us? (INCENTIVE OR STIMULUS)

12.- Regarding energy consumption

a)Yes b)No 17.- Our consumption in kWh or Our consumption in $

13.- Regarding car fuel consumption

a) Yes b)No 18.-Our consumption in lt or Ourconsumption in $

14.- Regarding LP gas consumption

a) Yes b)No 19.-Our consumption in kg or Our consumption in $

15.- Regarding potable water consumption

a) Yes b)No 20.-Our consumption in lt or Our consumption in $

16.- Regarding solid waste generation

a)Yes b)No 21.-Our generation in kg or Our generation in bags

Thank you for your willingness to participate in this family and civic project. We will be in close contact with you.

Developing self-confidence through the transformation of evaluation practices

Francine PELLAUD, Philippe GAY, Gilles BLANDENIER
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Abstract: Self-confidence is the driving force behind learning. But does it not also underlie the ability to make strong and courageous decisions when faced with various challenges? With the aim to provide an education for sustainable development and ecological transition, or even an education on the state of our planet, to what extent do academic evaluation systems prevent pupils from developing the self-esteem they need to face current problems calmly and take an active role in dealing with them? This article proposes practical approaches for setting up an evaluation system that is based on a teacher-pupil dialogue and provides pupils with the opportunity to work on their cognitive, metacognitive and emotional skills.

Keywords: self-confidence, evaluation, education for sustainable development, emotional skills, metacognition.

Introduction

An individual must have had the opportunity to develop self-confidence and confidence in his or her ability to learn and take action in order to propose technological innovations that favour ecological transition, to engage in actions that aim to combat the climate crisis, to assert his or her values or even to oppose a political or economic system. However, statistics show that young people in France who are climate activists are largely from affluent middle-class backgrounds. According to de Cabanes (2019), "72% of them have at least one parent who holds a managerial position or a position in a high-level intellectual profession[1]". Therefore, these characteristics were not developed at school, but in the family environment or outside of school. If we consider that education for sustainable development has been included in school curricula for more than a decade in France, these statistics indicate that instruction on the topic has failed. Indeed, if this were not the case, all pupils – or at least most of them and, above all, pupils from all socio-cultural backgrounds – should have the necessary skills to react when faced with a challenge requiring change at all levels, from the supranational to the individual level. However, beyond this lack of representativeness, several questions remain unanswered. What skills should these young people acquire? How can these skills be defined and developed? And what is the desired outcome?

Skills needed by pupils in the 21st century

We can distinguish between several types of skill. To avoid limiting ourselves to country-level skill requirements, our considerations are based on the competences set out by two supranational bodies which might, a priori, seem to have contradictory goals These are the ten competences defined by the Word Economic Forum (WEF) for 2020 and the competences defined in the UNESCO guidelines for its 2030 Education Programme.

[1] https://theconversation.com/ces-trois-jeunesses-qui-se-mobilisent-pour-le-climat-113297

Table 1: Competences for the 21st century according to WEF and UNESCO

Typology of competences	World Economic Forum	UNESCO Education 2030
Logical thinking and mathematical competences	Solving complex problems	Analysing and solving problems
		Taking initiative
Creativity	Being creative	Being creative, ingenious, curious
	Demonstrating cognitive flexibility	Perseverance
Emotional / relational competences	People management	High-level interpersonal and social competences
	Negotiation competences	Tolerance, respect
	Coordinating with others	Collaborating
	Demonstrating emotional intelligence	Empathy
	Service orientation (recognition of other people's needs in order to respond to them as well as possible)	Development of the competences, values and attitudes needed to lead a healthy and fulfilling life
Mixed competences – requiring several of the previous competences	Judgement and decision-making	Making informed decisions
	Critical thinking	Critical thinking

We can already draw some surprising conclusions from this comparison. Although the vocabulary used is not always identical, the competences are very similar, and they are classified in the same categories as we defined previously (Pellaud, Bassin, Blandenier, & Massiot, 2019). However, even more surprisingly, emotional and interpersonal skills make up half of all the skills put together. "Collaboration" has become an indispensable competence since socio-constructivism and theories of conceptual change found their way into the classroom and were recognized as the theoretical bases for the act of learning. However, few "methods" have been proposed to ensure that this ability to collaborate is fostered in the best possible conditions and, above all, to ensure that pupils acquire all the other emotional and interpersonal competences in the table.

These emotional competences are also considered to be important by educators. During our training sessions, we interviewed about 100 teachers from four classes[2] in order to find out what "attributes" 21st century pupils need so that they can face the complexity of today's world. Once the "attributes" had been defined (by grade), they were asked to evaluate what their current school was doing to develop these attributes. Their evaluation was based on the following scores: a lot (++), a little (+), very little (-) and nothing at all (--) or even the school was considered to undermine the development of this attribute. A score of 0 meant that the school did not do anything specific to foster the development of this "attribute" but did not implement practices that hindered it either. We noted 0/+ or -/0 when pupils had too much difficulty categorizing accurately. Because the classes did not necessarily evaluate the same "attributes", some boxes are not completed in the table below.

[2] This survey was conducted in Switzerland in 2019 on students in a Master's class on special education – the participants were already practising teachers (Grade 1) – and on three Bachelor's classes who were completing their initial training as primary school educators.

Table 2: "Attributes" that 21st century pupils should possess

Typology	***The 21st century pupil should be capable of:***	***Gr.1***	***Gr.2***	***Gr.3***	***Gr.4***
Logical thinking and mathematical skills	working autonomously	0	-	-	+
Creativity	adapting, flexibility	+	+		-
	curiosity	0	+	+	-
Emotional / relational competences	collaborating/cooperating	0/+		+	+
	respecting others / tolerance	+	+		+
	personal commitment/responsibility	-/0	-	+	+
Mixed competences	critical thinking	-	-	-	0
	using all of his or her skills/self-knowledge/cognitive flexibility/reflexivity	- -	-	+	-

It should also be noted that creativity was only mentioned spontaneously for Grade 1, with the school's involvement in its development being evaluated as "not at all (--)". The researcher prompted the other three grades, asking them to evaluate the role of creativity. The following is a summary of their evaluation:

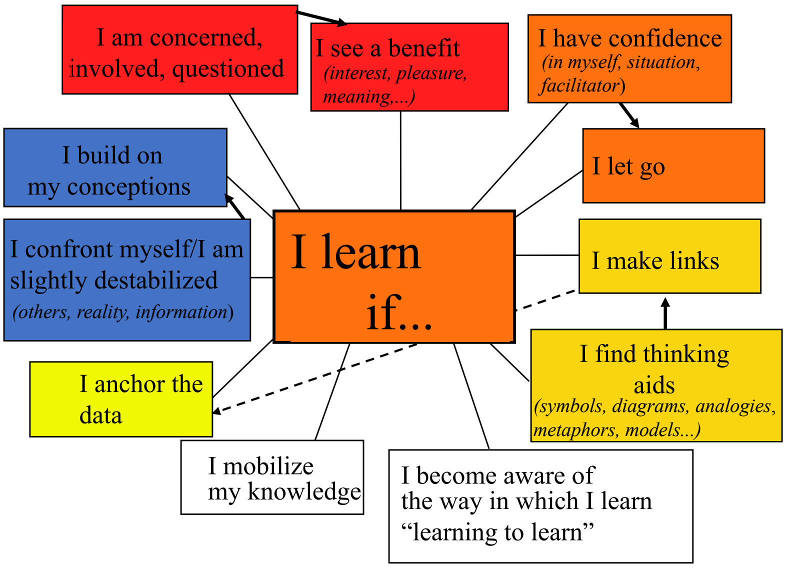
Creativity	Creative, open-minded	- -	-	- -	-/0

Two grades observed that what schools do best is to develop conformity, a respect for rules and produce "good consumers", although these characteristics were not identified as being among the "attributes" that 21st century pupils should possess by the survey participants. As in the first table, we can see that emotional skills play a key role, but that the school system does not seem to pay particular attention to developing them. If emotional skills are indeed developed in schools, it is often solely in the context of collaboration required by the curricula, where pupils necessarily have to show respect for others and tolerance.

A major gap...

Self-confidence does not feature in these tables. Only one grade in our survey mentioned it and negatively evaluated the role of the school in fostering its development. As for the competences set out by WEF and UNESCO, it can of course be argued that self-confidence underpins all the other competences, because without it the very foundation of learning is jeopardized. Is it enough not to mention it or to consider that is acquired "by default"? According to the scientific literature, this is not the case. Psychologists and educational specialists agree that self-confidence has to be built, and building pupils' self-confidence should be a clearly defined goal for teachers. For this reason, it is part of the didactic environment proposed by Giordan and Pellaud (2008). Their vision is that the development of self-confidence constitutes an essential foundation for all learning. It enables pupils to "let go" of their previous knowledge and gives them the courage to change their conceptions. It also plays a key role in the way in which pupils deal with confrontations and destabilization, both factors that are inherent to constructivist and, to an even greater extent, socio-constructivist teaching methods, where cognitive conflicts constitute an essential component of learning. But what exactly is the role of the teacher in the development of this crucial aspect – pupils' self-confidence? On what elements or moments should teachers focus their attention in order to foster pupils' self-esteem to such an extent that, in turn, pupils build genuine self-confidence?

Figure 1: Environment Conducive to Learning



Source: Giordan, Pellaud (2008)

The role of trust in the school system

"A trust-based philosophy is one of the distinctive features of the Finnish education system, which manifests itself in the way the system functions, like a culture. In addition to trusting an individual's ability to learn, trust is also reflected by the way the system functions. There are few control mechanisms, such as inspections or high-stakes pupil evaluations. (...) Teachers strive to guide and support their pupils, encouraging them to build on their own strengths and personal motivation to learn better. (...) Trust as a guiding principle of the education system requires teachers to be able to act independently, to take responsibility and collaborate with other partners". (Halinen, Niemi & Toom, 2016, 147-148). French-speaking schools – characterized by numerous summative evaluations, examinations, student graduations and students having to repeat grades – are a long way from providing an ideal trust-based environment. Therefore, it is necessary to work with these parameters in order to adopt a philosophical vision of school that allows us to incorporate what we define as "islands" for building self-confidence into instruction. So, what might these "islands" be made up of?

With its emphasis on the importance of benevolence, positive psychology, which is very much in vogue today, highlights three fundamental psychological needs: "*The first psychological need is a* ***feeling of autonomy****. This concept refers to the feeling of being at the origin of one's choices and actions or, if this is not the case, feeling that the actions one is asked to do are aligned with one's individual values. Thus, for pupils to be motivated and feel a sense of academic well-being, it is important that they understand the meaning, the interest and the usefulness of what is offered in the school setting. (…) The second psychological need is* ***a feeling of competence****. This concept refers to the feeling of being able to cope with the demands of the task at hand. (...) The third psychological need is that of* ***social closeness****. (...) For example, when a child feels accepted and appreciated by his or her teacher and/or peers, this helps fulfil the child's need for social closeness, thus promoting motivation, commitment and academic well-being*". (Shankland, Bressoud, Tessier & Gay, 2018, 3-4).

The second point described by the authors as part of the Theory of Self-Determination is similar to the concept of *flow* developed by Csikszentmihalyi (2004), which emphasizes both the importance of the requirements of the respective task being aligned with the pupil's capabilities as well as the importance of the task arousing the pupil's interest. If the latter point is fulfilled, the pupil does not need an external reward as an incentive because the experience of doing the task is in itself intrinsically rewarding (Shankland, Gay & Bressoud, 2017).

Based on these basic needs, we can deduct the fundamental attitudes that a teacher should develop. In addition, we extracted the points that recur most frequently from the extensive body of research on this subject[3].

Listening attentively and appreciating. This involves taking the time to genuinely listen to pupils, taking an interest in them, in their difficulties, and in what motivates and fascinates them as well as appreciating their results. This time devoted to the pupil and the appreciation must be sincere and given without a feeling of regret. Appreciation should not be limited to praising what the pupil has produced but consider the progress the pupil has made and his or her potential. Because pupils cannot be duped. If they see that their work is appreciated regardless of the result presented, they will quickly understand that this fails to acknowledge the final result of the work, but only focuses on the fact that it has been completed.

The role of errors. Neuroscience and cognitive psychology, especially Dehaene's latest research (2019), support what many authors before Deahaene found: "*an error is a piece of information, not a mistake*" (Favre, 2015, 95). Errors provide information on a pupil's way of thinking, on his or her modes of reasoning and his or her conceptions. Moreover, Dehaene (2018, 266) states: "*To make a mistake is to learn.*" He goes a step further, quoting the philosopher Alain (1932, 265): "*One should learn to make mistakes in a good mood. (...) Thinking is going from mistake to mistake*". When errors are given a positive status, the pupil can make progress by using errors as a tool or as a springboard to advance even further. In addition, the educator refrains from associating the child with his or her error but takes an interest in what led the child to produce the error in order to find the best way(s) to correct it. These practices are already accepted but not yet sufficiently established.

Evaluation. Having reflected on errors, the next logical step is to consider evaluation. The prevailing system of summative evaluation is only suitable for students who have already gained some self-confidence. To develop self-confidence, formative evaluation, as described by Scriven (1967) needs to be implemented. This type of evaluation does not involve awarding grades to pupils; it should be identified by the pupil as the best time to understand his or her errors and find ways of remedying them. In many cases, a formative evaluation is presented only as a test to verify that the pupil has learned the respective topic and is conducted prior to a summative evaluation. In such a situation, a pupil who has "performed well" in his or her formative evaluation is very frustrated when he or she is still subjected to a summative assessment. If it is well designed, an evaluation is an important moment for monitoring one's own progress and setting oneself additional challenges or additional goals to stimulate further progress. Of course, with a view to building self-esteem, it is imperative that "class averages" and comparisons with the results of others are eliminated in order to prevent "the shame of having failed" – a feeling that undermines the building of confidence in oneself or in others. Ideally, as is the case in Finland, pupils should

[3] We offer a compilation of several authors which we consulted; the references are provided in the bibliography.

be able to test their competences when they feel ready to do so and not according to a pre-established programme, a class evaluation or benchmark[4] evaluation set at a specific time in the school year.

Metacognition. Metacognition is characterized by two complementary aspects. The first aspect is the ability to identify what the pupil knows and what he or she does not know, what he or she has learned and what he or she has not yet understood. The second aspect is more subtle and is based on having determined the first. It goes beyond identifying what a pupil has learned and involves also identifying the cognitive strategies that enabled him or her to acquire his or her knowledge or competence.

Self-evaluation and formative evaluation: the keys to developing self-confidence?

Based on the theory described above, we have developed resources[5] that foster an evaluative approach which incorporates a dialogue on the pupil's self-evaluation and an evaluation of competences performed by the teacher. Taken separately, these two types of evaluation already have merit; however, by fostering a pupil-teacher dialogue, they provide the opportunity to truly build pupils' self-confidence. This is supported by Bressoud, Bétrisey and Gay (2019, 13) who stated that, "the consistent synthesis work conducted by John Hattie (2009) reveals that the two indicators that are most conducive to learning are the relationship of trust between the teacher and pupil and the quality of feedback provided by the teacher to the pupil". This dialogue allows a comparison between the teacher's and pupil's perception of the pupil's work, giving rise to mutual respect and trust.

More specifically, pupils are instructed on the learning objectives that the proposed exercises should enable them to achieve with the goal of giving them a feeling of autonomy. The next step, conventionally, is that pupils complete the exercises. Finally, pupils are required to perform a self-evaluation, in which they assess, on the one hand, the feeling of ease they experienced during the exercise and, on the other hand, they describe potential difficulties and how they suggest overcoming them.

[4] In Switzerland, cantonal benchmark tests are regularly imposed on students. They aim at harmonizing requirements in order to ensure that pupils are treated equally (state of VD), but also at "*taking stock of the knowledge and competences acquired with a view to making decisions related to graduation, orientation or certification.*" (Admée, 2008)
[5] These resources are available free of charge to teachers and their students at: https://blog.hepfr.ch/transformations/

Figure 2: Example of a worksheet from the resource: Transformations: Who owns water?

To understand a problem, you have to be able to estimate how serious it is. The following exercise requires you to use your mathematical knowledge.

Roughly estimate the surface area of the sea in 1960 and the surface area in 2014. What unit will you use to express these values?

In 1960, the area was………………………………

In 2014, the area was ………………………………

Therefore, what percentage of the sea has disappeared? ………………………………

Knowing that the sea had an average depth of 70m, what is the volume of the water that has disappeared? Explain how you will proceed and do a **rough** calculation.

On average, how many litres of water disappear in a year?

On average, how much surface area disappears in a year?

When making approximate calculations, we use what is called an "**order of magnitude**". It is very important as it helps you check whether the answers you have found with your calculations are possible (even if they are not exact).

Do you feel comfortable doing these calculations? 😀 🤔 😕 🤢

If not, specify what else you need to practise.

To go further, what else would you need to know?

We propose a grid for teachers to evaluate competences, which is presented in this form:

Figure 3: Excerpt from the teacher's guide for the "Transformations resource": Who does water belong to?

Proposed evaluation of mathematical skills:
Identifying the information needed for the calculations and using it appropriately (understanding why it is being used in this way) to answer the different questions is more important than the accuracy of the answers. The observations help to pinpoint the student's difficulties and define targeted remedial measures:

Does not know which information is necessary	Knows how to find the necessary information but does not know how to use it	Knows how to find the necessary information and uses it partly correctly	Knows how to find the necessary information and uses it effectively

The comparison between the pupil's self-evaluation and the evaluation of his or her competences by the teacher should provide a suitable basis for a dialogue, during which the teacher listens attentively and appreciates the pupil's work. By performing a self-evaluation, pupils should develop their metacognitive abilities and, in turn, a feeling of autonomy as well as a feeling of competence regarding the task at hand.

Self-confidence: the driving force behind commitment and taking action

This first step aims at building the self-confidence needed for learning. But does it enable pupils to gain enough self-confidence to make decisions and take responsibility? To achieve this, emotional competences are needed. They should lead to a "*clarification of values*" (Pellaud, 2011) and a "*need for value*" (Pellaud, Gay, 2017) which, in turn, results in them taking action.

In the excerpt from a worksheet below (Figure 4), pupils are asked to verbalize what they feel when looking at images showing massive destruction of the ocean floor. To help them express their feelings, some terms are proposed which they may or may not use. The purpose of the self-evaluation proposed to pupils next is solely to determine their ability to express their feelings and encourage them to identify any difficulties they may be experiencing.

An evaluation grid is also provided for teachers (Figure 5). As this exercise is repeated at different points of time in the project, the teacher can keep track of his or her observations regarding individual pupils and determine whether they have progressed, changed or even regressed. Of course, this is not an evaluation that leads to a grade or any other value judgement, but rather an observation that can result in the teacher seeking a dialogue with individual pupils in order to better understand their possible difficulties and, if necessary, to offer them a teaching environment that is more conducive to developing these emotional skills.

Figure 4: Excerpt from a pupil worksheet from the resource: Transformations, Oceans

If you are able to express your feelings, it helps you to communicate more calmly and to listen better to the arguments and feelings of others. It is an important skill that enables you to live better with others.

Now that you know what caused this transformation at the bottom of the ocean, how do you feel when you look at the pictures on Page 1?

You can add other words if you want or circle several of the suggested answers.

sadness	fear	amusement	injustice
incomprehension	empathy	"well done!"	rage
powerlessness	anger	nothing	horrible

Other suggestions:

………

Can you explain your feelings?

………

………

………

………

………

………

Do you find it difficult to express what you are feeling? 

If so, can you say why?……………………………………………………………………………………………

Do you have any ideas of what might help you to do so?……………………………………………

***Figure 5**: Excerpt from the teacher's guide: "Transformations, Oceans"*

Figure 5: Excerpt from the teacher's guide: "Transformations, Oceans"

Proposed evaluation of emotional skills:

Emotional intelligence involves self-awareness, awareness of one's feelings, the ability to deal with and express one's emotions. It is not innate; it is learned. The act of verbalizing the feelings that these pictures evoke can give rise to insights. The description of these feelings should not be followed by a value judgement. Pupils should identify their feelings individually. This can be kept completely personal, without the feelings being disclosed in plenum. Pupils complete the description of their feelings with a free drawing.

There are, of course, no right or wrong answers for this worksheet. It is therefore important that no value judgements are made. It must also be considered that too much feeling can be the source of cognitive non-learning. It is therefore important to take this into account.

Unable to express it	Chooses a word but cannot explain why he or she chose it	Expresses his or her feeling

Conclusion

At the moment, we do not have sufficient experience to say whether our approach will enable us to achieve the ambitious objectives we have set ourselves, namely to develop the self-confidence of pupils, which will enable them not only to learn more effectively, but give them the courage to uphold their values and embody them fully. Today's society needs individuals with a strong conception of sustainable development and a genuine education on the "state of our planet" (Pellaud & Eastes, 2019). Such a vision requires individuals to be able to stand up to surges of extremism – regardless of whether economic, religious or even environmental – in order to best preserve democracy, which continues to promote freedom of thought and expression.

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SDGs Oriented Action

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Abstract: In the context of the adoption of the Sustainable Development Agenda and its 17 Sustainable Development Goals (SDGs), it is important to promote intergenerational cooperation to achieve sustainable development. The aim of this article is to present the results of the SDGs Oriented Action research programme on activities undertaken by two generations: students and their parents in workplaces/faculties/residences. Respondents often declare that they and their families live in a sustainable way. Less often, respondents declare that the municipality, the country, and the world in which they live is developing in a sustainable way. The majority of participants declare that the most important benefit deriving from the implementation of the Sustainable Development Agenda will be the life quality of all citizens.

Keywords: SDGs, SDGs perception, intergenerational survey, sustainable development, Poland, France

Introduction

Most research focuses on SDG implementation on the global, international and national level. This article presents the knowledge and actions undertaken for the implementation of SDGs by individual students and their family members from the Faculty of Management of University of Warsaw (Poland) and Centre Européen Universitaire (CEU Nancy) of Université de Lorraine (France). Progressive changes related to the depletion of natural resources, climate change, or demographic changes force the adjustment of the behavior of individuals, organizations and societies. There are growing warnings from researchers and international agencies on the need to urgently mitigate change and to implement adaptation measures at all scales (IPCC 2019; Global Commission on Adaptation 2019). Past and present events, but also anticipated future events can be a reactive response to challenges. Decisions to change behaviour, to adapt one's actions in response to the challenges ahead affect individuals and societies. These decisions are not disconnected from other decisions, but occur in a demographic, cultural and economic context, and depend on access to and use of information (O'Brien and Leichenko, 2000). According to Barry (1997) practically anyone who has studied the situation seriously and has retained objectivity (...) should come to the conclusion that the most elementary cooperation of people for the sustainable future requires great changes in our way of acting.

In response to the challenges ahead, 193 heads of state and government signed the 17 Sustainable Development Goals (SDGs) and 169 targets, which showed the scale and ambitions of the new universal agenda. The targets are based on the Millennium Development Goals (MDGs) and are complemented by what has not yet been achieved. The SDGs are a globally accepted development agenda. The signing of the agreement by world leaders was a collective decision that is binding for all actors in the global social system.

The Sustainable Development Goals have set targets and challenges for all countries. Any scenario for achieving the SDGs inevitably depends on the assumptions of changes in people's and societies' behaviour and it requires a conscious and large-scale social transition or transformation (Bonnedahl and Heikkurinen, 2019). Joint decision-making is necessary in any situation where people have common goals to achieve and where these goals can be achieved more effectively with the participation of others. This is referred to as joint production (Lindenberg and Foss 2011). There is relatively little research on intergenerational relations in communities concerning sustainable development (Pain, 2005). Intergenerational and inter-cultural differences in perception and action for sustainable development are produced by a complex range of factors at individual, family, and social levels. Understanding what different social groups know and what SDG activities they undertake can be a starting point for policy formulation for SDGs implementation. The perception and necessity of actions for the implementation of sustainable development objectives by the researcher can be characterized as potential actions that he or she undertakes. This article presents selected results of research on perception and action for the benefit of the SDGs. The results particularly emphasize that greater efforts are necessary in the areas of information and communication. The findings also reveal gaps in knowledge about the society and its relation to the SDGs.

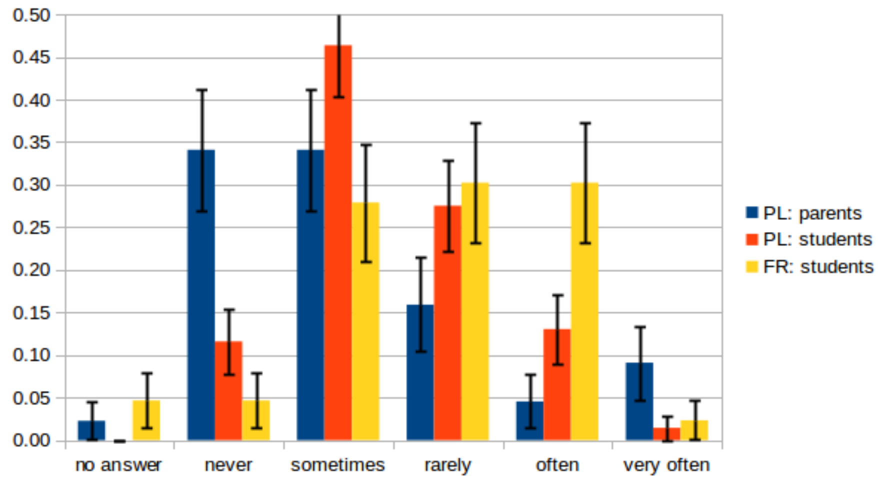
Methods

The survey was conducted at the Faculty of Management at the University of Warsaw and at the European Centre of the University of Lorraine in France, between 14-31 January 2019. Students and members of their families from two generations took part in the survey: 69 Polish students; 44 French students and 44 parents of Polish students. In the following qualitative comparison of these three groups, an analysis is carried out with regard to the knowledge, attitudes and evaluation of actions for the implementation of SDGs.

Selected Results

The answers of the group of Polish students were compared to responses of their parents and the group of French students. The first reported question was about how often one encounters the SD concept (Fig. 1). It is evident that French students (FRS) report more frequent contact with that concept than the two other groups.

Figure 1. How often do you meet with the concept of sustainable development (SD)?



At the same time, 34% of parents of Polish students (PLP) answered that they have never heard about SD. The most popular answer (46%) of Polish students (PLS) was "sometimes".

Next two questions were about reality (Fig. 2) and necessity (Fig. 3) of the SDGs. These goals were listed in the survey form. Conditional yes was the most popular answer inside all three surveyed groups as far as the reachability of SDGs is concerned (Fig. 2).

Figure 2: Do you think that SDGs are achievable?

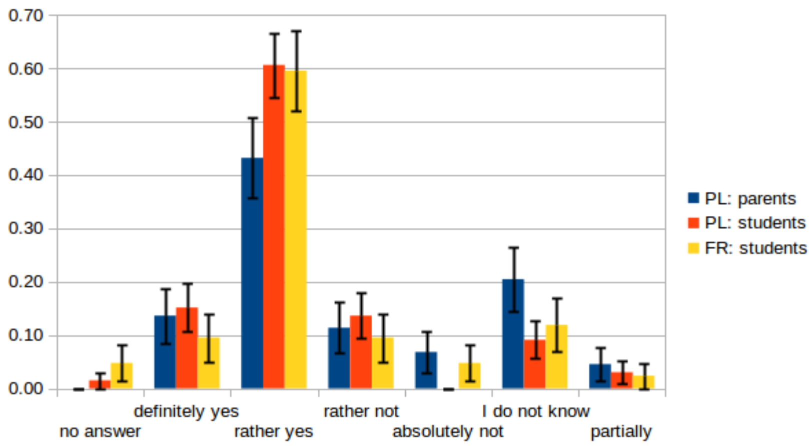
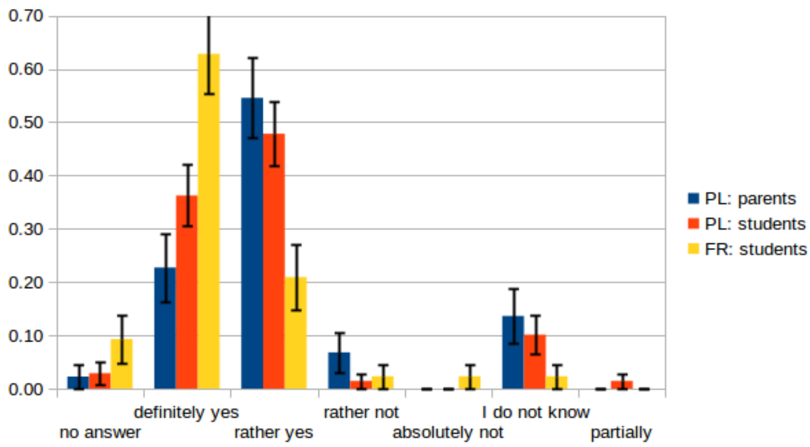


Figure 3: Do you think that we need SDGs?



For the question about the necessity of SDGs, the answers shifted towards "definitely yes". The effect is the most pronounced for the FRS group and the weaker for the PLP one. It looks like the surveyed persons appreciate slightly more the SDGs than they believe in a possibility of their realization. Two consecutive (multiple choice) questions were about who should care about the achievement of the SDGs (Fig. 4) and who will benefit the most from their implementation (Fig. 5). For the question about responsibility the answers were scattered. The parents of Polish students (PLP) mostly indicated state and local authorities, whereas French students (FRS) pointed to the EU and the rising responsibility of all citizens more than other groups. Polish students (PLS) indicated entrepreneurs and employers more often than the other groups but most frequent answers were "state" and "EU".

Figure 4: Who should care or be responsible for the implementation of the SDGs?

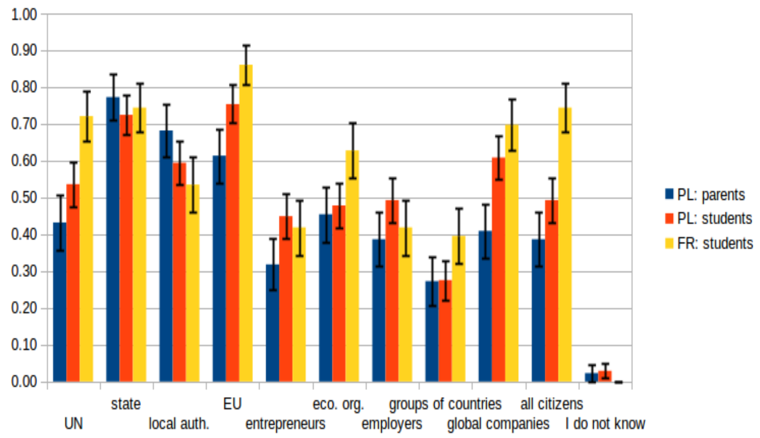
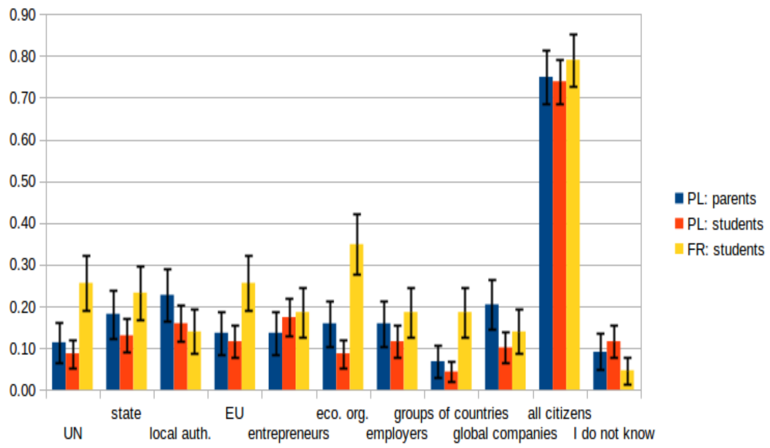


Figure 5: Who will benefit the most from the implementation of the SDGs?



As far as potential beneficiaries are concerned, by far the most popular answer was "all citizens" in all three surveyed groups (around 75% answers in each of them). Other possibilities were less popular by more than a factor of two. One could spot, however, significant difference in indication of ecological organizations by French (35%) and Polish (9%) students. Next five questions were about opinion about the extent to which the development of the world (Fig. 6), country (Fig. 7), the place of leaving (Fig. 8) as well as family (Fig. 9) and self (Fig. 10) is aligned with the SDGs.

Figure 6: Do you think that today's world is developing based on the SDGs?

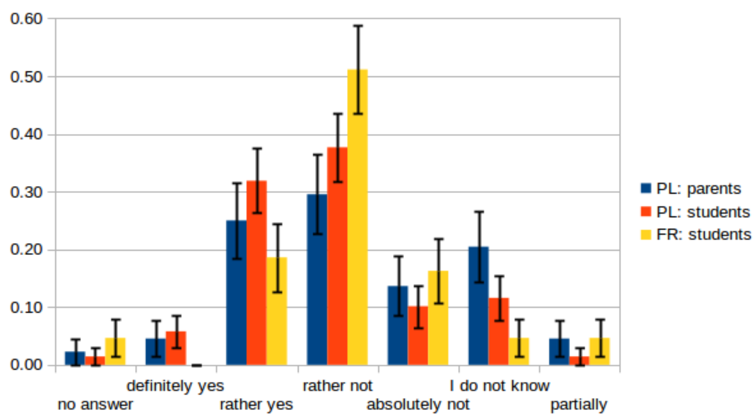


Figure 7: Do you think that your country is developing based on the SDGs?

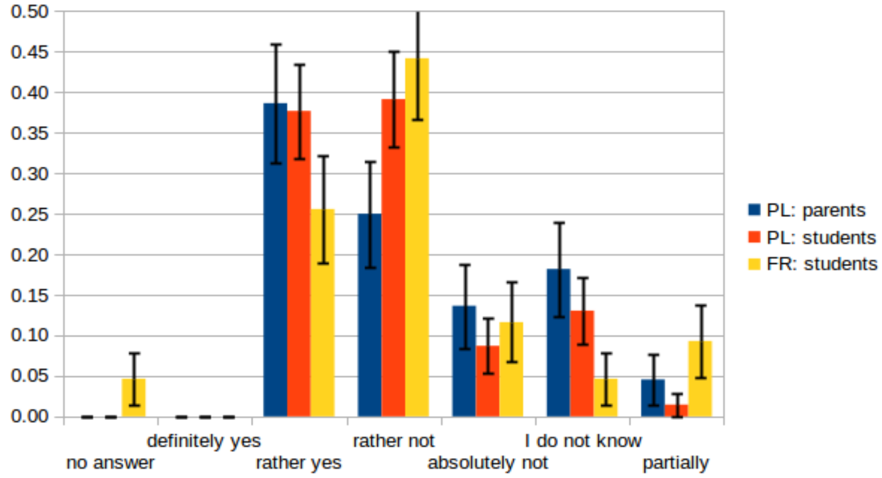


Figure 8: Do you think that the place you live in is developing based on the SDGs?

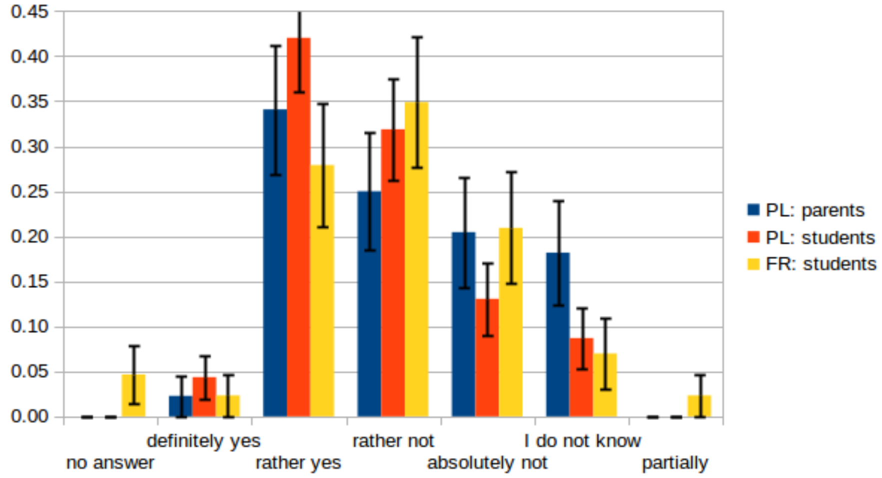


Figure 9: Do you think that your family is functioning based on SDGs?

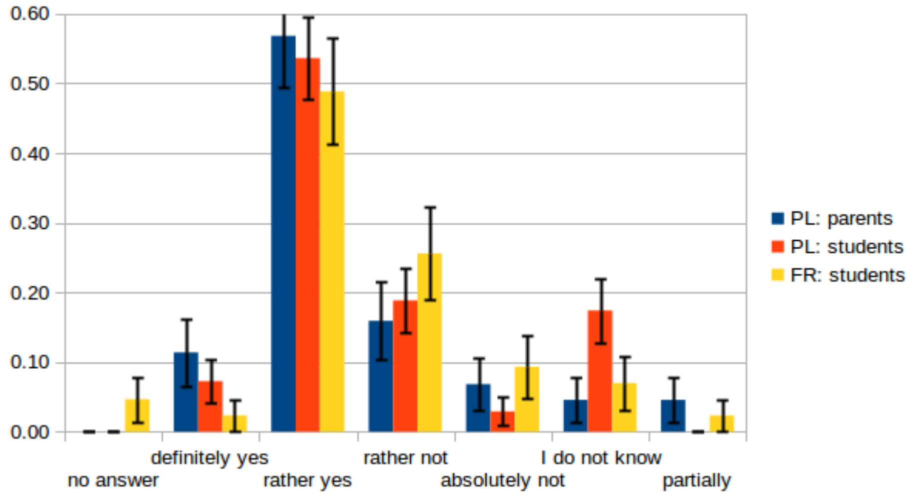
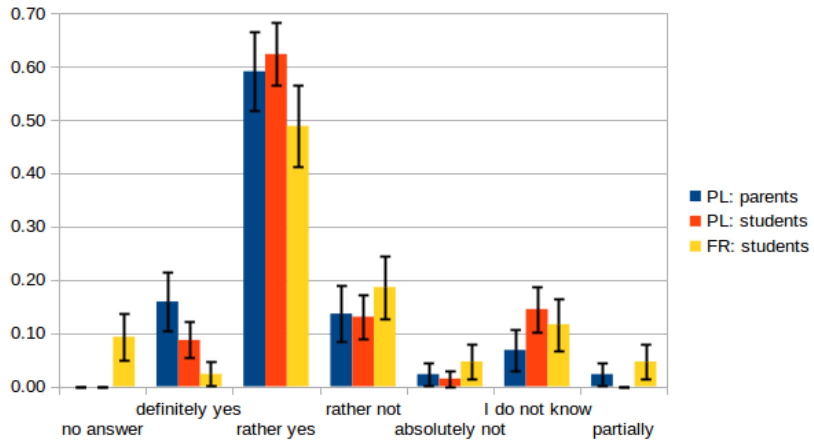
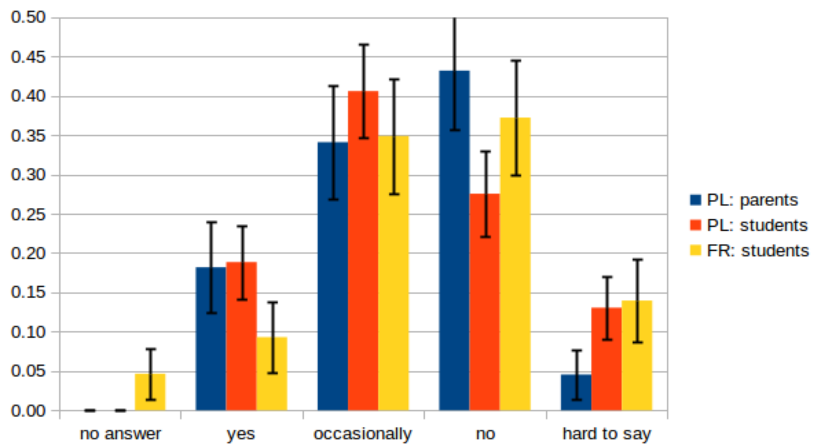


Figure 10: Do you think that you live based on SDGs?



One could observe that the closest the subject of question to the surveyed the more positive is the answer. The most skeptical were surveyed from the FRS group, whereas more optimistic (or less self-judged) were the members of the PLP and the PLS groups. For the question about the world, the answer "rather not" prevailed in all groups (but only for FRS the difference is significant), whereas for the self-behavior the "rather yes" collects 59%, 62% and 49% of votes respectively for PLP, PLS and FRS groups.

Figure 11: Do you engage in pro-social or pro-environmental initiatives?



With regard to involvement in pro-social or pro-environmental initiatives 18% of Polish parents, 19% of Polish students, and 9% of French students replied positively to this question; but 43% of PLP; 28% of PLS; 37% of FRS answered they did not engage in such actions at all.

Discussion

This article presents some of the results of the research conducted within the SDGs Action Oriented project. These pilot studies show that there is no clear indication that there is greater similarity between students from different countries (Poland and France) than between generations of students and their parents (Poland). There are questions in which Polish students answer more similarly to their parents and others in which they answer more similarly to their French colleagues. But there are few questions in which French students answer in a similar way to Polish parents. One clear difference is in the knowledge about SDGs. It could be that Polish and French students receive knowledge/ information about sustainability during their recent education. The fact that 34% of parents of Polish students answered that they have never heard about SDGs signify that there is a lot to be done to promote the SDGs, in particular among this generation. On the other hand, although less informed, the Polish parents reported living more aligned to these goals than the best-informed French students. In general, respondents declare more often that they and their families live in a sustainable way, and less often that the municipality or the country in which they live is developing in a sustainable way. Less than 20% of the surveyed population participates in pro-social or pro-environmental initiatives. The majority of participants declared that those benefiting most from the implementation of the SD would be all citizens. It seems that the majority of respondents from all three surveyed groups perceive these goals very positively, a significant proportion believe that they are achieving them to some extent, but at the same time do not feel that they are being implemented by others. It can be only biased self-assessment, but even if this is the case, it can be concluded that it is worth building on these goals.

Conclusion

On September 25th 2015, the 193 Member States of the United Nations unanimously adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). The objectives are a response to humanity's global challenges: poverty, inequality, climate change, environmental degradation, peace and justice. SDGs are universal and can be implemented by all interested stakeholders and citizens.

This article presents the results of a survey in which students and their parents from Poland and students from France took part. The respondents answered questions about SDGs sustainable development goals: awareness of their existence, possibilities and needs for their implementation, responsibility for implementation, benefits from implementation, involvement in activities for the implementation of SDGs. The results for each of the three surveyed groups were compared in charts.

The main results of presented pilot studies are the following. There is no clear indication that there is greater similarity between students from different countries (Poland and France) than between generations of students and their parents (Poland). All surveyed groups support SDGs but they are not convinced of the feasibility of their full implementation.

On the other hand, over 70% in each of the surveyed groups replied that *All citizens will benefit the most from the implementation of the SDGs* (question 5).

Hence this is the most important message from this survey to policy makers. It is worth building on SDGs focusing on showing that these goals are achievable at every level, from individual decisions to global scale.

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PART 6

ARTS AND SCIENCE COMMUNICATION ON SUSTAINABILITY

Reflections on the Panel Discussion: Communicating Sustainability Challenges

Hildred CRILL

Stockholm University, Department of Geological Sciences, Sweden

How can we achieve successful scientific communication, given the fundamental difficulty of truly communicating in general? This question, raised by a conference participant, remains at the heart of the challenge. Nonetheless we can go back to basic guiding principles, including the starting point of audience and purpose. Assumptions about what we should include or exclude stem from a good understanding of the expectations and needs of each specific group, brought into focus by the communication's purpose. In the broad and complex endeavor of science, no one person can do or communicate everything. Aristotle points out that in pursuit of truth "each thinker says something about nature, and individually they make small contributions to it, and from them altogether a certain volume arises" (The Metaphysics, tr. H. Lawson-Tancred, London: Penguin Books, 2004). Scientists have to rely on each other. Thus the choices about content and scope are bound up with shared ethical standards. Integrity means that scientists must not leave out critical, relevant information, cherry-pick data or distort the implications of findings.

The first audience is the scientific community in both the narrow, or specialist, sense and the broad sense. The purpose might be to report research, place it in context, discuss the limitations and implications and convey a conclusion. Challenges emerge: complexities do not enter easily into words and words often give a hazy idea of uncertainties. In addition, scientists aim to persuade colleagues of the reliability of the experimental design and results along with the soundness of the reasoning. Within research fields that entail potentially grave real-world consequences, such as the existential threat at issue in climate-related sciences, persuasion takes on significance beyond its usual role in intellectual discourse.

Then come the additional stakeholders including policymakers, decision makers and the wider public. Again, the particular group and purpose give shape to what is written and said. The less background an audience has, the greater is the need for fundamental information to underpin the message. But how can scientists accomplish this while communication is shrinking to Twitter and other truncated forms of social media? Does the task become merely deletion and simplification in the face of this constant bombardment and distraction alongside complex ideas and absolute urgency? Can rapid, reduced messages always adhere to ethical standards, and can they be truly persuasive?

One approach is to think of the flow of scientific information to the broad public as a matter of bilingual text and elucidating translation or metaphor, put into compactly summarized context. For instance, model results can be presented as a clear, concise, predictive narrative, and why not accompanied by a skillful dive into an equation to convey a sense of where the model comes from? The extent of deforestation, fire or flood can be translated to numbers of sports arenas or the area of a well-known country. Visualizations support the words, such as a map of fires or a time-lapse video of a melting glacier.

Expansion of communication modes can strengthen the art of persuasion. In fact, the arts provide many ways to reach public audiences at an emotional level. Excellent, memorable art and experiences of creating art ourselves make us feel, see, imagine and understand. Diverse voices bring many perspectives and reminders that we are all in this together. A play acted out in the street catches us by its surprise and immediacy. A striking picture, sculpture or installation leads our thoughts to new places. A poem is brief and felt in the body. A song replays in our minds. People know what to expect from art: it is linked to the real world but transmits deep truths without necessarily listing facts. This means art can appeal to the emotions for persuasion without raising certain ethical issues, as can be the case with some rhetorical devices occasionally employed in scientific literature.

Even before the audience of peers and of public, scientists face the audience of the self. Many ways set the thought and expression of it in motion. These streams converge, diverge and change. Just as what were once philosophical questions become scientific questions tractable to testing, so too can the arts stimulate the creativity, imagination and insight of science. Think of Galileo Galilei at the start of the 1600s painting watercolor washes of the Moon from what he saw through his telescope. In his representational series of illumination and shadows, the art of chiaroscuro helped to reveal, to Galileo himself and later to others, the features of a distant celestial body.

How to communicate Scientifically ?

Elise ASPORD

Communication Laboratory, University Clermont Auvergne, France

I am an Art New Media Historian (PhD Art and Artificial Intelligence, 2007)[1]. On this panel we considered the fundamental question of how to communicate scientifically. To explore this question I used artistic examples, anecdotes, and testimony. I presented two videos: Natürmorg from the Turkish artist Bilgi Diren Günes produced in 2014 for the VIDEOFORMES Digital Festival Clermont-Ferrand, and a second video from the French Ministry of Culture entitled "The sustainable world of tomorrow will be cultural".

Humanity is on a collision course with the natural world. In 1992 the Union of Concerned Scientists[2] signed a manifesto calling for an end to the destruction of the environment. That was 28 years ago![3] Today, in 2020, we are more than ever up against a wall.[4] The environmental challenges are certain, but in a world where money is everything, the question of resources (e.g. financial) is also very important. We saw it, here in France, with the yellow jacket movement. We simply cannot go green without talking about social and equity.

What is the scientific current context?

We have scientific communication challenges. Behind this term 'communication', there are power struggles between citizens, politicians, sponsors, funders, major firms. This inevitably leads to tensions. Some research colleagues often speak of 'incommunication' where the information does not contain a message or if the receiver cannot decode the information contained in the message. How does scientific discourse interact with this incommunication? The scientists' words are sometimes being undermined. Science and pseudo-science mix together. The question of confidence (trust), of legitimacy is raised. Next week (10th Dec.) I will participate in a Bad Faith Contest with scientists and a former French TV journalist (Florian Gouthière)[5]. That should be an interesting game and a good exercise for everyone!

Which avenues are available for humanity?

Consider what does not work for a large audience: prohibition/obligation. Prohibition is pedagogically moderately interesting. We *must* do this or that. I think the expression 'it's for our

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[1] 2007, Paris X-Nanterre, France. I belong since 2012 to a Communication Laboratory here at UCA Clermont-Ferrand (http://communication-societes.uca.fr/).

[2] The Union of Concerned Scientists (UCS) was founded in 1969 by faculty and students of the Massachusetts Institute of Technology. UCS is a nonprofit science advocacy organization based in the United States. The UCS membership includes many private citizens in addition to professional scientists. https://mediabiasfactcheck.com/union-of-concerned-scientists/

[3] In 2017, about 15 000 scientists from 184 countries called for action about the State of the Planet. Maybe some of you signed it? I don't know if it changes anything for the moment - the awareness and implementation are slow to come – BUT I hope that profound changes come from the sum of small repeated actions.

[4] 2020: VIVANT is an exceptional cultural event that will take place from March to October 2020 on the occasion of the next World Conservation Congress, to mobilize public opinion and the public sphere on biodiversity issues.

[5] https://www.echosciences-auvergne.fr

own good' does not work very well, nor does the expression 'make a blank sheet of the past' (you've got in mind the image of the candle). 'Must' and 'have to' do not work, except if we use the art of provocation and play the devil's advocate (a good exercise for a critical mind). In 2017 I hosted a talk organised by Effervescence[6] with the theme 'Art and Ecology'. I began with a provocative question: should a good green dictatorship be established?[7] With such a question effect was guaranteed and the discussion was lively many human contradictions.[8]

In the classic 'use a carrot and a stick' expressions I do not think the stick works, but the carrot, perhaps. It is used with humans for many centuries (I have a child, I know what is it!). Incentives are used in computing and artificial intelligence. One thing is for sure, if you use reward you must have lots of great carrots (lots of alternatives). Art is perhaps one of these alternatives for a better communication and action.

What is the place of art and artists on these issues?

In 2010 France created the COAL Art and Environment Prize, supported by the Ministry of Ecology, the Ministry of Culture and the CNAP (National Centre for Fines Arts).[9] I recently learned that the French Ministry of Culture is integrating a new Strategy for Social and Environmental Responsibility. The last session was in November 2019 and held in Paris.[10]

Now that everything's gone *green* with marketing, does 'green art' exist? For me, I distinguish two categories of artists. On the one hand there are the *theorists* – artists who use sustainable development as the subject of their work. And on the other hand there are the *practitioners* – artists who are part of a sustainable development approach.

The theorists

It is through their narrative power, because they imagine other possible futures, that works of art succeed in mobilizing consciousness as well as acting people. By their creations, artists can encourage decision-makers to grasp and grasp the reality of displacement caused by climate change. Here two trends are intertwined: *sensibilize* and *engage*.

Sensibilize. The artist follows a poetic way to look differently the nature (e.g. land art at the end of the 1960s with Andy Goldsworthy who uses naturals materials). Sometimes poetic becomes caustic. (e.g. *Atomic radio 137* from Christophe Ruetsch in 2009, a sound journey through this paradoxical territory, the forbidden zone of Chernobyl).

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[6] Which is the committee that is bidding for the Clermont-Ferrand European Capital of Culture.
[7] This question comes from Usbek & Rica's magazine and its « Court for Future Generations ». https://usbeketrica.com/
[8] I remember the first intervention and this sentence from an artist really concerned about ecology: "as an artist my carbon footprint is just catastrophic"
[9] This group was created in 2008 by professionals in Contemporary Art, Ecology and research with the aim of fostering the emergence of a culture of ecology. Presented at COP25 in Spain, the COAL Prize will be invited to the negotiating table to help ensure that political decisions are translated into concrete changes for a habitable and shared land.
[10] There are many projects in Culture and Sustainable Development.
https://www.culture.gouv.fr/Sites-thematiques/Developpement-durable
https://www.culture.gouv.fr/Sites-thematiques/Developpement-durable/Objectifs-du-Developpement-durable-et-culture

Engage. This is referring to 'artivism' or 'hacktivism'.[11] Their credo: social innovation and collective performance.[12] The idea is of acting, changing a system, generate concrete projects.[13] Two examples:

- *Voice of nature* from Maria Lucia Cruz Correia[14]. It's a site-specific court piece, in which we investigate ecocide. She is developing a new legal and artistic institute as an alternative to the current environmental justice system.
- *The Ecological Pact* from the Yes Men in 2007.[15] They pretended to be ultra-reactionary US political journalists. They came in France and presented a fictitious report in which major American industrialists threaten to stop investing in France if Nicolas Hulot's ecological pact is implemented. Three French politicians have agreed to participate in the interview. Check out their reactions it's quite interesting !

The practitioners

Art, culture and sustainable development go into action (e.g *Guarana Power Bottle Project* from Superflex, the Danish collective art design in 2003).[16] *Guarana Power* is a cooperative of guarana producers in the Brazilian Amazon to produce a soft drink and counter the aggressive policies of naughty multinationals.

Here in Auvergne, there were territorial actors of ecology and solidarity who create a new synthesis between culture, arts and ecology. For example, *Coupure de Courant* - Power failure, a festival without electricity[17]/*Parc Oasis*. The idea is to put the human being at the heart of the collective[18]/The Project of Récupératech at the School of Fine Arts of Clermont-Ferrand entitled 'Panic'[19].

Conclusion

In conclusion I think we have to get people (and us) to ask themselves (and ourselves): What are the essential elements of human life for you today? What we can't give up on ? What do we need to set up for 'doing our part'?[20] Day-to-day actions, activism, involvement in our work as researchers and educators but also the opening to art, to culture, to critical mind are some of the answers. Into our common quotations that we shared with the others speakers before this collective talk, the term 'storytelling' appears many times. I do not know if I totally agree with Joshua Schimel[21] when he says "We don't have to become science populariser… we just have to become

[11] Word contraction: hacking and art. Culture of hacking has to be taken in the right sense of the word.
[12] The format of these works-performances is for some rather low tech.
[13] This idea is not new. e.g.: 1968: Panic in Venice: The Grand Canal turns fluorescent green! The artiste Nicolas Uriburu spilled a simple dye and denounced the pollution - even then! -).
[14] It's nominated this year for the COAL Prize.
[15] The Yes men are hoax activists. They denounce liberalism through caricature, fake identity, fake website. They are known for the project around the Bhopal disaster (India).
[16] *https:*//**superflex**.*net*/*tools*/**guarana_power**
[17] To see a movie, you have to bike.
[18] They talk about: Self-directed project of collective realization
[19] It's a collective tool managed by students and accompanied by the school that promotes the reuse of materials in a school dedicated to creation. There is exhibition and a display on this subject in the school lobby.
[20] Punchline of French Calibri (hummingbird) movement (2007) based on empowerment.
[21] *Writing Science:* How to Write Papers That Get Cited and Proposals That Get Funded, Oxford University Press Inc., 2012, 240 p.

better storytellers". I think that what we all need are concrete proposals as shown in many presentations during this symposium.

The strength of artists is to give, to see, but also to act. The strength of artists is to question and challenge standards. The strength of art is to disrupt, to create a shock, to expand the time and space for debate and reduce the share of incommunication that I mentioned at the beginning of this text. We have to understand why we do not understand each other.

As an Art New Media Historian my field is not really green (computer components, energy-intensive servers[22]). There are also real issues here with digital art. The digital artist Franck Ancel says: "We must maintain confidence and believe in change, without duality between nature and technology, with pause modes, and feedback on readings... Techno-sciences can be ecological practices connected with the universe."[23]

We need hope, positive attitude and dynamism because I do not know if we have to laugh or cry about my last quote. "Team of engineers from Riverside, a university in California, has just created a new bikini. The Sponge suit would have the particularity of cleaning up the polluting particles released into the ocean."[24]

"Humanity has become its own victim" according to the French anthropologue Claude Lévi-Strauss.[25] "I am at the heart of the paradox" says Christophe Ruetsch, quoted above.

We are at the heart of the paradox. But we don't have a choice. We have to move on and try to survive. That is the challenge.

[22] An email is as energy consuming as a light bulb on even if there are alternatives with ecomail designed by little frenchies. https://www.ecomail.fr/

[23] *« Il faut garder confiance et croire aux mutations, sans dualité entre nature et technique, avec des modes pauses, et des retours sur lectures … Les techno-sciences peuvent être des pratiques écologiques connectées avec l'univers ».* http://lecube.com/revue/refondation/le-sixieme-paradoxe

[24] https://www.youtube.com/watch?v=KTDiDZf4U3A

[25]https://www.lemonde.fr/idees/article/2005/05/20/au-vif-la-lecon-de-claude-levi-strauss-par-edwy-plenel_651408_3232.html

Writing Workshops

Hildred CRILL

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Surrounded by world literature on the walls, several of us sat around a table twice during the conference week to write poems and flash fiction. Poetry delivers rich content in compressed language, documents observations, creates tension, asks questions and follows thought where it leads. Fiction builds up a narrative arc, tries out scenarios, engages in conflict, finds telling details, illuminates reality and is open to possibilities. Thus art promotes what can move science forward. It stimulates creative thought and insight, gives room for imagination, encompasses the range of scales, broaches mysteries and uncertainties and resonates in the memory. Art and science share constraints of form and unlimited potential.

For scientists, artistic expression can also provide a therapeutic release from the routine of writing scientific articles and from exposure to existential threats they might be considering daily. This temporary shift can therefore benefit scientists at an emotional level as well as in their work. Like science, art reaches and energizes audiences. We read the results of the rapid writing, presented in three languages, to each other and later to all the conference participants at dinner. As everyone listened, interest, pleasure and reflection were obvious.

New Endings and Old Beginnings

Jay Sterling GREGG

UNEP-DTU Partnership, Technical University of Denmark, Climagination.org, Denmark

Abstract: A short story (inspired by the biblical genesis and advances in virtual reality) set in the near future or distant past- or perhaps several times in between. We come to a point where the Governing Authority has determined that drastic measures are needed to reduce humanity's impact on the environment. The first "volunteers" for the new program have been recruited.

Keywords : sustainability, reality, free will, epistemology, religious doubt

"I'll miss this- the way each blossom tickles my fingers in their own unique way," Evelyn said, as she graced her hand just below the lowest hanging branches, backlit by the setting sun. "I think I'll miss you little ones the most," addressing the white and pink petals.

Addison's face twisted into a mocked shock.

"Oh, hush, Addy. You know what I mean…" Evelyn playful reached to tickle Addison's abdomen, right below the ribcage. "Like, isn't it weird how you can't tickle yourself?"

"Hey! Ow!" Addison jolted out of the way. "And do I? Do I know what you mean?" Addison playfully lifted his eyebrows.

Evelyn sighed, allowing the mood to change. She bit her lip in thought. "It is just that, this is… I don't know... real. And I know it's real."

"The Governing Authority assured us that we will believe the new world is just as real as this one. We won't know the difference. And we can create whatever we want there," Addison reassured her, as if by rote.

Evelyn paused trying to find the words to articulate her hesitation. "I know, I know. It is just that- don't you fear there will always be some doubt? I mean, we are giving control of what we experience to some abstract… 'Authority'. Even if it is wonderful, I think I'll always know it's not this world. And then we'll be constantly monitored, and maybe the Governing Authority can even remove my doubt. But then, I'll always be wondering if my choices are really my own."

"You know we shouldn't talk like this. Anyway, how do you know we aren't already in some simulation? How do you know you have free will now?"

Evelyn spun on her heels and kissed him on the lips. "*That's* how I know," she said, winking and tapping her index finger against his nose.

There she goes again… connecting to nature and mysterious 'energies'. It was a side of her that he always admired. Or was it envied? He was never sure. All he was sure about was that he never knew quite how to respond when she talked about mystical connections or conversed with the plants and animals. He wondered how the Governing Authority *could* ever recreate her experience of the metaphysical. Or love, for that matter.

Then, a thought seemed to coalesce in the foggy ether of his reverie. Tomorrow, his consciousness would be linked with hers in a new reality. But how would he know if it was really her, and not just some reproduction of her? And what difference would it make? His stomach felt heavy. A chill swelled inside of him. The prospect of losing reality had never felt so *real* before.

“Hey, there- you okay?”

Addison looked down at his frozen feet. Evelyn was staring at him with a cocked head. Her kiss had faded from his lips, but then, a kiss is never as ephemeral as it seems.

“Yeah, fine.” He shuddered a little. He hoped that she didn’t see this manifestation of his doubts. He was supposed to be the rational one. The confident one. “Look. It's for the greater good. For survival on this world. We all have to make some sacrifices. After all, what type of world would be left if we don’t do this? You know as much as I do, that we don't really have a choice.”

The Governing Authority had inculcated this into his head, and it always felt like a buttress of strength and courage. Now, as the last day in this reality ebbed away, his voice only managed to squeak out a meager echo of the Governing Authority's rationale. The cracks in his voice betrayed a surge of loneliness that was now overflowing from his chest. *Just who am I trying to convince, anyway?*

“I know, Addy.” Evelyn mumbled. She wasn't looking at him anymore. Her attention was drawn to the spaces between the blades of grass winding along the ground. She squinted in the last beams of sunlight that illuminated the clouds in hues of indigo. Addison stretched out his hand and held it under the tips of the dew-heavy blossoms hanging in front of him, feeling them sway and dance above his palm. It *did* tickle.

"Yeah, I'll miss this the most, too."

Fabric and fire. At no additional airfare

Claudiu Eduard NEDELCIU

University of Iceland, Reykjavik, ERASME

The gusts of wind were way too strong for the helicopter to take off so here it was they would have to do it themselves, with no air support, in subarctic temperatures and with a vicious rain pouring from all directions. It was December so all they had was four hours of daylight, although daylight was a gross overestimation of the grim light shyly permeating through the thick clouds. "Why the heck did we pick Iceland?" Jack was thinking while unloading the big, heavy wooden containers filled with titanium plated nails as thick as your wrist. Indeed, they were unlucky. The company had operations under way in Indonesia, Japan, many of the sub-Saharan countries, most of Latin America…Yet Jack and his mates figured a quick helicopter-assisted job in Iceland would leave them with a few days to explore the land of fire and ice. "It's Icelandair's fault, they got me hooked with their damn unrealistic commercials" Jack kept thinking. And he was right. The Icelandic air carrier had been aggressively increasing its tourism ads, based on the idea that a one- or two-days stopover in Iceland will instantly make you experience the fantastic Viking living. Which got Jack's mind back at the job at hand. He and his mates didn't need to do all this if people flew less. But then they'd be unemployed.

The six of them started to climb the black basalt paved slope leading to the top of Iceland's infamous and unpronounceable volcano: Eyjafjallajökull. They were just one of the 50 units spread around the base of the mountain. The wind was strong, the clouds looked menacing and the pouring rain made it hard to open your eyes. They had to use climbing ropes and good sturdy boots with crampons. But not for the snow and ice, although "jökull" means glacier in Icelandic. That glacier disappeared – just like most of Iceland's glaciers – in 2040, only three years ago. "Thank God for that" Jack pondered while battling the rainy gusts "a bit of ice and I'd sure as hell be slipping down and be gone in that abyss".

Jack's party advanced slowly, taking small steps. Not one of them felt anything but misery. After three hours that felt more like an eternity, they finally reached the summit. Around half of the other teams were already there. The others were within sight, their headlights resembling fireflies on a summer night. Afterall, it was summer in Iceland now, just not the kind of summer Jack was used to back in California. "I don't even know what's worse" Jack told his mate Phil "this horrendous weather or the forest fires that destroyed half of our forests back home". Phil was too dispirited to even reply. About a quarter of an hour later, everyone was on the summit, gathered in an orderly circle around the massive container the company's helicopter had placed on the spot two weeks ago. The expedition leader moved forward, entered a code, had her fingerprints and iris scanned and – voilà – the door opened!

They started at once, each taking charge of a pre-assigned part of the white fabric, with their party's name written on it. Off they went again, down the slope, past the big boulders, through the unbearable rain, and – alas – back at the base camp again. The titanium nails were patiently laying around, waiting to be used; and that they were. Another half an hour later and the fabric was nailed to the volcanic bedrock. All you could see looking back towards the summit was a white cover. For an untrained eye, for someone unaware of what had been going on for the last six hours, this whitescape would look like snow. But sooner or later, you would see it, written in big, capital, black letters: UNITED GEOENGINEERING CORPORATION LTD.

Micro mess

Marie SCHELLENS
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By this time, there weren't many left of us. Our voices remained unheard, just like the past four millennia. Our needs remained invisible.

Dad told us yesterday we would need to move again. Today would be a good day to let us flush out of Ganna's body. All the processed foods she had started eating while trying to meet some apparently important deadline had turned her gastronomic system from our flourishing home to a battle field.

But it was dangerous to let go of Ganna. She had been taking care of her, body very well. We had heard how other humans had made a mess of theirs, and even their surrounding environment, home to so many of us, them, and other organisms.

Since short, the humans slowly started to recognize us. Stomach aches and depressions were the only signs they seemed to answer to. We, being forced out -or killed- by their intoxicated intestines, made them realize what services we had been providing to their bodies, their soils, their ecosystems. But would they ever understand that *we* and *them* are one indivisible whole? Together, we are our body, our soils, our ecosystems, … our earth.

If we are lucky, we might end up in a certified water treatment plant, be part of some organic fertilizer for a while, and find our peace on a biodynamic farm.

Hope is belowground biomass

Hildred CRILL
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Hope is a face toward the sun
the light within snow
and color of oak leaves
Hope is calendar and clock
Hope is the best gestation
and the appetite of odds
Hope is a heterotroph, no, an autotroph,
a product of photosynthesis,
a nanosecond and geology
saying *recent* at the same time
Hope is a vein of minerals
and the face in a granite wall
Hope is a surplus pair of eyelids
a body of water and dead stars
a story told about lungs
Hope is the inductive training of sunrise
and delayed strike of a tiger snake
Hope is a statistical method
Hope is Pascal's wager
Hope is only on the way
Hope is only hope against hope
a loss and gain of reflex
a foot in the door and door in the face
Hope is the pros of cons
Hope is triage and palliative care
sustainable fuel
an ecosystem
a change of weather
Hope is *I hope you are well*
Hope is the human hour

Dust of Snow (with apologies to Robert Frost)

Jay Sterling GREGG

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Abstract: A poem about sustainability, the individual struggling to cope with a system built around conspicuous consumption, and the aspiration for a collective change of heart.

Keywords: Nature, consumption, ecocide, collective values

Years ago,
A mentor had me remember a poem about December.
Me at barely 15, trembling knees, meekly squeaking out lines,
Lines I still know
Would you like to hear it?
Ok, here I go:

"*The way a crow*
Shook down on me
The dust of snow
From a hemlock tree"

But OK.
I'm gonna stop right here because over the years,
I fear we're near to having the words flow empty in our ears.
We've got this one shot and we've forgotten a lot, given the spot were in.
Again- before the window's closed, what can we learn from the crows?

You see,
That old hemlock tree was chopped down with a thud
The dust of snow now just muddy sludge.
And that murder of crows, well, who knows?
Winter won't come and the spine shudders

Nevermore! Nevermore!

…those woods outside my door-
But WAIT! There's more! Don't be sore! A new mall to explore! Shopping galore!
Four floors! One hundred n' fourteen stores!
And yeah, so maybe I have enough… but…
What the fuck? I like stuff!
Besides, what else is money good for?

No new taxes: Read my lips!
'Cause the fact is, the rising tide lifts all ships.
...but watching our cities sink, it makes me think
Are we not on the brink of an eco-pocalypse?

Is it hypocrisy to propose-
"Maybe we oughta just move Jakarta!"?
It's just how far we gotta go, heaven knows,
If they're gonna have water to drink.

So…
One for sorrow, two for joy! More technological toys! What else can we deploy?

And now how much would you pay?
As we consume our way to a planet in septic disarray.
Conservative? Progressive? What can I say?
Today, I think we all long for a hidden third way.

But are we really receptive to a collective perspective?
Would it be effective?

And what does this transformation comprise?
Our eyes lifting up
        to the stars
                in the sky.
Blackbird singing in the dead of night
You were only waiting for this moment to arise

And so now let's come back to the start.
The last four bars of that lonely crow in a winter wood:

"*It's given my heart*
A change of mood
And saved some part
Of a day I had rued"

A collective effort by the international master course "Climate Change Management"

Western Norway University of Applied Sciences, Campus Sogndal, Norway

The story of 17 or the alternative story of 1

1
Children in school,
Fair wages for all,
Sustainability.

2
Fresh food, enough for all,
No one dines alone.
Sustainability.

3
Humans live long,
Cars don't kill.
Sustainability.

4
Right to learn, lifelong.
Teachers are cherished.
Sustainability.

5
Human rights for all,
Parliaments mixed.
Sustainability.

6
Rivers & lakes clean,
All toilets flush.
Sustainability.

7
Cooking with easy breath,
Even for those with little to cook.
Sustainability.

8
Work, decent and safe,
Production when needed.
Sustainability.

9
Rethink & renew,
Connecting the world.
Sustainability.

10
The rich reduced.
Poverty past.
Sustainability.

11
Cities, small & large,
Life pulses.
Sustainability.

12
Economy circulated,
Reduce, reuse, recycle.
Sustainability.

13
Kept within two °,
Damages avoided.
Sustainability.

14
Corals & coasts safe,
Life thrives.
Sustainability.

15
Forests, lakes & rivers,
Life thrives.
Sustainability.

16
Peace cherished,
Wars in the past.
Sustainability.

17
I share with you,
You share with me.
Sustainability.

18
Fresh air & foaming spray.
A lonely bird sings.
Sustainability?

SDG 16 seen holistically

We destroy when we can create,
Keep the peace, erase the hate.

A paved way to justice,
Transparency is like atmosphere for the earth,
Discrimination drowned deeply in the ocean.

Partnership for the Goals

I share with you,
You share with me.
Sustainability.

I am your arms
and you are my hands,
as we stretch for
Sustainability.

A world without us

Fresh air & foaming spray,
A lonely bird sings.
Sustainability?

No child picks flowers,
No woman wears an earing of a cherry.
Just the sound of nature.
A world without us.

Marie SCHELLENS

Stockholm University, Sweden, ERASME

Researching conflict
Inhumane acts of mutual violence
Data gathered and models that predict
Dissociate us from its essence
Fade the fire and explosions
Mute the cries and emotions
Quell the smell
Numbs the pain.
Can insensible analysis bring any gain
Or is the effort in vain

Afrika NDONGOZI-NSABIMANA

University Clermont Auvergne, France, CERDI

La paix semble être impossible
à atteindre pour certains pays
Et pourtant, elle n'est pas inaccessible
Grâce à elle, plusieurs enfants pourraient vivre heureux leur enfance
Et pourtant, certains s'entêtent à se haïr à cause de leur différence
Grâce à elle, les pays pourraient se développer plus
Et pourtant, certains préfèrent le pouvoir plus.

L'effondrement

Arnaud DIEMER

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Et si la transition vers la durabilité supposait la ruine d'un monde désenchanté,
l'anéantissement d'une société qui n'aurait pas su faire preuve de sobriété.
Cet effondrement qui sous-entend une perte soudaine de valeurs,
annoncerait-il des jours meilleurs ?

Lâcher prise, dirons certains, pour mieux comprendre notre moi et celui des autres
Prendre conscience de l'instant présent, sans faire de nous de quelconques apôtres.
Le vrai, le Bien et l'esthétique n'auront jamais aussi bien porté leur nom.
Ils préfigurent un âge de raison et rejettent au loin tous nos démons.

Effondrement dirons certains, car nous n'avons d'yeux que pour l'économie,
Revenus, consommation et profit décuplent notre boulimie.
Un monde sans limites, qui assure notre confort,
et c'est peut-être là, notre premier tort.

Effondrement dirons certains, car nous sommes trop nombreux,
Et nourrir des milliards d'individus reste un vœu pieux.
Toutefois, ce n'est pas la famine qui nous mettra à terre,
Mais bien les migrations et leurs fléaux sanitaires.

Effondrement, dirais-je, pour jouer au gourou du 21^{e} siècle
Ou tout simplement remettre au goût du jour les miracles de Saint Thècle.
Evoquer une fin proche, c'est surtout faire preuve d'utopie
L'ultime rempart à des années d'idéologie.

Au miroir de la complexité

Arnaud DIEMER

University Clermont Auvergne, CERDI, ERASME

La complexité à l'infini, c'est ce qui nous nourrit.
Au plus profond de nous, elle s'est enfouie,
Au point de rendre notre vie, si compliquée.
Chercher à simplifier, ne serait-ce qu'un instant,
serait inespéré, mais c'est nier notre besoin de liberté.

Fixer des limites à la complexité, c'est envisageable,
il suffit de modéliser des objets inclassables.
J'ai un temps souhaité, tout désagrégé,
pour me rapprocher de la vérité.

J'ai très vite compris, mon plus grand souci,
c'est de mettre en équation, le sens de la vie.
Nos esprits animaux ne peuvent être rationalisés,
Ni même mesurés ou évalués.

Hume avait raison, ce qui nous guide, ce sont nos passions.
Et pour rien au monde, je ne voudrais faire scission
entre la raison et mes pulsions.