MAREA[1]

From MARine Ecosystem Accounting to integrated governance for sustainable planning of marine and coastal areas

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Deliverable 3.1

Report on the conceptual structure and user guide of the Sustainability Compass

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1 Introduction

As mentioned in the description of the MAREA project overview, ecosystems and human well-being are linked by the benefits the marine environment and its resources deliver to society. However, this integration is weak, as it can hardly describe cumulative and systemic impacts and interactions.

This deliverable aims at initiating a process of understanding and social learning about systemic interactions and achievement of human needs and capabilities within the environmental boundaries. For this purpose, it presents the Sustainability Compass, a novel multi-dimensional and multi-disciplinary methodology of analysis, which seeks to adequately reflect the complexity of human-nature systems interactions. It integrates existing knowledge and selects some of the most important indicators, creating the basis for a virtuous competition towards sustainable development.

This deliverable constitutes a user guide for participatory social learning, self-assessment and decision-making about daily practices for the use of resources in pursuit of human well-being, according to a model of overall sustainability. This report is structured in five sections. Besides this introduction (section 1), section 2 describes the theoretical background of the Sustainability Compass. Section 3 describes the construction of the Sustainability Compass as a systemic interaction among means and goals of sustainability, around some key sustainability principles. In Section 4 the Compass is applied to selected cases of mussel farms, fish farms, offshore wind parks and collecting common reed. In Section 5 conclusions are drawn and further plans for integration as an interactive tool are described.

2 The conceptual idea of the Sustainability Compass

The rise of scientific rationality (especially 500 years ago; Harari 2012), has certainly led to an increase of the level of education and knowledge among the society at large. However, the technical and economic rationality, and the strong belief in economic growth (since the last 200 years), has caused a loss in the natural instinct and capability of humans to live according to the natural world. The original sensitivity and vulnerability of humans within nature led to the development of the human brain and intellect, the adoption of different lifestyles through very successful intelligent engineering, which has determined a progressive detachment from nature. Sadly, the focus on the sole use of rational intelligence has decreased the ability to listen to nature, which is the ultimate bottom line for human life, thereby exposing humans themselves to a great risk (Sajeva et. al. 2020c).

Since millennia (starting 12.000 years ago; Harari 2012) humans are more and more decoupled from the understanding of the resources nature can deliver, and the importance of more objective, basic and non-negotiable human needs, as well as the level of resources and services extracted from the natural environment. The level of resources and services extracted is determined through the political process, through the action of decision-makers (since the last 200 years; Harari 2012).

The growth of rationality and the classical economic perspective focus merely on political, societal or consumer choices, and not on what the system optimally can deliver in terms of human needs by the ecological resources and functions in present and future times. One difficulty with economic models has been the attempt to incorporate externalities into economic accounts, referring to environmental resources or impacts produced, and generating costs or benefits that affect a third party who did not choose to incur on them (Buchanan and Stubblebine 1962). Externalities are produced when the price/cost of production or consumption of a product or service cannot reflect the true costs or benefits generated for the society as a whole (Mankiw 1998), missing to reach the Pareto optimality.

In order to better regulate the use of resources or to mitigate environmental impacts, the ecosystem service approach attempted to include these externalities into economic accounts, referring to costs and benefits for humans and the society, from a top-down, anthropocentric and short-term perspective (Kosenius et al. 2013). However, this means that in order to valuate ecosystem services, the purpose and spatial (or administrative) relevance of decision-making, and the related societal and political aims should be known beforehand.

As an example, till a hundred years ago, fishing was not regulated and considered assimilable to hunting and gathering. Later, policy and research organisations for fisheries were established (e.g. the International Committee for the Exploration of the Sea (ICES)) in order to increase the economic efficiency of fish catches through more advanced fishing techniques. However, until 20 years ago this was done without considering the ecosystems' production capacity, and overriding the Maximum Sustainable Yield, generating overfishing of e.g. herring and cod (fishing down the food chain; Pauly 1998). Even if the EU and the ICES already advised on a fishing quota, only at the start of the 21st century ecological working groups were established for setting ecological principles.

Only after many years of top-down policies, a bottom-up and nature-inclusive approach was adopted through models based on the carrying capacity of the ecosystem and the optimum yield. However, a strong top-down control based on economic principles remains, through regulatory policies based on market prices, so that ecological functions that do not have a price (e.g. plankton) are not taken into account.

In this context, earlier research (Sajeva et. al. 2019ab, Sajeva et al. 2020ac), as result of a research project funded in 2017 by the Office of the Finnish Prime Minister, has proposed a Sustainability Compass, as a participatory bottom-up process of social learning in support of business for the evaluation and planning of innovation in pursuit of UN Sustainable Development Goals (SDGs). The Sustainability Compass was thought as a bottom-up tool for re-learning about how to live and act sustainably according to a multi-dimensional approach that measures a contextual case by adequate metrics.

Sustainability Compass User Guide			
Actor	Business	Consumer or expert	Decision-maker
1. Construction of the Sustainability Compass per sector: which metrics od criteria cand we use to valuate the proposed themes? Which other themes can we propose?			
Innovation design	Think about how to design an innovation so that it can improve the indicators related to the themes proposed. Think whether the evaluation of the sustainability of the innovation would require new themes or indicators. Sif this is the case send a proposal.		
Adoption, commercialisation and support	Design the competitive strategy for the adoption and commercialisation of the innovation through the themes anf indicators proposed. Propose new themes or indicators if not present nuovi temi.	Suggest models for markets, governance or public services that can promote more sustainable innovations, according to the themes and indicators. Propose new themes or indicators.	Design market models, governance or public services to promote and support more sustainable innovations, according to the themes and indicators. Propose new themes or indicators.
Cooperation	Propose and design cooperation models in support ofmore sustainable activities.		
2. Self-evaluation: measure your performance level according to themes and indicators of your sector. If some of them do not concern your activity you can leave them blank by an adequate justification.			

Figure 1. The Sustainability compass user guide for business and decision-makers (Sajeva et al., 2019a, b)

The Sustainability Compass (Sajeva et al, 2019a,b see Figure 1) is an interactive, bottom-up and participatory tool for identifying key indicators through which one can perform a self-evaluation of own daily activity or innovation. This allows continuous improvement towards sustainable behaviour through virtuous competition and towards higher levels of well-being and sustainability – initially represented by the Sustainable Development Goals (SDGs) of the United Nations.

To be clear, the Sustainability Compass is not a traditional and rigid system of indicators, but rather a dynamic scheme for understanding contextual key factors of sustainability. Again, it is not a system for mandatory compliance, but rather a construction to support learning about the direction towards prosperity and sustainability. The aim is to acquire again the ability to achieve happiness and well-being harmonized with the environment and to be willing to learn bottom-up, rather than obliged to comply with top-down policies. It does not aim to precise assessments, but rather to precautionary thinking to avoid breaking of systems' functioning.

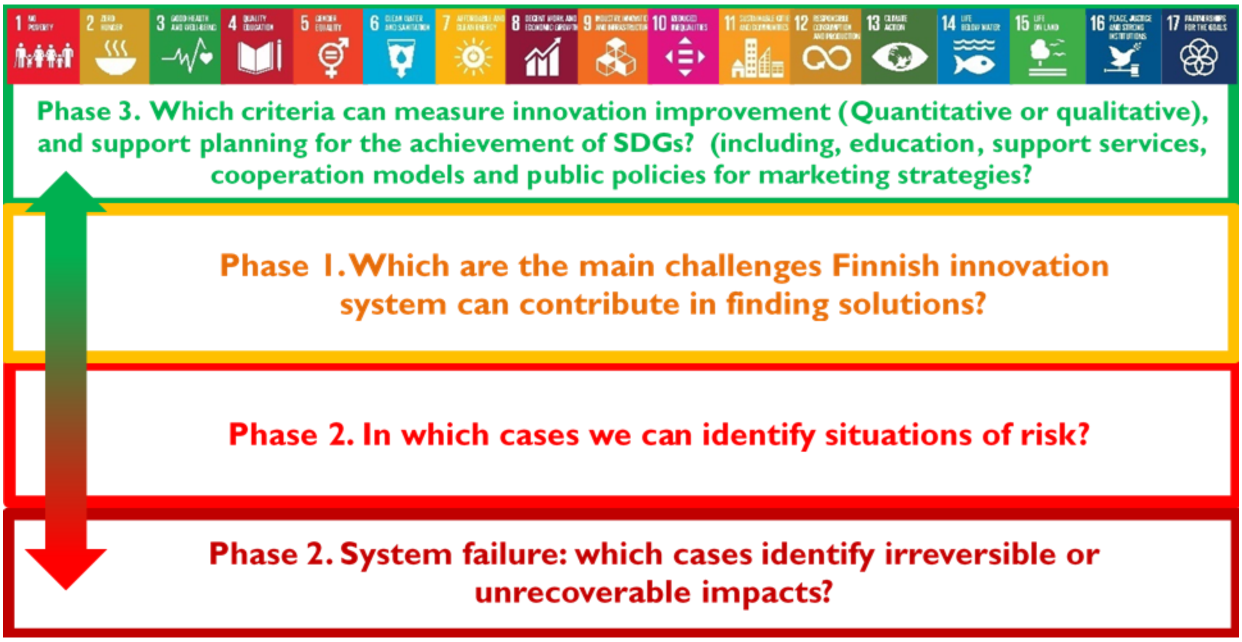

Figure 2 The application of Inno-GAME to the achievement of SDGs for the participatory construction for the Sustainability Compass (Sajeva et al., 2019a, b)

The Sustainability Compass has been applied in workshops, through brainstorming with experts, planned according to the scheme of Figure 2. However, the research conducted has revealed some critical points:

1. The very generic nature and vagueness of SDGs, which makes hard for participants to focus on concrete objectives
2. The description of SDGs as independent and not as systemically interacting, which does not help in the identification of cause-effect relationships between one or more of them. This may result in possible high correlation, or even redundancy, implying the difficulty for participants to decide to which of them a single measurement can be assigned, or possible trade-offs or even contradictions between SDGs
3. The lack of a bottom-up approach of continuous development of knowledge, according to the scientific debate

In the light of these weaknesses, the conceptual framework of the Sustainability Compass has been revised as hereafter described.

3 Systemic framework for the Sustainability Compass

In relation to point 1, presented in the previous chapter, the list of indicators has been re-interpreted according to the outcomes of earlier research. A concept of governance for sustainability takes advantage of Sen's capability approach of "*getting-by with a little assistance"* or 'GALA' (1997), to be achieved within environmental boundaries and (Jackson, 2009:35) or, in other words, the resources available. As earlier presented (Sajeva et al. 2020c), this vision refers to the original root meaning of economics, or οἰκονομία (oikonomia), as 'household management' (Sajeva et al. 2019a; Sajeva et al. 2019b; Sajeva et al. 2020a), which is '*the effective allocation of resources for meeting human (as householder) needs'* (Sajeva et al. 2020a). The notion of 'household management' helps for interfacing natural and social sciences (see Figure 1; Sajeva et al. 2020a).

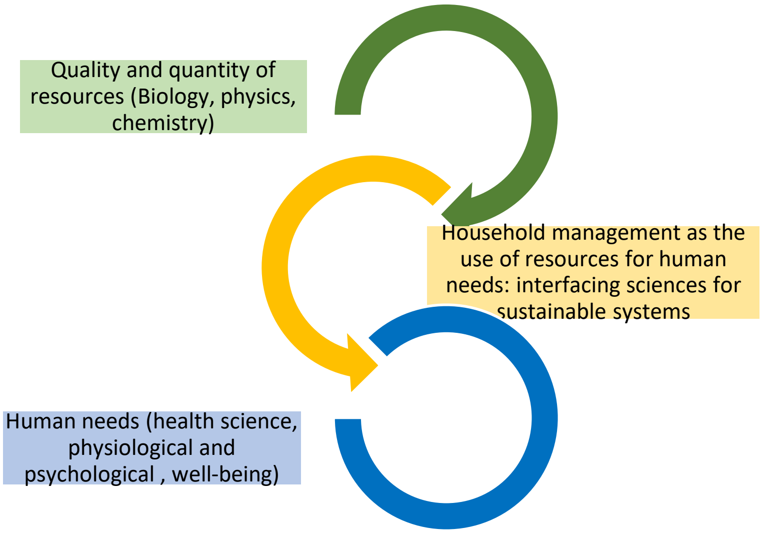

Figure 3. Economics for natural and human systems equilibrium (Sajeva, et.al. 2020a)

Sen (1997) in particular refers to the existing confusion between means and goals of development. More specifically economic growth (goal 8) is not a goal in itself, rather a mean through which human well-being can be produced. This is particularly true for early stages of development whereas in mature economies additional increments of wealth and economic growth do not always produce better quality of life (Slim, 2013). This vision can be implemented by referring to the Five capitals Model of Sustainability (Forum for the Future 2021), which is based on the idea of 'carrying capacity' (Wackernagel and Rees, 1996; Chambers et al. 2000; Schuller et al. 2000), describing the external limit within human development can take place.

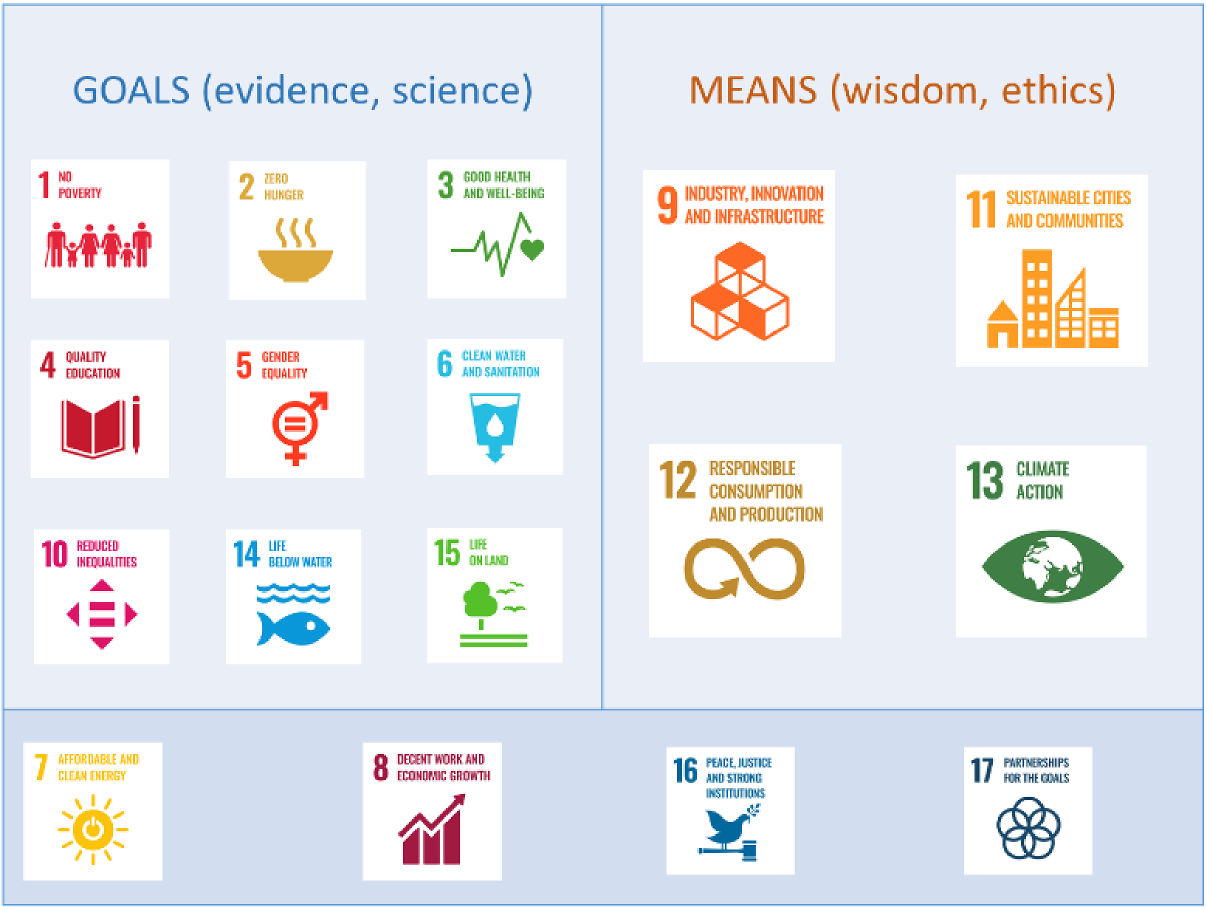

Figure 4. A first classification of SDGs according to means and goals

As for point 2, the isolation of scientific fields limits knowledge integration. However, the whole, according to von Bertalanffy (1968) '*is more than the sum of its parts».* Science integration assumes great importance in consideration of the irreducibility of integrated systems (Laszlo and Krippner, 1998: 13), because, as Morgan (2005) states, in these systems *«the behaviour of the parts depends more on how the parts are connected rather than on the nature of the parts».* The lack of 'hard' scientific evidence and the higher uncertainty about complexity, leaves room to 'softer' political judgement (Funtowicz and Ravetz 1990). In presence of high uncertainty, as described in earlier research (Sajeva et. al. 2020c), a principle of wisdom in the analysis of systems is the use of measures and methods can reflect systems' actual complexity and multifaceted aspects (Ashby 2014; Conant and Ashby 1970) and can provide a *'repertoire of responses which is (at least) as nuanced as the problems you face'*. In other words, the measures and methods should reflect the multi-dimensionality at hand (Türke 2008), or, in the words of Conant and Ashby (1970) *'every good regulator of a system must be a model of that system'*. Flyvbjerg's phronetic research planning approach (2004) promotes the understanding and sharing of knowledge on the basis of emerging evidence. Therefore, the Sustainability Compass can be based upon two main principles:

- Representation of sustainability factors by adequate metrics and indicators
- Adoption of a precautionary approach, when the complexity at hand goes beyond current knowledge and understanding. This means avoiding too complex approaches that may easily produce uncertain results.

Phronesis, from the Greek language ‘φρόνησις’, refers to the knowledge and practical wisdom to address choices under incomplete, dynamic and uncertain information rejecting the traditional economic models, in which rational economic agents—*Homo economicus*—possess complete knowledge for efficient action. Therefore, in matters concerning very complex and hardly understandable impacts on human health, a precautionary approach has been adopted, and a principle of healthy nutrition and avoidance of advanced technologies of genetic manipulation with unknown long-term impacts, has been adopted (goal 3).

Point 2 links with point 3 as a bottom-up approach and scientific discussion is never ending especially in conditions of uncertainty. In the same way, in presence of uncertainty, a continuous scientific debate would generate a deeper understanding of trade-offs and correlations among objectives. An example of this is the overlapping of goals 1 and 2. According to Sen (1999), poverty represents a systematic or structural denial of basic freedoms, jeopardising the ‘capability’ to meet basic needs. The lack of one freedom causes in turn the denial of other freedoms, making the poor vulnerable to a wider range of violations. An inadequate income may generate impairment (goal 5) of access to adequate healthcare (goal 3), water, shelter, education (goal 4) and welfare services, and the possible consequent enjoyment of human, civil and political rights (Landman, 2006), which by the way are strangely missing in the framework of the UN SDGs. These arguments were taken as the basis for the reverse Maslow pyramid (Sajeva et. al. 2020a), where the systematic and continuous accumulation of power and agency by some would reduce others’ capability to meet basic needs or to assure human rights. Galtung (1969) refers to violence as an *‘avoidable impairment of fundamental human needs or, to put it in more general terms, the impairment of human life, which lowers the actual degree to which someone is able to meet their needs below that which would otherwise be possible.*’ Galtung (1990) described different kinds of violence, as personal, structural, and cultural. According to the author, structural violence indirectly is produced through the structure of a society, in terms of unequal power and life chances, for instance upon race or gender bases but also in terms of concentration of power (Ho, 2007). As an example, neo-liberal governance arrangements, such as the Transatlantic Trade and Investment Partnership (TTIP), are focused on profit maximization by dumping environmental, safety and work regulations (Stiglitz, 2014).

On the basis of Galtung’s formulation, Paul Farmer (2005) reports that structural violence is *“not the result of accident or a force majeure; they are the consequence, direct or indirect, of human agency,”* which manifests through structures that support an unequal distribution of power or resources and the consequent disproportionate life chances, disease or poverty. This happens, in Farmer’s understanding, because of exploitation (Galtung 1990), through unequal distribution of power among actors and because “*the power to decide over the distribution of resources is unevenly distributed”* (Galtung, 1969). In short, when social structures are planned in pursuit of the needs of some major stakeholders, they may systematically disadvantage all the other people, who do not hold as much if any power at all.

According to the United Nations Development Programme 1999 the growing concentration of wealth and power in mega-corporations may erode fair competition. For example, by 1998 the ten largest pesticide manufacturers controlled 85 percent of the global pesticide market, and the ten largest telecommunication companies 86 percent of the global telecommunications market (Ho, 2007). Again, not all these aspects of equality are described in the SDGs, therefore the issue of equality has been complemented by the need of supporting small and medium size businesses.

3.1 Key sustainability principles for the Sustainability Compass

Upon these theoretical bases, the SDGs have been organised according to The Five Capitals Model of Sustainability (Forum for the Future, 2021) and triangulated with the sustainability principles of the Natural Step (2021), the Five Capitals Models, and other relevant literature (see figure 5).

In order to form the final generic structure for the Sustainability Compass, some main sources have been considered as represented in Table 1, and put in relation with the UN SDGs and other relevant literature as described in the previous section.

Table 1. The main sustainability principles from the Forum for the Future (2021) and the Natural Step (2021)

<table>
<tr><th></th><th>Forum for the Future</th><th></th><th>The Natural Step</th></tr>
<tr><td rowspan="3">Natural Capital</td><td>In their extraction and use, substances taken from the earth do not exceed the environment's capacity to disperse, absorb, recycle or otherwise neutralise their harmful effects (to humans and/or the environment)</td><td rowspan="10">In a sustainable society, nature is not subject to systematically increasing…</td><td>1… concentrations of substances from the earth's crust (such as fossil CO2, heavy metals and minerals)</td></tr>
<tr><td>In their manufacture and use, artificial substances do not exceed the environment's capacity to disperse, absorb, recycle or otherwise neutralise their harmful effects (to humans and/or the environment)</td><td>2… concentrations of substances produced by society (such as antibiotics and endocrine disruptors)</td></tr>
<tr><td>The capacity of the environment to provide ecological system integrity, biological diversity and productivity is protected or enhanced</td><td>3… degradation by physical means (such as deforestation and draining of groundwater tables)</td></tr>
<tr><td rowspan="3">Human Capital</td><td>At all ages, individuals enjoy a high standard of health</td><td rowspan="3">4… concentrations of (exogen substances) substances in human bodies (as analogy to others)</td></tr>
<tr><td>Individuals are adept at relationships and social participation, and throughout life set and achieve high personal standards of their development and learning</td></tr>
<tr><td>There is access to varied and satisfying opportunities for work, personal creativity, and recreation</td></tr>
<tr><td rowspan="4">Social Capital</td><td>There are trusted and accessible systems of governance and justice</td><td rowspan="4">5. in the society there are no structural obstacles to people's health, influence, competence, impartiality and meaning.</td></tr>
<tr><td>Communities and society at large share key positive values and a sense of purpose</td></tr>
<tr><td>The structures and institutions of society promote stewardship of natural resources and development of people</td></tr>
<tr><td>Homes, communities and society at large provide safe, supportive living and working environments</td></tr>
<tr><td>Manufactured Capital</td><td colspan="3">All infrastructure, technologies and processes make minimum use of natural resources and maximum use of human innovation and skills</td></tr>
<tr><td>Financial Capital</td><td colspan="3">Financial capital accurately represents the value of natural, human, social and manufactured capital</td></tr>
</table>

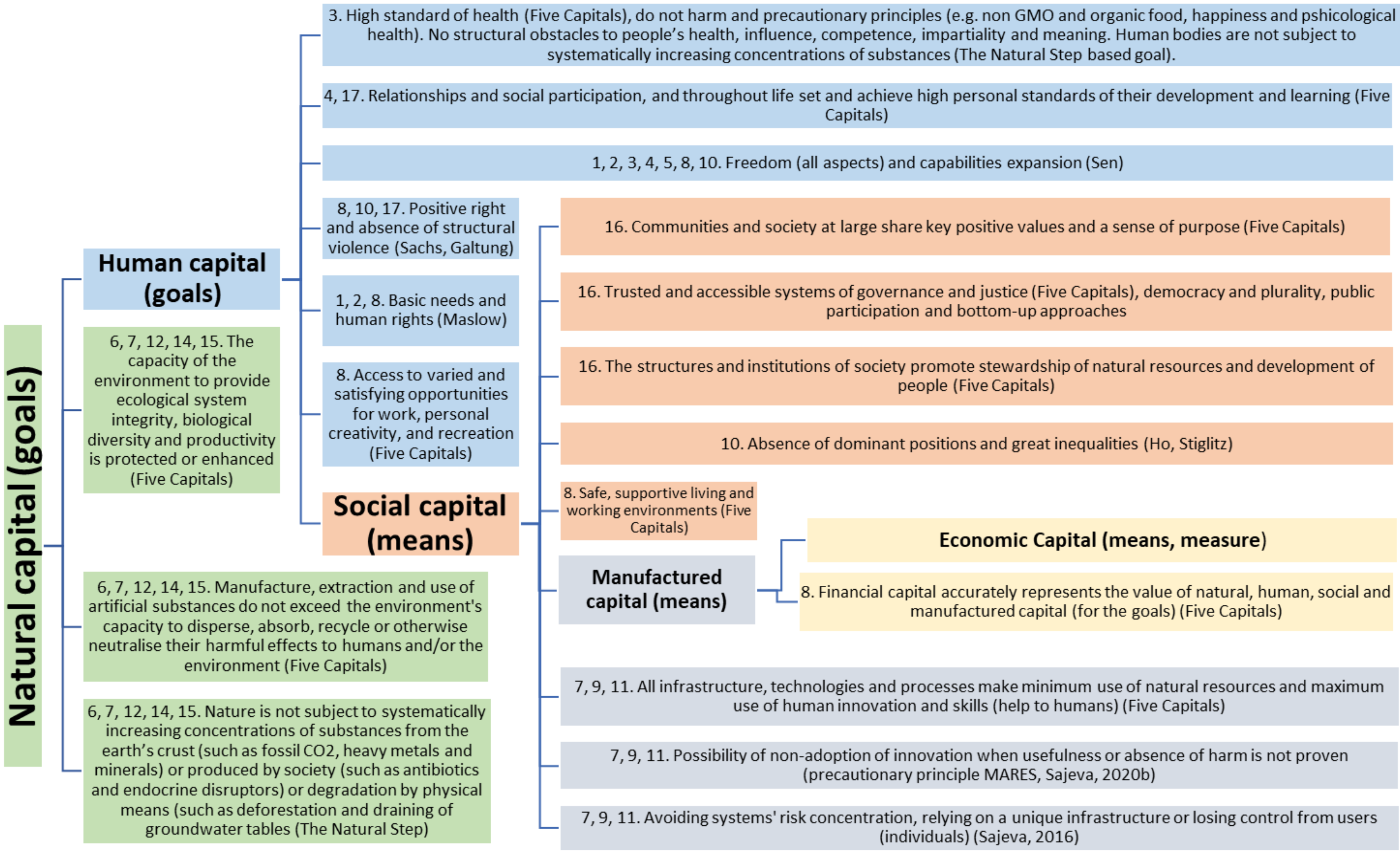

Figure 5. Sustainability principles as triangulation between SDGs and Sustainability literature

4 User guide for the application of the Sustainability Compass to selected cases

On the basis of the previous analysis, a generic scheme which systemically relates the SDGs with the sustainability principles, is provided as a hint for the users to plan their own actions. In figure 6 the scheme is organised from left to right as means (or intermediate goals) towards final goals.

Depending on the role of the actor, they can start from any node of the system and think about what the input for their own activities is and what they need for their own operations. Then the actors can think about the key principles to consider their own activity with. Finally, they can consider are there outputs of their activity that could support other actors pursuing the final goals.

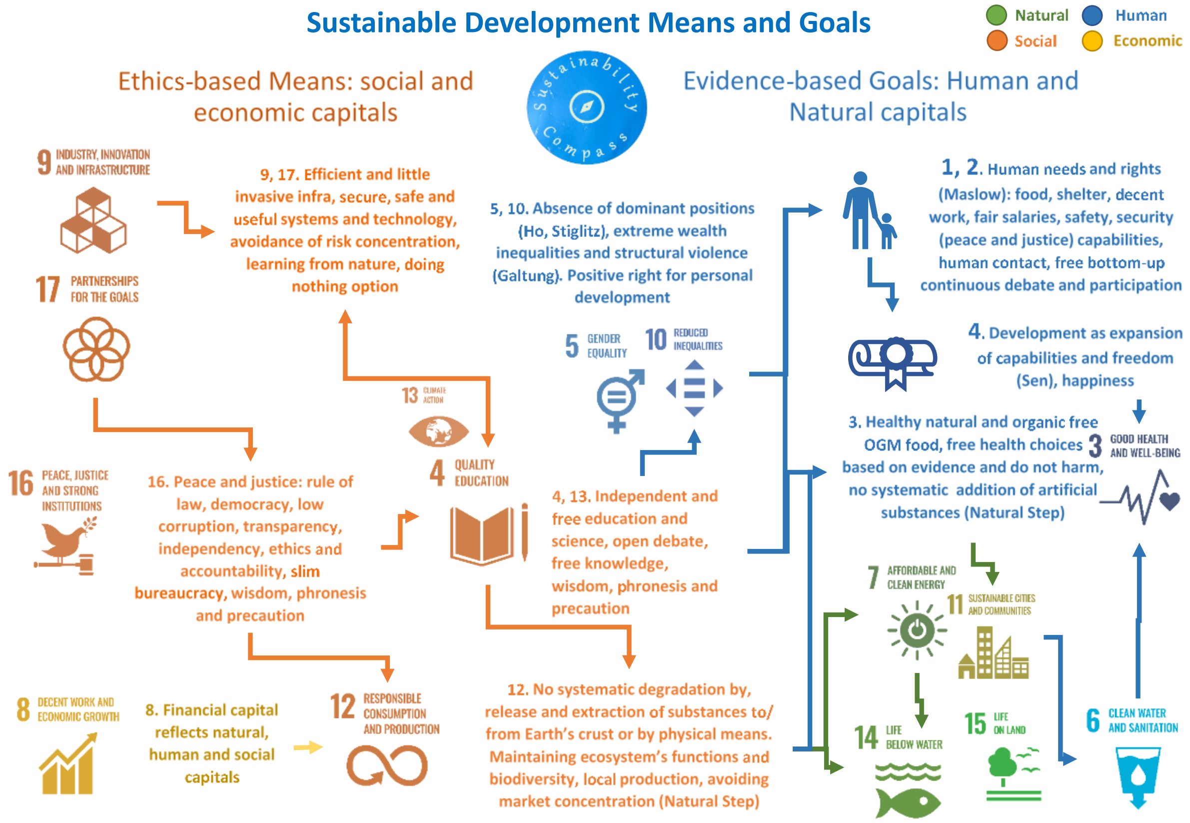

Figure 6. A systemic integrated representation of UN SDGs, triangulated with sustainability principles.

4.1 Implementation for selected cases

The process for the application of the Sustainability Compass to the selected cases (mussel farms, fish farms, offshore wind parks and collecting common reed) consists of three stages. In the first stage overall systemic sustainability goals are listed after analyzing background sustainability literature, SDGs and the structure of the Sustainability Compass. In the second stage a first sketch of indicators associated with the goals is produced after analyzing case reports and inputs from partners. In the third and final stage a questionnaire, based on the goals and indicators outlined in the first two stages, for experts and practitioners is carried out. Based on the analysis of the questionnaire and the work carried out in the first two stages, an updated version of the Sustainability Compass is formed. The process is visualized in Figure 7. At the moment of writing the first two stages of the process were completed, but the third stage was still ongoing.

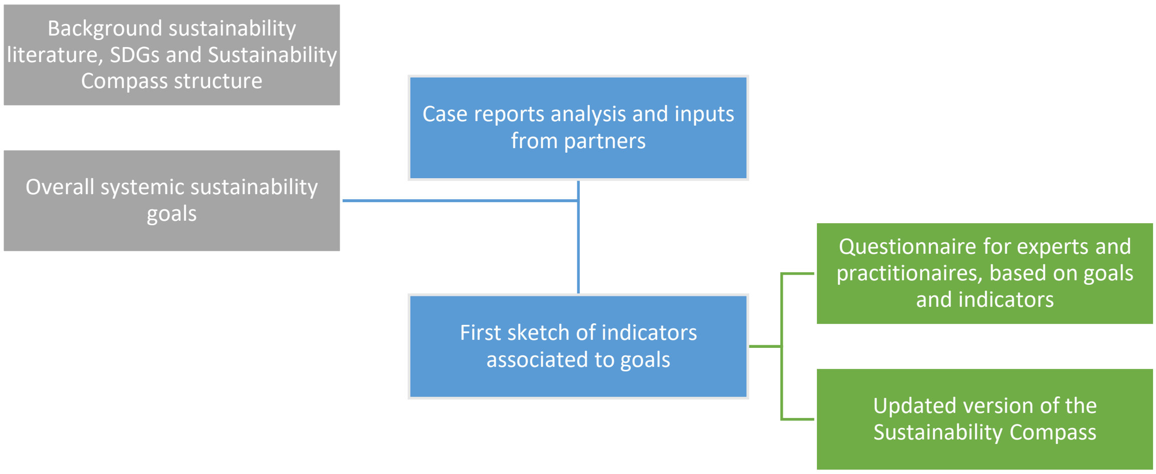

Figure 7. Process for Sustainability Compass application

The construction of a Sustainability Compass for each of the selected cases began with a preliminary review of existing literature and reports. The aim of the review was to understand the metrics and indicators used to assess sustainability, and then relate them with the sustainability principles presented in Figure 6. After this, the MAREA project partners were consulted for gathering the knowledge they already possess about the indicators.

The initial process of the review is not planned as a systematic literature review, which is more commonly undertaken in scientific research. The reasons for this choice responds, as hereafter described, to the need to adopt a bottom-up approach, which is closer to field operators and the society.

Firstly, systematic literature research identifies a large number of publications and can discover a large amount of scientific data and complex interrelations. Often these are not familiar to field operators and the society, and consequently not easily translatable into practical knowledge about sustainable practices. However, scientific knowledge is important and therefore the systematic analysis has been replaced by expert consultation, so that the most relevant knowledge can be communicated. This expert consultation is not limited to academics, but also involves businesses, field operators and workers.

Secondly, much knowledge exists, which is not present in scientific publications, but is rather contained in technical reports by the industry or by associations of operators in the field.

Thirdly, science can provide knowledge about complex interrelations, for instance between the parts of an ecosystem or between ecosystems and human systems. However, the more complex these are, the more uncertainty is likely to increase. Instead, this approach is based on a precautionary principle, which does not claim to understand all complex interrelations, but avoids possible risks a priori. For instance, the knowledge about the impact of heavy metals on human health and certain diseases might be limited and the direct effect hardly detectable. The precautionary principles would tell us: 'better avoid eating tungsten, even if I do not know exactly why'. The precautionary principle is well represented by the sustainability criteria of the Five Capitals Model and of the Natural Step, as previously described.

The outcome of this process will be a triangulation between different orthodox (scientific) and heterodox (practical) knowledge, according to a bottom-up approach.

Table 2 presents studies that were reviewed in the first stage of the process and the focus of each. As the purpose was to construct a Sustainability Compass, the literature search was conducted on the basis of different aspects of sustainability, especially focusing on socioeconomic sustainability. Regarding offshore wind, a few studies were found concerning socioeconomic aspects of industry developments and the impact of the industry on ecosystem services. For aquaculture, finding literature concerning other than biological or ecological aspects of sustainability proved harder.

Table 2. Summary of reviewed articles used for identifying suitable indicators

Author(s)	Study	Category	Focus of the study
Shiau & Chuen-Yu (2016)	Developing an Indicator System for Measuring the Social Sustainability of Offshore Wind Power Farms	Offshore wind	Generating social sustainability indicators while considering social, economic and environmental aspects
Glasson et al. (2020)	Guidance on assessing the socio-economic impacts of offshore wind farms (OWFs)	Offshore wind	Socio-economic aspect of OWF industry development. A special focus on local and regional coastal communities
Gil-García et al. (2019)	Categorization and Analysis of Relevant Factors for Optimal Locations in Onshore and Offshore Wind Power Plants: A Taxonomic Review	Offshore wind	Determining factors for optimal location of wind farms. Categories • Socio-environmental • Location • Economic • Political
Mangi (2013)	The Impact of Offshore Wind Farms on Marine Ecosystems: A Review Taking an Ecosystem Services Perspective	Offshore wind	OWF impacts on • Supporting services • Provisioning services • Regulating services • Cultural services
Aldieri et al. (2019)	Wind power and job creation	Offshore wind	Job effects of wind power
Amundsen and Osmundsen (2018)	Sustainability indicators for salmon aquaculture	Fish	Indicators of sustainability that cover aquaculture production
Baltic Blue Growth (2019a)	Advice for the future Baltic mussel farmer – a summary of lessons learned from the BBG project	Mussels	Factors affecting successful production of mussels
Baltic Blue Growth (2019b)	Mussel farms in the Baltic Sea	Mussels	Lessons learned from five mussel farm pilots
Hambrey (2017)	The 2030 agenda and the sustainable development goals: The challenge for aquaculture development and management	Aquaculture	Relevance of the SDGs to aquaculture development

Katila et al. (2019)	Defining and quantifying the sea-based economy to support regional blue growth strategies – Case Gulf of Bothnia	Aquaculture	Estimating the economic significance of blue economies
SUBMARINER Network Mussels Working Group (2019)	Mussel farming in the Baltic Seas as an environmental measure	Mussels	Mussel farms' potential to contribute to the achievement of SDGs
Ozolina and Kokaine (2019)	Socioeconomic Impact of Mussel Farming in Coastal Areas of Baltic Sea	Mussels	Social and economic impacts of mussel farming development
Petersen et al. (2020)	Policy guidelines for implementation of mussel cultivation as a mitigation measure for coastal eutrophication in the Western Baltic Sea	Mussels	The potential of mussel farms to extract nutrients. Ecological and economic effects of mussel cultivation.
Valenti et al. (2018)	Indicators of sustainability to assess aquaculture systems	Aquaculture	Proposes economic, environmental and social sustainability indicators for assessing aquaculture systems

In addition to the studies in Table 2, the EU taxonomy for sustainable economic activities (The establishment of a framework to facilitate sustainable investment, Regulation 2020/852) was reviewed as well. However, at the time of writing, the technical screening criteria (European Commission, 2021) was available only for two out of the six environmental objectives. The two objectives to which the criteria were published were climate change mitigation and adaptation. The review of the technical screening criteria related to the two environmental objectives revealed matching indicators with those found from other sources for the case of wind power. However, for now the EU taxonomy was not relevant for aquaculture as the technical screening criteria for the remaining four objectives will be published in 2022.

Based on the related literature for each case, initial social sustainability indicators and measurements were identified as the process considered various aspects of sustainability. After the initial sustainability indicators were selected separately for mussel farms, fish farms, offshore wind parks and collecting common reed, they were categorized in line with the UN Sustainable Development Means and Goals according to the structure in Figure 6 and the general sustainability principles in Figure 5.

Overall, the literature review process and the consultation with MAREA partners in the second stage of the process produced indicators, which were linked to sustainability principles. In addition, the planning of questionnaires for experts and practitioners commenced and four separate web-based questionnaires were created, but had not yet been sent at the time of writing. Separate questionnaires were designed for offshore wind parks (see example in Table 3), mussel farms, fish farms and collecting common reed. The objective of the questionnaires is to gain knowledge from experts and business practitioners on the provided initial indicators (or explanatory factors) regarding their relevance for the United Nations Sustainable Development Means and Goals in the selected case studies.

Table 3. An example of Sustainability Compass questionnaire for Offshore Wind Farms on the basis of existing knowledge

Question	Explanatory factors provided
SECTION I: Work and economy: access to varied and satisfying opportunities for work, personal creativity, and recreation, for people and businesses, especially rural depressed areas	
How likely do the following explanatory factors or metrics address OWF business's performance in sustainable economic development?	○ Employment of local people for local jobs ○ Tax revenue generated for the region ○ Indirect or direct job creation ○ Higher salary levels in the region ○ Enhanced energy security ○ Enhanced energy affordability ○ Proportion of population with access to clean energy ○ Revenue generated from electricity exports/avoidance of electricity imports
How likely do the following explanatory factors or metrics address OWF business's performance in inclusive, safe and satisfactory working environment and conditions?	○ Equal pay for equal value for everyone (no matter of gender, race/ethnicity, age) ○ Low skilled labor training and education ○ Number of employees with access to occupational health services and the extent (quality) of occupational health services ○ Safety conditions of workers (rates of employee injury, disease and fatality) ○ Labor rights (proportion of employees with contract of employment and/or collective agreements) ○ Youth employment (apprenticeship opportunities, mentoring) ○ Career development opportunities ○ Employment stability
How likely do the following explanatory factors or metrics address OFW business's impact on the human well-being and local economies?	○ Utilization of local services and natural, human and capital resources ○ Income and tax revenue generated for the region ○ Developments or built new infrastructure (such as roads, grids, ports) in the rural areas ○ Efforts to strengthen local ownership and engage local government and community ○ Increased investments and new businesses in the area ○ Wage level relative to the local average ○ Increased attractiveness of the area (net migration)
How likely do the following explanatory factors or metrics address OFW business's performance in people's personal creativity, recreation, happiness or psychological health?	○ Efforts to protect the existence of natural heritage ○ Efforts to protect the cultural heritage and identity (the sense of connection with the marine environment) ○ Aesthetic and spiritual value of a place affected by the OWF ○ Effect on offshore recreation opportunities near the OWF site ○ Effect on onshore recreation opportunities near the OWF site ○ Effect on tourism and tourism activities near the OWF site ○ Property and house values near the OWF site
SECTION II: Societal aspects: fair institutional support and services, to avoid dominant position and assure equity with special attention to rural depressed areas	
How likely do the following explanatory factors or metrics address the components of prosperous OWF business?	○ Government support for research and development in the renewable energy sector ○ Promotion of entrepreneurship, innovation, enterprise development; and facilitation of access to financial services ○ Infrastructure provided in the local community to support construction and production ○ Public acceptance
SECTION III: Environmental sustainability: maintaining the ecological systems' functions, integrity and biological diversity	
How likely do the following explanatory factors or metrics address OWF business's impact on the natural, physical and human environment?	○ Visual pollution ○ Noise pollution ○ Adverse impacts of underwater noise and vibration ○ Adverse impacts on bird life ○ Adverse impacts on marine mammals ○ Adverse impacts on fish ○ Decreased local air pollutants ○ Decreased greenhouse gases when renewable energy is used to replace fossil fuels ○ Increased share of renewable energy in final energy consumption ○ Chemical emissions from offshore wind farm structures to the marine environment ○ Physical loss of the seabed ○ Physical disturbance to the seabed (modification of seabed-morphology) ○ Enhancement of benthic flora and fauna due to substructures

The triangulation between different sources and experiences provides the Sustainability Compass increased robustness. The questionnaires are subdivided into sections. For each section one or more questions are formulated and respondents can mark their answers according to the following criteria of:

- Factor relevance:
    - Very unlikely
    - Quite unlikely
    - Quite likely
    - Very likely

- Quality of knowledge:
    - Personal perception/ inclination (weight 1)
    - Publication (weight 1,5)
    - Verified replicable evidence from the field (weight 2)

The factor relevance expresses how much a given indicator or metric can provide a reference metric to a certain aspect of sustainability. The quality of knowledge describes the level of objectivity of the evaluation provided. The quality of knowledge is given weights ranging from 1-2. The highest weight of two is given to verified replicable evidence from the field and the lowest of one to personal perception/inclination. Publications are weighed by one and a half.

As a result, the Sustainability Compass is built as a bottom-up scheme for social learning about sustainable behaviour, which concretely applies to everyday life of business operations, consumer behaviour and policy making. The more each social group or individual learns in a systemic way how to operate in a sustainable manner in their specific and practical contexts, the easier the system can maintain a general equilibrium of continuous functioning of human-nature systems.

5 Plans for applying the Sustainability Compass in real life situations, geospatially represented

The first examples of the Sustainability Compass for selected cases are planned to be piloted in practical cases (aquaculture and wind parks) and represented by a geospatial tool, which is currently being developed by the University of Tartu for the MAREA project.

The initial indicators can be adjusted or changed in relation to their specific relevance, and in relation to the specific case. The availability of data can be verified. For each of the indicators previously identified, data may even be unavailable, which would suggest the need to produce this data. Even if data would not be available, an indication of the direct or inverse relation among indicators will be provided, in order to indicate the most sustainable direction.

Certainly, not all the knowledge and data needed for the Sustainability Compass can be collected from the operators of the cases proposed. This knowledge may be searched from other sources. This suggests that a multi-dimensional sustainability evaluation can only take place by a systemic approach, which considers different actors and institutions that interact within the society. In this way, the single actors and operators can also get acquainted with the knowledge about impacts of their own activities within the society, not just limited to restricted fields. This approach realizes a bottom-up approach in which individuals search for sustainability and virtuous competition, not only by complying with top-down rules, but learning to live sustainably, even when these rules would not apply or would be missing. The approach can end up in even reducing the load of bureaucracy and compliance with top-down rules, which might become by the time redundant and useless. Social bottom-up behaviour can become more effective than top-down regulation because it becomes internalised as part of an individuals' thinking.

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