MAREA[1]

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

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Deliverable D.T3.3.1

Roadmap for implementing the developed sustainability compass, as a collective input from the various expert task force meetings

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1 Introduction

The aim of the MAREA project is to improve the understanding of the benefits the marine environment and its resources deliver to society. This because currently the level of integration and the understanding of the existing linkages between ecosystems and human well-being is weak. In the framework of the MAREA project, as anticipated in the *Report on the conceptual structure and user guide of the Sustainability Compass* (Sajeva et. al, 2021) the Sustainability Compass is a bottom-up method and process for participatory social learning to adjust the direction towards human prosperity, freedoms, capabilities, happiness and wellbeing within natural bounds. In order to achieve this general theoretical aim, there is a need to make it operational, and realise a tool that can be applied to concrete situations and practice on the field, integrating the continuous functioning of ecosystems and the achievement of human needs.

In section 2 of this report the aims of the Sustainability Compass are described. Section 3 oulines the theoretical background for construction of the framework. The process of application to specific cases of aquaculture and offshore wond power are specifically described in section 4. The practical experience in the field is analysed in terms of ecosystem services in section 5. Section 6 exposes the developments and plans for future application.

2 The aims of the Sustainability Compass

The Sustainability Compass was realised for the first time for a project funded by the Office of the Finnish Prime Minister in support to planning and adoption of sustainable innovations and published after further research (Sajeva et al. 2020a).

The Sustainability Compass seeks to create a virtuous competition towards sustainable development. Therefore, unlike traditional and rigid systems of indicators or more traditional approaches of top-down uniformed and centralised governance of sustainability and mandatory compliance, the Sustainability Compass is based on a voluntary, dynamic and self-improving set of context-based indicators and metrics, and on a bottom-up process for continuous learning on the basis of scientific debate and triangulation of information from diversified sources towards best practices. This takes place through sharing and comparing multiple dimensions of sustainability between companies of the same field, thereby improve their knowledge and understanding of overall sustainability, beyond environmental requirements.

The Sustainability Compass strives to reach the following aims, futher specified in the following sub-sections:

1. Representing the complexity of socio-ecological systems' sustainability
2. Social-learning for understainding of case-specific most important factors and indicators, as well as uncertainties
3. Realise a bottom-up participation for decision-making: empowering and activating citizens, researchers, as well as private and public organisations
4. Communicate real values rather than compliance with mandatory or uniformed principles of responsibility

2.1 Complexity of socio-ecological systems' sustainability

The Sustainability Compass aims at representing the complexity of cause-effect relationships of human-nature systems. Within the MAREA project, the technical aspect concerning cumulative

impacts is treated specifically by UTARTU. The Sustainability Compass provides a framework for multi-dimensional and multi-disciplinary methodology of analysis that could contain even a larger amount of information, which would adequately reflect the complexity of human-nature systems interactions.

This is done according to a general principle for building wisdom and knowledge according to which the methods of analysis and representation of systems should be designed to reflect their actual complexity and multifaceted nature (Ashby, 2014) providing a *'repertoire of responses which is (at least) as nuanced as the problems you face'*. The evaluation models should adequately reflect the multi-dimensionality at hand, (Türke, 2008), because *'every good regulator of a system must be a model of that system'* (Conant and Ashby, 1970). This is why the Sustainability Compass is structured by criteria that can assess all sustainability dimensions, across five capitals (Forum for the Future, 2021), as further specified in sub-section 2.2.

This means in practice integrating existing knowledge from various sources, such as literature, company reports and practical knowledge from the field. The Sustainability Compass unlocks knowledge and information and activates the enlarged participation inclusion and free debate among of all those who wish to share their experiences, citizens and companies, even in anonymous form.

2.2 Social learning for understainding of case-specific most important factors and indicators, as well as uncertainties

Social learning is a multi-disciplinary concept, belonging to the individual cognition and learning and then expanded to interacting groups and organizations (Johnson et. al., 2012). Social learning has a strategic role for understanding the mechanisms for effective participatory management of complex social-ecological systems (Steyaert and Jiggins, 2007). It focuses on how the interactions within a group can change individual knowledge and understanding and at the same time how individual learning influences and informs collective knowledge and actions (Reed et al.,2010). Social learning results in the sharing of diversified knowledge and experiences, revealing and even integrating contrasting viewpoints (Mostert et al., 2007), to eventually build shared and informed visions or to understand diverging perspectives. Social learning is particularly relevant for fields characterised by social-ecological complexity and high uncertainty, such as, for instance, natural resources management, wildlife or water management and environmental risk assessment (Johnson et. al., 2012).

Therefore, social learning can help to find and share common goals (Webler et al. 1995), in pursuit of collective action (Wenger 1998, Röling 2002), and for understanding differences and local characteristics. The increasing understanding of emerging evidence puts Flyvbjerg's phronetic research planning approach (2004) into practice, where phronesis, from the Greek language 'φρόνησις', is the knowledge and practical wisdom able to address choices under incomplete, dynamic and uncertain information.

This vision is clearly in contraposition with an idea of certain science, and of *Homo economicus* models of traditional economics, which portrayed humans as economic agents equipped with complete knowledge upon which to make decisions. The Sustainability Compass reduces systems' complexity by continuously updating major key case-based indicators for specific fields and geographical areas, by precaution and triangulation of scientific and operational knowledge from multiple sources, allowing the natural emergence of probable best practices at local level.

The reference to science involves the consideration of its uncertainty. Uncertainty is an essential part of science, as has been shown by studies carried out at EU level (Funtowicz and Ravetz, 1990; Sajeva,

2005a,b). The scientific method does not provide truth and certainty, rather constitute a process of research and learning that constantly confirms, modifies or refutes evidence and generates new evidence. Very often, results that appear to be certain are later found to be uncertain or even disproved by subsequent research.

2.3 Bottom-up participation for decision-making: empowering and activating citizens, researchers, as well as private and public organisations

The recent trends of always more cerntralised science and decision-making processes put more distance between institutions and local communities and citizens, which can undermine the achievement of sustainable development. Increasingly centralised decision-making, for example at European or international level, often proves inadequate to take account of local differences, i.e. local economies, the culture and needs of citizens, and the conditions and characteristics of local ecosystems. The more the system is highly centralised, the more multinational corporations can influence decisions and have a dominant position than citizens and other actors in local socio-economic realities. Too often, general regulations are unsustainable for small and medium-sized enterprises. The related concept of structural violence is analysed in the section 3 in more detail, with reference to sustainability goals.

The notion that decisions should be based on scientific evidence is also frequently put forward in many recent scientific projects. Recent trends towards the centralisation of decision-making processes, both at European and international level, are pursued by supporting them with scientific theses.

Previous studies at European Commission level (Sajeva and Masera, 2006) have shown the need for mechanisms, including voluntary mechanisms of enlarged citizen participation, and for fragmenting or isolating critical systems that are at risk of negatively affecting each other. In relation to critical networked infrastructures, governance was defined as *'a conceptual construct dealing with societal sensitive and complex issues that can be translated in a decision-oriented process, inclusive of all concerned private and public stakeholders. The outcome of the process is based on participative deliberation, the informing of options, and commitment to the implementation of the joint deliverances. The governance process represents the interface with stakeholders, the source and support of strategic decisions and the instrument through which the principle of accountability can be properly implemented. Governance is a concept that expresses the aspiration for 'joint and integrated management' of affairs that cannot be handled by single stakeholders because of their multi-impact effect and because of the complexity of relations between them'* (Sajeva and Masera, 2006:8).

The notion of stakeholder can have different meanings for different organisations. As the object at hand is the overall sustainability, in this context a generic definition from Cambridge dictionary is the most suitable interpretation: *a person such as an employee, customer, or citizen who is involved with an organization, society, etc. and therefore has responsibilities towards it and an interest in its success.* In practice, for sustainability matters stakeholders are all citizens, as well as private or public organisations. An extended participation of citizens and the sharing of knowledge, too often limited to a monopolistic and separate class, is a key element of governance (Sajeva, 2005b). As the author continues, citizens and their 'knowledge' social cohesion, labour policies, access to education and positive right are key factors andl source of development and suitable evaluation tools are needed for their appreciation in the context of knowledge-based economy.

This is also the reason why sustainability should also be pursued by voluntary mechanisms, of which the Sustainability Compass is an example. The Sustainability Compass indees activates and empowers people by initiating a bottom-up continuous social learning process based on concrete experiences and research. The public participation allows a '*joint integrated management of common affairs'* (Sajeva and Masera, 2006) in national/regional plans, in pursuit of citizens' needs capabilities and freedoms, whitin the boudaries of ecologycal systems.

The Sustainability Compass provides companies with a proactive tool to voluntarily communicate its values on sustainability and responsibility to customers and along value chain, going beyond mere environmental requirements. It also provides a tool which can be consulted by public institutions, for the definition of their policies. The self-assessment of sustainability forms bottom-up company-specific principles and social culture which fosters the scientific foundation of research results, can make own voice heard and achieve overall sustainability goals more effectively than top-down governance and control.

However, the consideration of the uncertainty of science as mentioned above is the reason why even when science is put as an indicative base for decision-making, it cannot provide a principle on which decision can rely, because findings are uncertain and can change the day after. In the case of complex systems with a high or hardly determinable degree of uncertainty, no one can take responsibility of the impacts produced, also from a legal and economic perspective, on citizens' well-being and natural rights. Ethics plays therefore in these cases a key role.

Sometimes large systems can be described as merely 'complicated', meaning a context in which the interrelations are intricated but known, complexity refers to a context which is holistic—i. e. the whole is not the results the mere accumulation of its parts—emergent—i.e. high-level patterns derive from simpler rules at lower levels—and chaotic—i.e. non-linear behaviour sensitive to initial conditions (Kastenberg 2005). Uncertainties are indeed valuable knowledge as they provide additional elements on which the final conclusions can be drawn, and possible decisions can be made. Incorporating uncertainty (unknown knowns) into research results does not reduce the quality of scientific knowledge, but rather increases it. Sometimes uncertainty is also uncertain or unknown, which recalls the well-known concept of *unknown unkowns.* In this latter case, the precautionary principle has a key role to avoid dealing with too complex, uncertain, and unpredictable consequences, which might be as well unrecoverable and for which none, not even national States can carry the responsibility.

Nor basing decisions on scientific evidence means that the scientific method can be assimilated to political processes. Science is not based on consensus or trends among scientists, but on evidence that emerges over time. Anyone can challenge the claims of a Nobel laureate or an entire scientific committee on the basis of evidence. What matters is not the number of publications in support of a claim, but the findings that best explain the substance of the phenomenon and best answer the questions of the skeptics. Carter (2007) reminds us how the greatest breakthroughts in history have been possible thanks to 'free critical thinkers', often denigrated and blamed at first.

The scientific and evidence-based approach is based on continuous debate and co-learning on the ground and will change over time based on research findings. The Sustainability Compass enables participatory bottom-up processes for educated, informed and multi-perspective decision-making, through continuous participatory learning and experience.

The Sustainability Compass is not a traditional complex and difficult-to-read Life Cycle Assessment. Being based on the precautionary principle, aims at avoiding too complex and too uncertain analyses,

but rather at reducing the complexity of sustainability matters and identify key drivers and indicators that are more relevant for the specific case. It allows an extended use by researchers, practitioners, or anyone who has got relevant knowledge and best practices for that case, so that they can learn (anonymously if they wish) from one another.

To solve the challenges posed by centralised regulation and scientific processes, the aim of the Sustainability Compass is indeed to empower and activate citizens and organisations locally, because not all knowledge and its related uncertainty is available from "strictly" scientific sources, so that a broader approach of social learning from complementary publications is needed. The substance knowledge presented in sections 5 and 6 constitutes just initial inputs obtained by consultations with companies in the field, while much more insights could be added from existing knowledge. And not all of them are known to other citizens, researchers and organisations.

The Sustainability Compass provides therefore a tool to address socially sensitive and even politicised social issues. To bring some examples, the interviews with companies in the sector of wind power revealed a lack of awareness about the existence of relevant research in the field about the possible impacts of erosion of wind power plants, which, according to the consulted sources, would release microplastics and other chemicals (Soldberg, et. al., 2021; Pugh and Stack, 2021). Other measurements raise the question of other kind of microwave pollution (Sieviläinen, 2019). Scientific arguments can be continuously brought about and generate highly debated cases. Challenges at the roots of the adoption of wind power can also be found, in contraposition with most well-known theories of climate change. Physics Nobelist Carlo Rubbia denies the actual possibility to succeed in maintaining the climate constant by keeping CO_2 under control, and even if this were possible, doubts about the need to do it, because climate in recent times has cooled down (2022), which puts is doubt the correlation mechanisms. Analogue arguments are brought for instance by Carter (2007), so that the impact of human CO_2 emissions remains under debate.

In the same way, physics Nobelist Ivar Giaever retired his membership in the American Physical Society holding that he could not agree that *'emissions of greenhouse gases from human activities are changing the atmosphere in ways that affect the Earth's climate'*, and that the evidence that global warming is occurring is incontrovertible (Climate Depot, 2011). He did not agree that *'if no mitigating actions are taken, significant disruptions in the Earth's physical and ecological systems, social systems, security and human health are likely to occur'* and that therefore emissions of greenhouse gases should be reduced. As the Nobelist explained, *'the claim (how can you measure the average temperature of the whole earth for a whole year?) is that the temperature has changed from ~288.0 to ~288.8 degree Kelvin in about 150 years, which (if true) means to me is that the temperature has been amazingly stable, and both human health and happiness have definitely improved in this 'warming' period'* (Climate Depot, 2011). Again, Franco Prodi, a physicist and academic specialised in meteorological studies and atmospheric physics, member of numerous national and international study commissions, director of Institute of Atmospheric and Climate Sciences of the Italian National Research Council until 2008 maintains that *'it is not possible, with current knowledge of the climate system, to quantify how much the anthropogenic effect is'*. He reveals that climate change is cyclical, that it has always existed, and depends upon a multiplicity of data, so that it is impossible to make certain long-term forecasts (DCNews, 2022).

Discrepancies between different views and possible actions can be found also in aquaculture, for instance in relation to the produced phosphorous and the possibilities for its recover.

2.4 Communication of real values rather than compliance with mandatory or uniformed principles of responsibility

In the consideration of the previous arguments, it is important to mention that, even if intended for the use of private and public organisations and even for inflamed debates, the Sustainability Compass is not a tool for marketing nor for political propaganda. It remains in the sphere of science and scientific method, based on knowledge and experience. It aims at empowering and activating public participation on the basis of substance, so that a virtuous process can take place and make reliable knowledge emerge. By allowing the contribution of different educated views, knowledge and experiences, the Sustainability Compass acts as a framework to reward the best information and solutions, not the loudest or the most present in articles or media. It can gather all existent and most important knowledge and suggest opportunities for further research, discover uncertainties and unknown unknowns. This way, decision-makers can more easily understand the various related issues, based on the facts. In particular, because the impacts, and their responsibilities, can be truly significant and sometimes impossible to be assumed, the Sustainability Compass can reduce regulatory load, support local, decentralised and participatory decision-making, and foster voluntary approaches to sustainability as embedded in everyday life.

The Sustainability Compass seeks to build a voluntary culture of sustainability through continuous social learning, so that sustainability is embedded in everyday culture and practices, promoting proactive communication of real values and responsibility. It allows for demonstrating voluntary corporate responsibility to customers and the value chain, instead of showing just the compliance to top-down regulatory requirements.

This is important to initiate virtuous processes, in which sustainability cultures would make too strict regulations useless and in which open discussion on substance matters, rather than propaganda, would make knowledge naturally emerge.

3 The theoretical framework for the construction of the Sustainability Compass framework

The initial version of the Sustainability Compass, referring to the UN Sustainable Development Goals (SDGs) found some practical challenges when implemented in workshops. Reasons for this were the inherent characteristics of the SDGs, as mentioned in the earlier MAREA report (Sajeva et. al., 2021):

- → Very well-known generic goals, which make it difficult to focus on concrete and practical objectives or criteria to follow. Basically, anything can directly on directly contribute to their achievement.
- → Self-standing, detached and not systemically interacting SDGs, which does not allow to understand possible cause-effect relationships between one or more of them.
- → Consequent possible high correlation, trade-offs or even contradictions between SDGs, or even redundancy, implying the difficulty for participants to decide which indicator belong to which objective
- → The SDGs were generated at UN level, thereby a bottom-up approach following the scientific debate was missing

In the first report a structure for solving the challenges of points 2, 3 and 4 was proposed (Sajeva et. al, 2021). In order to address the challenge of point 1 an additional literature analysis was performed and triangulated UN SDGs with relevant literature on sustainable development.

The analysis produced an updated framework (Figure 1) structured according to:

- An approach of Means&Goals of sustainable development (Sen, 1997)
- A classification of these Means and Goals according to the Five Capitals Model of Sustainability (Forum for the Future, 2021)

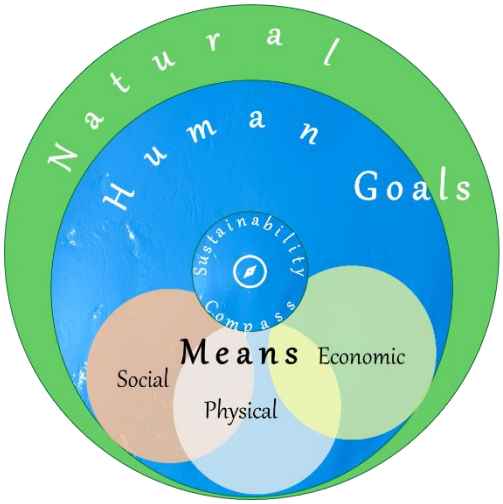


Figure 1. The Means&Goals approach of the Sustainability Compass

The approach of Means&Goals is based on Sen's approach of "*getting-by with a little assistance"*, or 'GALA' (1997), that he lent from Beatles' phrases, where the traditional economic and material growth are intended as means to reach the real sustainability goals, concerning the enhancement of capabilities. Jackson then adds the idea that this should happened within environmental boundaries (2009:35) as the ultimate bottom line of human life. Sen's conception is indeed in contraposition to the Churchill's idea of *'Blood, sweat and tears'* or BLAST, meaning that human beings should suffer to achieve development and growth.

This theoretical background meets the original root meaning of economics, or οἰκονομία (oikonomia), as 'household management' (Sajeva et al. 2019a; Sajeva et al. 2019b; Sajeva et al. 2020a; Sajeva et al. 2020c), as '*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, Sajeva et.al., 2021).

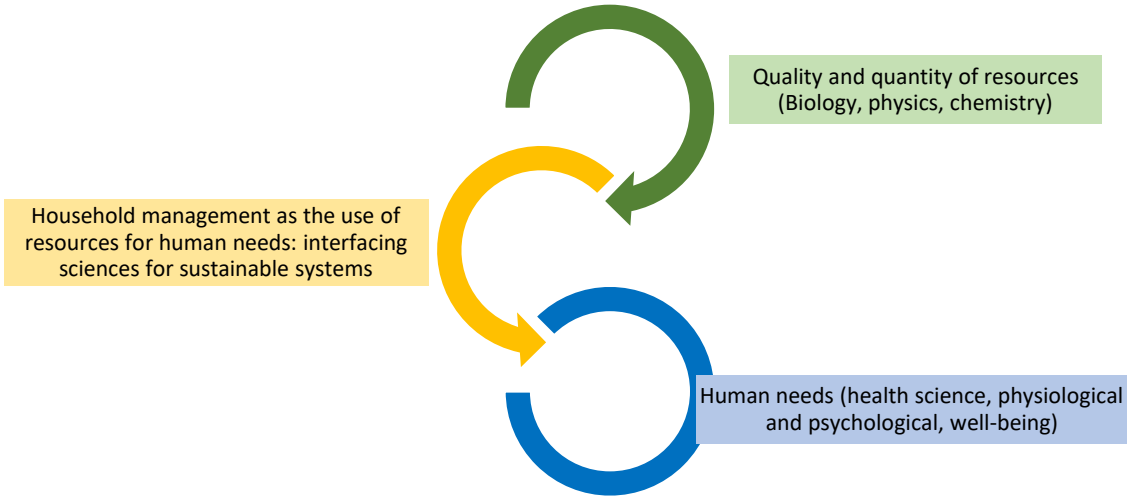


Figure 2. Economics for natural and human systems equilibrium (Sajeva, et.al. 2020a, Sajeva et.al, 2021)

The sustainability principles of the Forum for the Future (2021) and the Natural Step (2021) (Table 1) were used quite straightly for the determination of the Means&Goals of the Sustainability Compass, because for instance the Natural Step is a service already existing for sustainability assessment of

corporations, municipalities, academic institutions and not-for-profit organisations directed to prove that sustainable solutions, besides reducing ecological and social impacts create new opportunities as well, reduce costs (2021).

However, these principles were triangulated with the UN SDGs, marked in Figure 2 by the related numbers, and with other relevant literature. These were slightly modified and checked with communication experts and other scientific consultations for the Means&Goals, in order to facilitate the understanding for a larger and diversified community of users.

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

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

For instance, the earlier research conducted for the Sustainability Compass (Sajeva et al., 2019) revealed a need of cooperation between private and public sectors (e.g. through public support services) and within sectors, to enhance international competitiveness. The provision of public support was considered more relevant for new companies as it 'speeded' up the process or facilitated the constitution of new companies on purpose for the commercialisation of innovations, for instance by researchers or small start-ups. On the other hand, public support and funding for innovation was used just in half of the cases, because if initially provided but then not renewed, put the company into trouble, as external partnership funding at early stages risk to cause loss of control and threatens

developer's ownership rights. Already established organisations, considered it too bureaucratic and less efficient when compared to self-funding.

Public support and cooperation are important to improve the competitiveness for individual innovators/researchers and small business and to limit market concentration in a small number or bigger companies.

This can contrast the currently dominant neo-liberal approaches to governance, based on the primacy of market-based economics and excluding state and public intervention or including a '*paradoxical increase in [state] intervention'* (Jessop, 2002) through privatisation and liberalisation policies is made in favour of the neo-liberal order (Peck and Tickell, 2002).

Delegating the allocation of resources to the free-market means renouncing the role of governance and social accountability (Peck and Tickell, 2002), in pursuit of overall sustainability. The most well-known example of these neo-liberal governance arrangements are the multilateral trade agreements (e.g. the North American Free Trade Agreement or the proposed Transatlantic Trade and Investment Partnership (TTIP)), which, behind the declared aim to protect investors' individual property rights', pursues profit maximization by dumping environmental, safety and work regulations (Stiglitz, 2014). As Stiglitz argues, the 'Investor State Dispute Settlement' (ISDS), affords corporations the right to sue sovereign governments in arbitration tribunals when any national regulations, even when these protect citizens' interest, health or safety, represent a threat for their potential profits.

These arguments have been very important to define the sustainability goals concerning virtuous policy and avoidance of structural violence. Galtung (1990) classifies violence as personal, structural, and cultural. Structural violence is the indirect effect of social structures, which manifests as unequal power and life chances (Galtung. 1990; Sachs, 2003) and systematical disadvantage to parts of population (Ho, 2007).

Galtung's (1969) definition of structural violence refers to the *'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*.' An example is the case of social structures producing. In earlier research the reverse Maslow pyramid was presented as the aberration of the satisfaction of material and psychological needs (Sajeva et. al, 2020a). This is produced when higher positions of control within the society risk to generate unjust social, economic and political structures that limit or jeopardise the access to needs and rights to others or even reduce their life expectancy.

Paul Farmer (2005), a medical anthropologist and physician, builds on Galtung's formulation, and adds that structural violence is *"not the result of accident or a force majeure; they are the consequence, direct or indirect, of human agency,"* through structures that support an unequal distribution of power or resources and the consequent disproportionate life chances, disease or poverty. Structural violence originates, according to Galtung (1990) from exploitation, through unequal distribution of power among actors because "*the power to decide over the distribution of resources is unevenly distributed"* (Galtung, 1969).

According to Sen (1999), poverty is a systematic or structural denial of basic freedoms, when the lack of freedom and human agency is limited so that it jeopardises the 'capability' to meet their basic needs. The lack of one freedom may have a domino effect that multiplies the limitation of other freedoms, for instance the condition of poverty, involve disproportionate vulnerability to other violations.

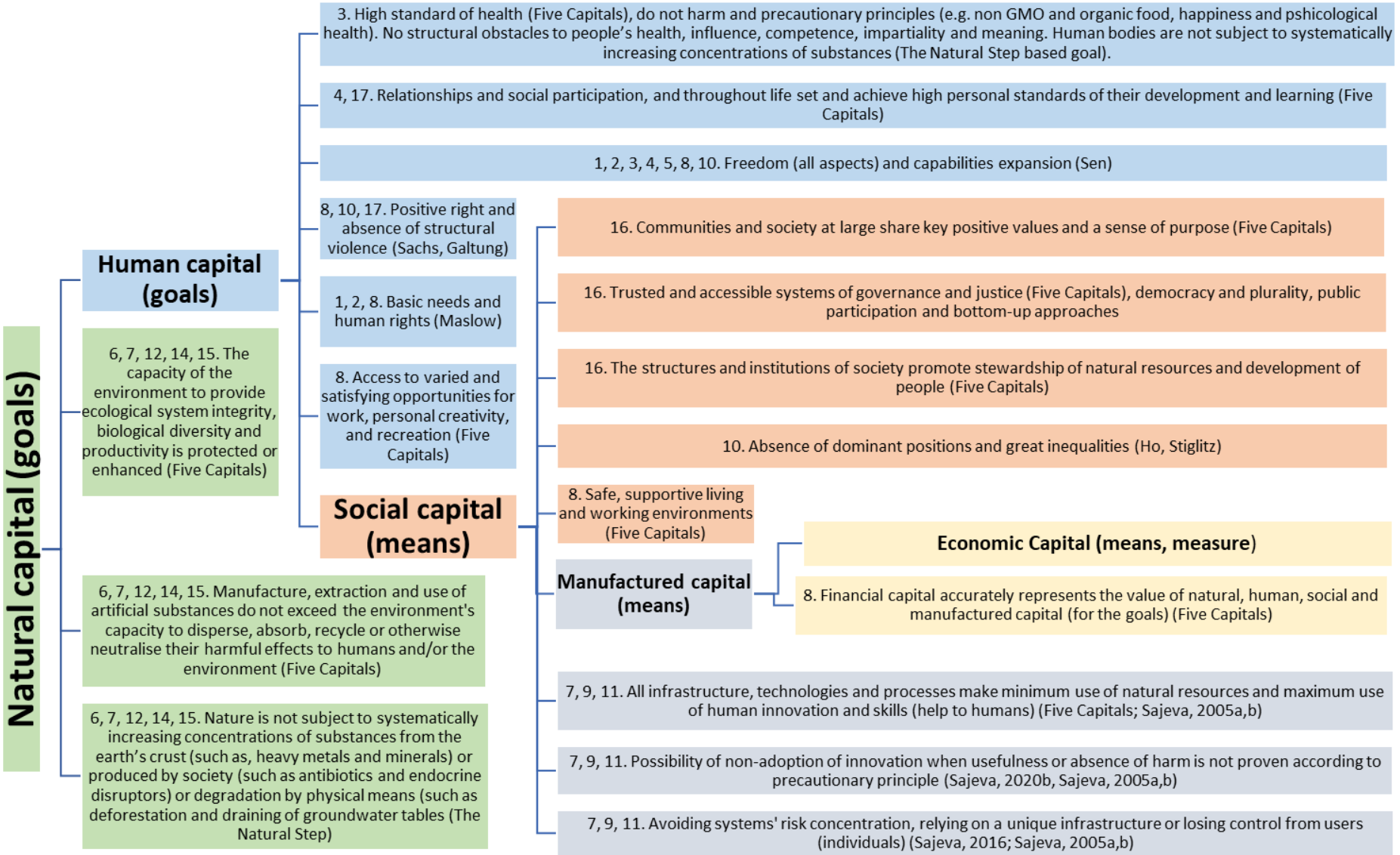


Figure 3. Sustainability principles as triangulation between SDGs and Sustainability literature

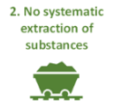
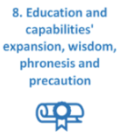
Impairment of access to adequate healthcare, water, shelter, education and welfare services can be produced and the possible consequent enjoyment of civil and political rights threatened (Landman, 2006). Indeed, according to Ho (2007), human rights violation constitutes structural violence. Therefore, structural violence is produced when social structures are planned by human agency on purpose so that the interactions would favour some dominant actors' needs and systematically disadvantage all the others who do not hold as much if any power at all or jeopardise the meeting of their basic needs (Sajeva et. al, 2020a). The existence of such situation is clear when considering how as reported in the United Nations Development Programme 1999 mergers and acquisitions, concentrating industrial power in mega-corporations, risk to erode competition: by 1998 the top 10 companies in pesticides controlled 85% of a $31 billion global market – and the top 10 in telecommunications, 86% of a $262 billion market (Ho, 2007). These arguments have supported the vision of the reverse Maslow pyramid, representing various levels of accumulation of power and agency, which progressively reduces others' capability to meet basic needs (Sajeva et. al. 2020a).

This analysis about the structural violence has been relevant both from the side of the identification of sustainability Means&Goals (Tables 2 and 3), and from the side of the general nature and function of the Sustainability Compass, enhancing the need of empowering and activating both local and distributed science and decision-making, in pursuit of social learning on sustainable development, in the context of complex and uncertain socio-ecological systems. The concept of the Sustainability Compass draws on the post-normal paradigm of complexity (Funtowicz & Ravets, 1990), and practically implements the theoretical vision described above in a mixed qualitative and quantitative methodology for holistic and systemic social learning and evaluation of systems' sustainability. The framework avoids oversimplification of complexity by initiating a social learning process for the identification of cause-effect relationships and allowing the integrated and holistic appreciation of the overall sustainability. At the same time, it strives to identify the most relevant indicators referred to concrete cases and specific fields and avoiding incurring in too complex and too uncertain analyses. This is done by relying to the precautionary principle. For instance, in order to assess the sustainability regarding the human capital and for instance human health, an analogy to the principles of the Forum for the Future and the Natural Step is made, about the need not to systematically input substances, which are extraneous to the natural functioning of human systems and to maintain human natural biological functioning. At the EU level research on the security of critical infrastructures highlighted how the risks and uncertainties related to development and use of development and use of new technologies should be carefully analysed, and *'dogmatic belief in a 'technological God',* capable to solve all human problems without generating new ones should be avoided (Sajeva, 2005a). According to the same research, as IT services have become pervasive, conversely identity management, privacy and use of personal information do not seem to be properly addressed. The security of infrastructures, critically dependent on IT control, such as energy supply or telecommunications networks, are subject to be hacked or to other kinds of failure. IT-tools are not always the preferred ones, or the most easily usable by all people. Some transactions can be made by simple phone calls instead that rely on complex infrastructures. In certain situations, mobile communication can be more difficult than a call from an old type of telephone, especially when the remote connection is unavailable or the signal too weak. For instance, not all implications of exposure to radio frequencies are known and many of them cannot be even identified in advance. A telephone call by cable or ordinary mail could remain a good and more reliable option, as for instance do not need electricity and can function well even in case of blackout, or when privacy would require a less tight tracking.

3.1 The translation of the theoretical analysis into the practical structure for the Sustainability Compass

The ultimate goals have been then represented by the Natural and Human capitals, numbered from 1 to 10 in Tables 2 and 3 as well as in Figure 4 and 5.

Table 2. The goals of the Sustainability Compass

Nature and resources	
1. Ecological system integrity: maintaining biological diversity and productivity	
2. No systematic extraction of substances, exceeding the capacity of the environment to neutralise their harmful effects	
3. No systematic release of substances, exceeding the capacity of the environment to neutralise their harmful effects	
4. No degradation by physical means, exceeding the capacity of the environment to neutralise their harmful effects	
Human well-being	
5. Work and economy: access to varied and satisfying opportunities for work and business, especially rural depressed areas	
6. Safety and support to living and working environments	
7. Human health: high standard of physical and psychological health through precautionary principle, to avoid to systematically increase concentrations of substances in human body, e.g. good quality of water and of GMO free and organic food	
8. Education and capabilities' expansion: independent and free education, open scientific debate, wisdom, phronesis and precaution	
9. Human well-being, freedom, privacy, individual human rights, peace, justice and happiness	
10. Equality between individuals and organisations, based on race, gender, age, health state or wealth, positive rights and absence of structural violence and dominant position for assuring equal opportunities of development	

The natural capital is the ecological substrate, bottom line for any human activity, whose continuous equilibrium and functioning must be assured. Human capital, unlike the traditional concept of production factor, is the ultimate goal of human well-being. These goals can be reached through means (or intermediate goals), which are numbered from 11 to 18 in Tables 2 and 3 as well as in Figure 4 and 5. These are social structures, for example private and public organisations and institutions, physical infrastructures and technologies, as well as economic/financial means.

Table 3. The means of the Sustainability Compass

Social: collective institutions, regulations and social infrastructures and services	
11. Business prosperity and competitiveness especially for of small-scale business and depressed areas, bottom-up approaches of cooperation and avoidance of monopoly or dominant positions	
12. Justice: assurance of trusted, effective fair, accessible and just institutional, legal and judicial services and protection of the citizens, peace, democracy and plurality, public participation and bottom-up approaches. Assurance of basic human rights of physical and psychological integrity.	
13. Virtuous policy and high moral values: social structures and institutions support human rights and development and to the environmental sustainability, absence of corruption, transparency, accountability, ethics, wisdom and phronesis	
Manufactured: physical infrastructures for production and services	
14. Security of critical infrastructure avoiding systems' risk concentration, and of relying on a unique infrastructure or organisation or losing control from users. Non-adoption of innovation when usefulness or absence of harm for individuals is not proven. Efficient, secure and less invasive infrastructure systems and technology, learning from nature. Assurance of individual freedom and privacy	
15. Minimal infrastructure, technologies and processes at support of human well-being, minimum use of natural resources and manufactured capital and maximum use of human work and skills (help to humans)	
Financial	
16. Financial capital accurately represents the value of natural, human, social and manufactured capital	
17, 18. Economic sustainability for 17. individuals, and 18. public/private organisations	

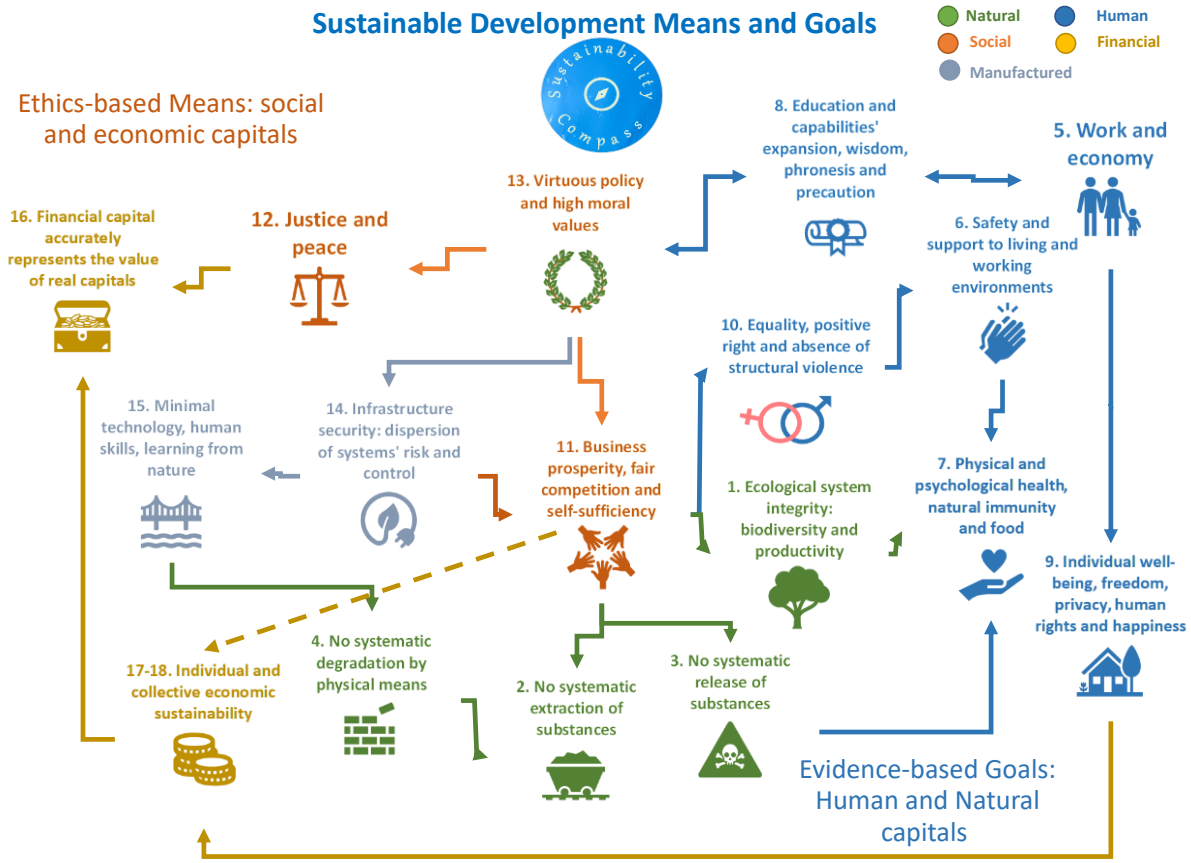


Figure 4. Sustainability as system thinking: the systemic interactions of means and goals according to the Five Capitals model of sustainability.

Figure 5. MEANS&GOALS for a single case and organization, within the whole interconnected system

The idea of means and goals is related to the tendency to confuse them, for instance when considering that growth of wealth or technological development or infrastructures would improve human well-

being. These are means to improve human well-being and not self-standing goals (Sen, 1997). Increments in means are not always followed by improvements in human well-being, for instance when the distribution of wealth is unbalanced or when technological hams and benefits are uncertain or when social and physical infrastructures and economic activities are controlled by few actors, limiting individuals' well-being, freedoms and human rights (the already treated structural violence).

Users can imagine in which node they are located. For instance, Figure 5 describes the role of a company within the society. Besides own goals of business prosperity, fair competition and self-sufficiency the company uses other services, and produces benefits for the society in order to reach the final goals.

4 The process and method for the construction of the Sustainability Compass as applied to case studies and organisations

The goal of the case studies is to build an initial framework for the Sustainability Compass in the field of fish farming. The framework will help companies to recognise the effects of their operations more broadly through the dimensions of sustainability (natural, human, social, economic, and of the physical infrastructural capital) and the impacts at regional level.

The construction of the framework is realised by a systematic process, in which the participants, researchers and companies map the cause-effect relationships of the companies' operations from its core business all the way to the sustainability goals. The specific aim is to build some scenarios (based on alternative choices) of chains of means to reach intermediate steps and final goals.

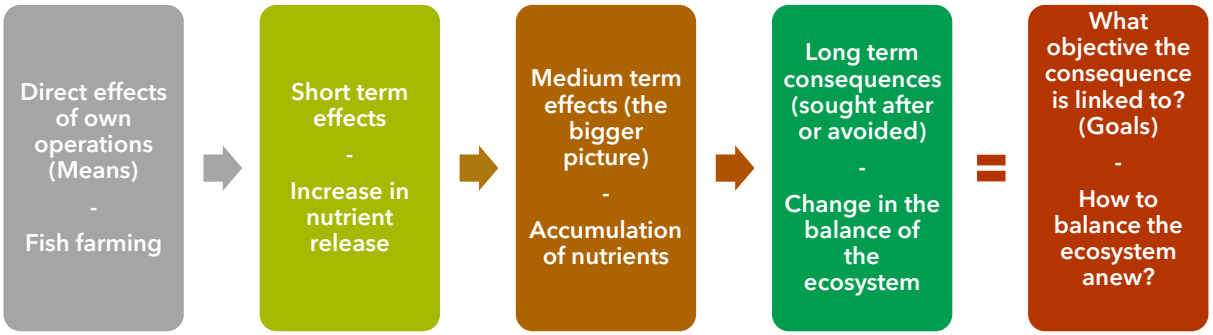


Figure 6. Sustainability framework and cause-effect thinking

This approach identifies a back-casting process in which, according to a coding system, described in Figure 6, and generates scenarios of cause-effect relationships or chains. To construct the path for cause-effect thinking, the framework and cause-effect thinking were based upon the generally used, well-known evaluation approaches of Theory of Change -framework (Center for Theory of Change, 2022) and logic models (Rogers, 2013). In addition, some previous work by others in combining the Theory of Change to the sustainable development goal framework and, also of instances where some of the estimated or desired impacts were seen to be in the future, were gathered and reviewed as basis (see for example: CVDTA, 2022 and Engendered Collective, 2022).

In order to realise the above-mentioned aim, the Sustainability Compass has been applied to specific cases, i.e. aquaculture and wind power. These sectors, although different from one another, impact on the natural and human life in the Baltic Sea region. Although the analyses provide some main insights about themes and indicators for these two fields, however, none of the two cases was developed to provide an exhaustive collection of sustainability themes and indicators. The final,

cumulative gathering of the substance from several companies and experts will be left to the online tool.

The main objective of the case studies was rather to produce some initial material and insights, examples of existing knowledge to be used for the initial development of the Sustainability Compass in these two fields. The other aim was to check possible discrepant arguments and to test the structure of the tool. The contents of the analyses were collected into datasets to be entered into the portal.

The two case-studies were conducted by different approaches. This because of the different structural characteristics of the two sectors, different propensity to cooperation and different practical possibilities in terms of time to be dedicated.

The approach used for the case of wind power was much lighter, due to the limited availability of companies in terms of time. However, the knowledge was then classified in the final geoportal in a similar way. This means that it is not really important from which sources or how the knowledge is collected. This can be considered even a strength for a good triangulation of the results. The important aspect is that the final scheme allows a bottom-up participatory approach users can rely on for drawing own conclusions.

The cross-border approach was produced successfully in the field of aquaculture, as 4 companies, 2 in Finland and 2 in Estonia accepted to participate and we could also get acquainted with the different approaches.

Table 4. Case studies and company collaboration approaches

AQUACULTURE	**OFF-SHOREWIND POWER (also in phase of planning)**
Workshops by Miro collaboration platform for in-depth bottom-up sustainability assessment with 4 local companies in Finland and Estonia	**Preliminary review of key sustainability issues and interviews with 3 local companies in Finland**
Description of the collaboration process	Identification of key sustainability issues by analysis of environmental impact assessments as basis for interview
Phase I. Brainstorming about the role and sustainable functioning of the company within the whole system	In-depth in-person or online interviews with company collaborators
Phase II. Building the framework of cause-effect relationships	Analysing key findings from the interviews
Reviewing the final structure of the framework	Reviewing the final structure of the framework

However, in the field of wind power, as only Finnish companies were available to participate, the analysis could not be carried out from a cross-border perspective. In Finland, desk-work analysis and interviews were done with 3 companies, which already had on-going operations or operations that were in planning phase.

The outcome of the analyses was reported as structured as outlined in Figure 7 as company specific excel lists for both cases and delivered to the University of Tartu for technical analysis and inclusion of the contents in the PlanWise4Blue geoportal, which shows visual information and is open to all parties (see Figure 8). The sustainability compass tool in the MAREA geoportal (http://www.sea.ee/marea/survey/compass) is described in more detail in the MAREA Deliverable D.T4.2.1 report *"Study tests of the decision-support geo-portal in the transnational pilot areas"*.

To make it easier to approach other interested parties, the process carried out guaranteed the anonymity of participants.

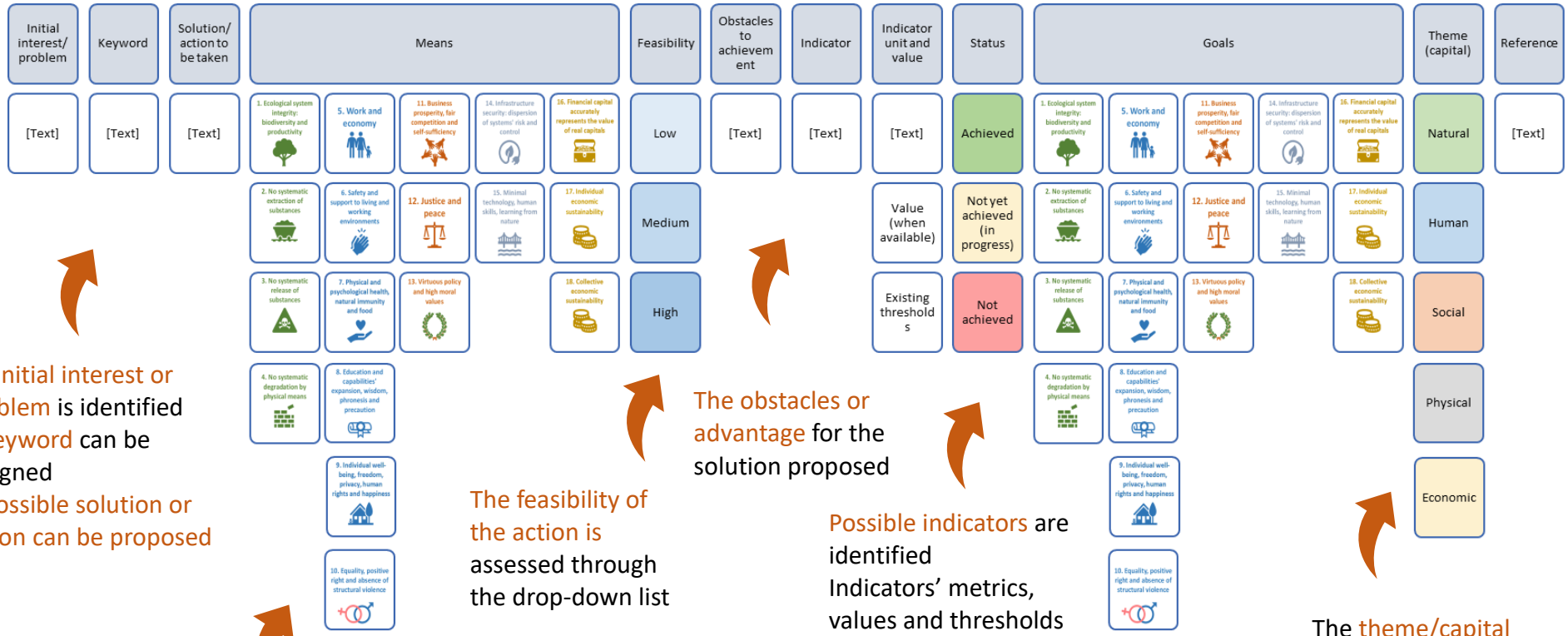


Figure 7. The final structure of the Sustainability Compass

The same will apply for the future applications of the Sustainability Compass. The analysis of an individual company does not need to be publicly shared. The analysis focusing on an individual company can be used only by the company itself. Whereas, the analyses of individual companies can be used to form sector level scenarios, which are made publicly available.

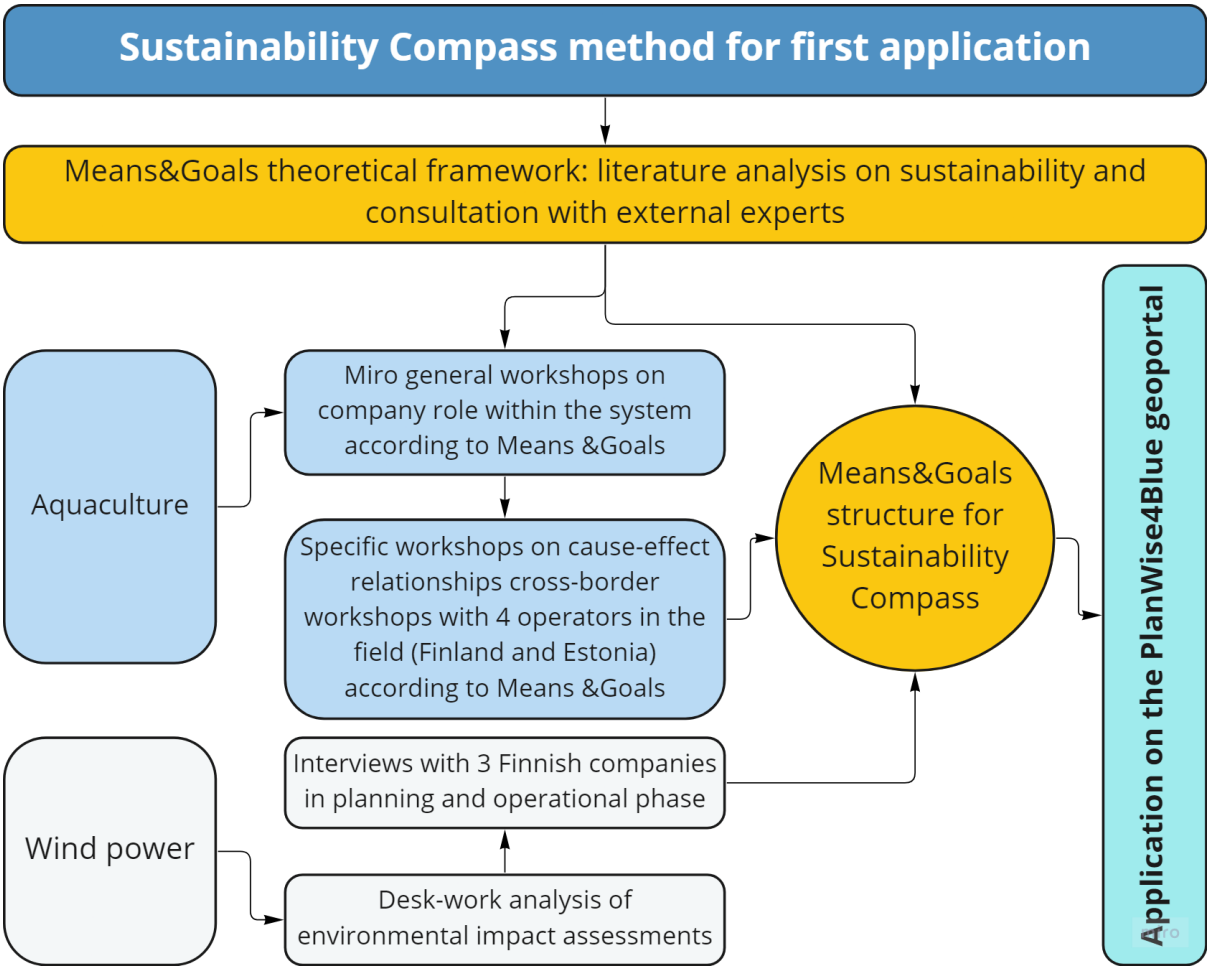


Figure 8. The methodological structure for the construction of the first Sustainability Compass

4.1 The case-study of aquaculture

The knowledge inputs for the realisation of an initial version of the Sustainability Compass in the field of aquaculture were gathered by a participatory approach with companies in the fish farming sector. For this purpose, after consultation with the Finnish Fish Farming Association, two of its member companies interested in the project were selected on the basis of their expertise and availability to participate in a series of focused workshops.

The purpose of the workshops was to build cause-and-effect chains from the initial interest/problem to sustainable means and goals. Cause-and-effect chains included possible means that support achieving the goal, feasibility (low, medium, high), potential obstacles or reasons in the context, possible indicators and measurements and status of the accessibility. The structure was clear to the participants, and numerous individual measures or points about different sustainability themes came up during the workshops. In addition, the representatives of the companies brought up several resolved or unresolved issues in the conversation.

The workshops aimed to get knowledge from the field beyond what can be found in the environmental impact assessment (a mandatory procedure in licensing for all companies before a fish farm is started

or extended) and to focus on sustainability issues in the whole scheme in sustainability, including environment, social, human well-being, infrastructure and economy. Hence, the sessions were successful in terms of the objectives of the workshops.

4.1.1 The structure of the methodology

The first session was dedicated to the presentation about the idea, enabling participants to learn and ask about the topic. The structure presented was valued as easily understandable and usable. The second and third workshops focused on context, meaning the company's activity and effort toward sustainability. Finally, the information gathered from discussions was attached to the PlanWise4Blue geoportal.

The aim of the second workshop is to think about the role of the company within the socio-ecological system (Figure 4). 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 whether there are outputs of their activity that could support other actors pursuing the final goals.

The process adopted for the second workshop involved the following activities, within the Miro framework, facilitated by initial questions:

- → Getting familiar with the icons and the definitions for each of them.
- → Finding the appropriate places or roles for your company within the system.
- → Thinking about the MEANS (from 11 to 18), the icons on the left side of the scheme in Figure 5, which represent the needs from other organisations, companies, individuals, infrastructures, and institutional services, in order to operate. In some cases, some MEANS could be, for the point of view of the company, goals, which in the context of the overall sustainability are intermediate goals in pursuit of the final goals.
- → Recognize the possible impacts of company's operations on other actors and also the effects that are not in your estimation important for your company, from a wider perspective.
- → By looking at the icons of the GOALS (from 1 to 10) on the right side, identify the outcomes, benefits and impacts of your activities and what might be instead irrelevant for the case at hand.

Notes are reported on the board to facilitate this process in order to be used in the following workshop (Figure 9).

In the third workshop, the task is to create a specific scheme, reflecting the possible scenario(s)for the participating company. To this aim, the template—an empty model (such as that in Figure 9)— is used as a model by editing it directly, and a link to the collaboration platform Miro is provided.

Starting from the “Fish farming” box possible relevant means (on the inner circle) and goals (on the external circle) are selected. Actions or impacts can be added by sticky notes, by choosing the colour according to the capital classification (see related colours in Figure 4). There is no need to cover all the sustainability goals and means. A remark can be written on the most important goals and means, and those that are not relevant for the specific case, with the related motivation.

The final goals can be placed on the outside of the outermost ring. Notes on the most important actions or means used in pursuit of the goals can be placed in between, according to a cause-effect logic, to explain and indicate how the means can be used to reach the goals. The colour of the notes can be

chosen according to the subject at hand, whether it is natural, human, social, manufactured or financial (see Figures 4).

Figure 9. The scheme for the workshop development

The information available on possible indicators and metrics regarding a factor can be marked by using a note, for example about quantities consumed or produced, areas occupied or metrics about infrastructures, and indicate whether data is available or should be collected. In this way, specific scenarios for each company can be built. The benefits delivered by the company's operations on society, competitors, partners, employees, and institutions can also be included. Specific consequences on other fields or organisations, which exceed the scope of your field/case, can be included if known.

An example of this process (in which the substance information indicated is not real) for fish farming is provided in Figure 10.

The last workshop focused on reviewing the results of the previous discussions, verifying that information was interpreted correctly, with reference to the final structure of the Sustainability Compass (Figure 8).

Regarding aquaculture, the results of the workshops have been treated according to different themes, as described in the next sub-sections.

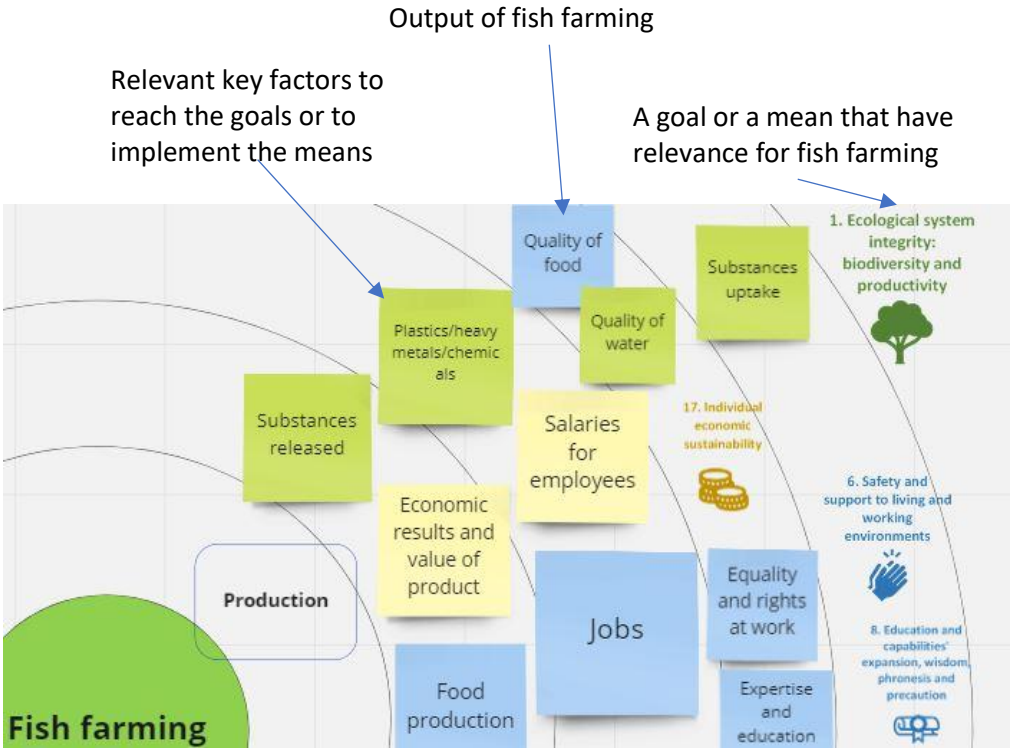


Figure 10. The example by the process of construction of the Sustainability Compass by MEANS&GOALS brainstorming

4.1.2 The results of the workshops: licensing

In Finland fish production requires a license from the Finnish Centre for Economic Development, Transport and the Environment. Generally speaking, the license process was described as a bottleneck for fish farming. The license is production site specific, so a fish farming companies need separate licenses for each of its production sites. The license also sets the highest allowed production volume, so that for increasing the production volume of an existing production site, a new license shall be obtained. According to the participating companies, it is currently impossible to get licenses for new production sites or production increases. In addition, both Finnish companies emphasised that the license process is arduous, expensive, and lengthy, also because it is often prolonged by complaints by environmental organisations, individuals and sometimes by authorities.

According to one participant, getting a license is equally difficult for everyone. However, the biggest companies have more economic resources for affording the related costs (hundreds of thousands of euros according to one participant). This means that the entry of smaller companies and new startups in the industry is practically impossible, because going through the difficult and expensive process is not worth doing for the sake of a small facility. These factors discourage the companies from applying for new licenses.

The main goal of the licensing process aims at achieving goal 1. *Ecological system integrity: maintaining biological diversity and productivity.* However, the situation described above identifies a situation in which the mean *12 Justice: assurance of trusted, effective fair, accessible and just institutional, legal and judicial services and protection of the citizens, peace, democracy and plurality, public participation and bottom-up approaches* by public policies and services can serve to pursue goals *11. Business prosperity, competitiveness and self-sufficiency especially for of small-scale business and depressed areas, bottom-up approaches of cooperation and avoidance of monopoly or dominant positions,* goal

10. Equality between individuals and organisations, based on race, gender, age, health state or wealth, positive freedom and absence of structural violence and dominant position for assuring equal opportunities of development and goal *5. Work and economy: access to varied and satisfying opportunities for work and business, especially rural depressed areas.*

One of the workshop participants noted, that in selecting the production site for which the license is applied for, they try to choose a site with as few limitations as possible. One of the factors considered is the number of permanent and leisure settlements in the area. The environmental aspects considered in the choosing of a site include water turnover at the breeding site (openness, dilution conditions) and the depth of the sea area. According to one participant, regardless of the licensing process, also other factors influence the choice of a production site, such as distance to the current facilities and the right to use land and water areas. In order to take multiple and cumulative factors into account, the FINFARMGIS geospatial tool is being used for the selection of the site.

4.1.3 The results of the workshops: employment

In relation to the themes of employment and working conditions, the goals *9. Human well-being, freedom, privacy, individual human rights, peace, justice and happiness* and *5. Work and economy: access to varied and satisfying opportunities for work and business, especially rural depressed areas* have been considered the most important Sustainability Compass goals.

In the Finnish model of fish farming the fry is grown in inland water and the fish is grown to full-size in fishing nets in the sea. The size of the workforce of a fish farming company primarily depends on its specialisation. Companies may specialise for instance in growing fry, growing fry into full grown fish and cleaning it, or both. After specialization the next things to consider are technology and production volume. The companies participating in the workshops grow fish in open water growing nets, do not process it further after cleaning, and sell the fish. The company may employ more people if it decides to specialise for instance in fish processing or applies and gets a license for increasing production at its current production sites or for a whole new site.

Based on the workshops, the technology used in fish farming centers around fish feeding and monitoring activities. Feeding is highly mechanised and may be automated to some extent, but still requires regular visits by workers. Cameras are used to monitor the conditions in the fish growing nets. Sometimes, if the activities include fish cleaning, the use of a fish cleaning machine is an important determinant of the number of workers needed.

Fish farming is a seasonal trade. In the workshops it was noted that the fish farming season is at its busiest in the spring, when the fry is transported to the fish farming sites at sea, and during summer when the fish is grown. At the end of the season the fishing nets are transported to the shore for autumn and winter storage. In the autumn and winter the fish farming company needs fewer workers. The seasonality of fish farming may necessitate the use of seasonal part-time employees. This depends on the companies' specialisation, technology, and production volume. The ratios of permanent, part-time, or seasonal workers depends on the choices the company makes. One of participants in the workshop said that their company employs part-time employees, and this is generally possible if in the same area there are part-time employment opportunities also at other companies or in the public sector. Many of companies' part-time employees work at the same time elsewhere. However, in areas of dispersed settlement, where fish farms are mainly located, the problem is that employment opportunities are limited.

In addition to direct employment, companies also employ workers indirectly by buying fry or services from other companies. Essentially, the service needs of a fish farm is determined by its production quantity. A participant emphasised that their needs are focused on the services provided by logistics companies. Another participant acknowledged that their company's needs for logistical services will remain at the current level, since at the moment new licenses for production increases or new production sites are not granted. If the production volume of the company cannot be increased, then it does not need more logistics services, and in turn increase the turnover or employment possibilities within the logistics services companies.

Worker permanence is important for any company. A workshop participant summarised that wellbeing in the current job and the experiencing of the workplace as a safe work environment are important factors for worker permanence.

In Finland, the educational opportunities in fisheries are quite limited and produce only a few skilled workers. This reveals a deficit in public services (mean 12) to produce the goal 8 and in turn the goal 11 for business prosperity, affecting then goal 5. Further, according to the participants, the industry's attractiveness could be higher. These aspects limit the availability of a skilled workforce, which is why companies train their employees by themselves. Regarding learning on the job, the options are on-the-job training and training through cooperation with educational institutions, for example, apprenticeships or paid internships.

In Estonia, in addition to the issues mentioned above, some other challenges were highlighted. First, finding workforce in rural areas was considered very challenging, due to the scarce availability of sector specialists. The offer of very good working conditions for workers partly solved this problem. The availability of bioeconomy teaching modules in academic programs was considered as one of the main bottlenecks and the participants pointed out the need for improvements. Second, according to the participants, in rural areas the lack of efficient IT infrastructures represents a real obstacle that hinders the development of digitalisation, including workflow efficiency. Third, the participants reported that overregulation—too slow and complex licensing procedures—impedes development and expansion of the operational activities.

4.1.4 The results of the workshops: working conditions

Labour legislation sets the legal minimum for work related issues. When it comes to work conditions, the participants emphasized that complying with labor legislation is the minimum for social sustainability. One participant emphasized that companies are free to do more. For instance, labor legislation requires companies to arrange occupational health care for their employees, but companies can provide additional occupational health care services. In addition to health care, one of the participants said that they carry out regular well-being surveys and extended surveys from time to time. One participant emphasized that these surveys are important tools in maintaining the occupational well-being of employees.

One workshop participant mentioned that one way to go further than the legal minimum in maintaining work conditions is to apply for a certificate, e.g., the Aquaculture Stewardship Council (ASC) certificate, that includes social responsibility. One of the participants stated that a certificate requires circumstances that are stricter than the labor legislation demands, such as paying more attention to the training of employees. It was also said that the downside of certificates is that they are expensive. One of the workshop participants stated that their customers carry out supplier audits,

which focus on financial indicators (e.g., turnover, EBITDA, equity), but also may include physical and mental safety of employees.

A workshop participant said that they have developed guidelines for safe work practices. Especially because at sea the risk for drowning is always present. The participant accentuated that even with the guidelines, it is always the workers responsibility to act according to weather circumstances and decide when it is safe to go to sea. In relation to this, the same participant said that some workers may find it difficult to assess weather conditions and decide when it is possible to go out to sea. According to the participant, younger employees can feel the responsibility of condition evaluation as trying. In the workshops it was also noted that, as part of taking care of safety, statutory inspections on boats are carried out regularly.

4.1.5 The results of the workshops: feeding of fish

About feeding of fish, it involves mean 12. This because feeding fish need phosphorous and nitrogen for the development of their skeleton, however the licensing process is challenging for companies because the environmental permit contains exact limits on the amount of feed, which is possible to use. According to companies, the emission amount is insignificant, especially when compared to that coming from agriculture, and part is recovered by cleaning procedures. From their point of view, the regulation of fish farming is stricter than for other economic areas. An external expert also agreed that the situation is not fair, when compared to agriculture and the industrial sector. However, the problem is that when adding these substances in the Baltic Sea their amount increase all the time, which is not in line with the goal *3. No systematic release of substances, exceeding the capacity of the environment to neutralise their harmful effects*. A better way to do it would be to make the amounts of these substances already existing in the marine ecosystem circulating, without adding them systematically. A keyword for this matter has been indicated as eutrophication, as it is the problem, which is mostly associated with it. As indicated, an indicator could be the amounts of phosphorous and nitrogen compared to the tolerance of the Baltic Sea. Alternative action could involve the use of competitors of fish feed—e.g. soy-based feed. According to the Animal Protection Act, live fish must not be fed to live fish.

It was reported how in the Estonian case the integration of mussel and fish farming can give a good contribution in terms of absorption of nitrogen and phosphorous. However, for Finnish farming this is not economically feasible as the quality of mussels is not good enough to put them on the market. For their case goal 11 cannot be reached. In the Estonian case, licensing is free of charge when the absorption of these substances is guaranteed. Therefore, the mean 12 is used in this case. Moreover, in Estonia the participating company is currently developing a production line that enables the efficient production of food for human consumption from small mussels, thereby also providing added value to the activities of impact mitigation.

In any case, goal 11 is put at risk when these limits tighten all the time. The aim is to ensure the nutrients are available to the fish. Ensuring feeding for every kilogram of fish. Must be cleaned earlier if limits are met. Alternative solutions should be searched for. More nature like modes of growth were proposed by the interviewer, which were not supported by the company. However specific reasons for this, other than increase of costs, were mentioned.

The same goal 11 is considered as a mean, when talking about feed supply from other companies. The Baltic Sea market in characterised by just two suppliers, one of which is probably closing down in Finland, so that feed has to be brought from Denmark. The goal 10 could be measured by an indicator

about the number of domestic producers. In order to achieve this objective, and in turn also other objectives concerning employment (e.g. goals 5), support from public institutions might be required (e.g. mean 12). Therefore, at the moment they are not evaluated as feasible.

4.1.6 The results of the workshops: animal and human health

Regarding the issues of preventing fish diseases, it is reported that the European Union defines related limits. This is the classical example of top-down regulation, to which the company relies. The respect of regulations is the only action, which companies performs. In order to avoid diseases, although it was mentioned that antibiotics are given just in specific cases, when there is a need, vaccines are given to all young fishes. Information about their composition is not available in order to assess whether objectives 3 and 7 are likely to be pursued. According to the information provided by an external expert, in the same way at it happens for agriculture, the intervention for the prevention of pests or diseases is needed in case of large monocultures, in the case of aquaculture, when a large number of fishes of the same species are concentrated in a limited space. In relation to this, the interviewer asked whether alternative aquaculture models, which would imitate nature, would be available. According to the interviewees such attempts would not be feasible.

4.1.7 The results of the workshops: water quality and environmental aspects

Water quality (goal 3) is considered an essential element for fish farming, as it affects the quality of fish which in turn contributes to the achievement of goal *7. Human health: high standard of physical and psychological health through precautionary principle, to avoid to systematically increase concentrations of substances in human body, e.g. good quality of water and of GMO free and organic food*. For instance, the microbiological quality can be clearly determined by related indicators. The related mean is the 11 as a good and affordable business operation.

A possible obstacle to these objectives is that not enough unbiased reference samples are taken and that the company takes samples from its own operations, but there is no comparative data. This refers to mean *13. Virtuous policy and high moral values social structures and institutions support human rights and development and to the environmental sustainability, absence of corruption, transparency, accountability, ethics, wisdom and phronesis*. A possible indicator could be the quantity and quality of the samples taken and the quality of the sampling plan. In relation to the same mean, an additional problem is the lack of the so-called neutral sampling points, not related to the mandatory sampling. The related indicator could be related to the coverage of the sampling plan.

4.2 The case-study of wind power

To carry out the case study for the sector of wind power, an initial outlook of the existing companies within the study region of the Baltic Sea was performed. Of the four companies identified two had already built offshore wind sites and two were still in the project planning phase. In addition, the Finnish Wind Power Association and the Finnish Association for Impact Assessment (FAIA) were approached in order to plan the participatory work.

A first review of the existing and quite comprehensive documentary evidence contained in Environmental Impact Assessments required for the early stages of project planning was considered the preferred approach. The review of the Environmental Impact Assessment was performed to pick out existing research, relevant sustainability themes and areas of interest for offshore wind. In particular, information about potential indicators was searched for and grouped by Environmental, Economic and Social/Human Capital. The data was organised in excel format according to the structure

of the Sustainability Compass as presented in section 4. In this way, the data could be easily transferred to the PlanWise4Blue geoportal.

Interviews were agreed with three of the four identified companies, all based in Finland, and were structured by referring to the identified themes and organised subsequentially by feasibility, obstacles, and status. The outline was sent to the interviewees beforehand to facilitate the process (Figure 7). The interviews, structured as presented in Figure 11, aimed to inquire if the company representatives spotted any missing themes or subthemes and to verify the relevance of the topics under discussion, the feasibility of possible actions and the possible obstacles for their actual implementation.

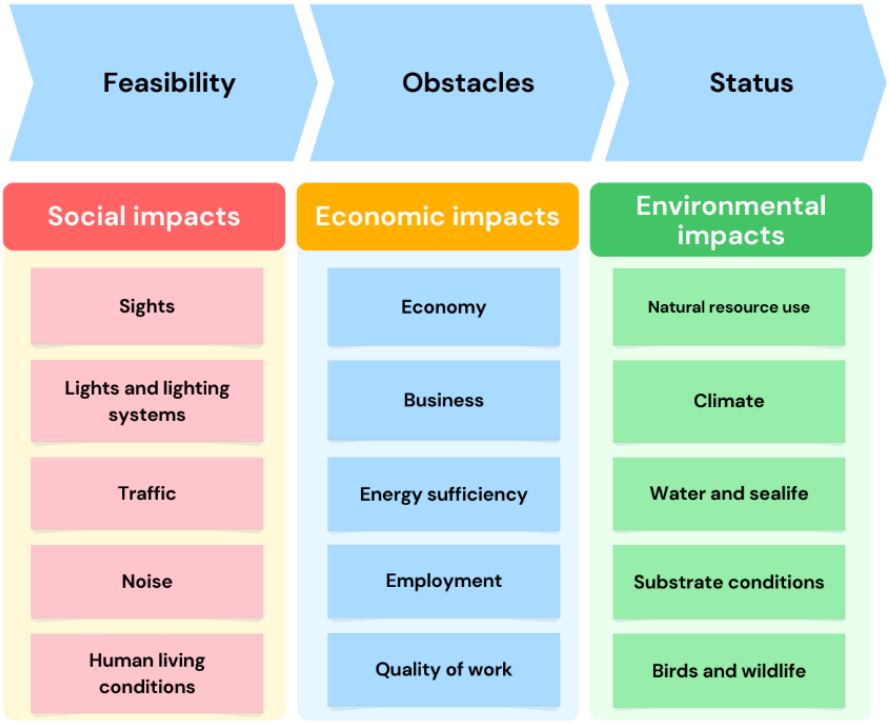


Figure 11: The themes and sub-themes covered in interviews

4.2.1 Main findings of the interviews

As a general note the environmental impact assessment process was seen by the interviewees to be a comprehensive method of capturing the sustainability themes of offshore wind projects.

The interviews revealed that due to the lack of agreement about indicators able to assess the themes presented, the status of the themes could not be determined and therefore not applicable for any company. It was noted that several themes were more applicable to onshore wind than offshore wind. For example, the themes of noise and sights were clearly less relevant for plants located further out in the sea. The problem of blinking light has also been solved by stable red lights, such as in radio masts.

The regulation for the granting of licenses involves long and heavy procedures, especially for the planning phase, which is seen as a major obstacle for setting up operations. This was not owing to the regulation *per se*, but to the difficulties in the lack of administrative coordination among all bodies involved. According to the interviews, there is relatively little experience in the administrative experience in the procedure of licensing for offshore wind as compared to onshore wind and thus regulatory bodies are in the process of refining their cooperation for these large processes.

The three companies interviewed cover 75 % of the whole Finnish sector in the Baltic Sea, while two of them are operative, so that they cover at present all the market. This reveals a high concentration in the sector by larger companies. The local acceptability of the offshore wind projects was seen as imperative and can be improved by using local services and contractors. However, local contractors may be too small for carrying out large scale offshore wind construction projects, thus they can work more easily as subcontractors. The parts needed are usually also shipped in because they need specialised manufacturing, but marina services are needed in the construction phase and to provide an economic boost to the area. Also, during operations some repair crew is needed.

As the wind power plants of the interviewed companies were either in planning phase or not yet at the end of their life cycle the theme of the recyclability of the blades was regarded as an issue to be treated further off in the future. While it was recognised that recycling surely will be an issue, it was mentioned how at present there are some good suggestions, for example mashing the blades in with concrete and the technical development of more durable mills. Instances of successful recycling were also described in the interviews. Increasing technological capacity was seen as important to also improve profitability and efficiency.

Regarding the theme of birds and wildlife, it was stated that according to relevant research the flight altitude of birds so far out in the sea is higher than mills, height, and they know how to fly past the mills. The painting of one blade black in use in some countries, which would ward off birds, is prohibited by Finnish law. Bird cameras are instead quite expensive, army-level equipment. Requirements regarding wildlife were seen as having increased over the years but then again, comprehensive environmental assessments were seen to cover these well.

It was also noted that geography and seasons set some limits that cannot be negotiated. For example, as the Baltic Sea freezes in the winter, it is impossible to conduct site building activities during that time. The suitable construction time also coincides with the nesting season, but the companies indicated that they try to take that into account by timing construction locations within the site so that it would not interfere with the nesting of birds.

Some observations outside the discussed sustainability themes were that offshore wind investments might catalyse other investments such as datacenters and other similar projects possibly interested.

As mentioned in section 2.4, in some cases unawareness of existing research, even of peer reviewed publications, for instance for what concern the erosion of blades was acknowledged in the interviews. These considerations reveal the general tendency to postpone some life cycle assessment issues to the future, instead of getting acquainted with them and planning possible effective solutions before sustainability problems would arise.

5 Integrating research and practice: what experience in the field means in terms of ecosystem services

The concept of ecosystem services aims to evaluate those aspects which are not normally economically evaluated, which means the uses of natural resources which are not translated into costs and benefits. In the context of the overall sustainability evaluation, this section aims at translating the knowledge which was produced by the interviews in terms of implications on these kinds of services.

The Common International Classification of Ecosystem Services (CICES, 2022) was created to standardise description of ecosystem services for ecosystem accounting and more generally to systematically name and describe ecosystem services. CICES's main categories of ecosystem outputs

are provisioning, regulating and cultural services. The supporting services are handled as part of the underlying structures, process and functions that characterise ecosystems. CICES uses a five-level hierarchical structure, with each level being more detailed and specific.

Ecosystem services could be violated or enhanced by human activities, or especially regulating services can alleviate harmful effects of human activities. Environmental Impact Assessment often focus on the negative effects, and a little attention is paid on the need of regulating services. Sustainable planning of green bioeconomy would benefit from a comprehensive assessment of interactions with ecosystem services.

5.1 The case-study of aquaculture

The self-evaluation of the participating fish farming companies was carried out in workshops. The potential negative impacts of fish farming identified by the workshop participants identified centered around the phosphorus and nitrogen emitted by fish feeding. These were paired in the expert evaluation with the CICES classification of ecosystem services (Table 8). In this case the observed impacts on provisioning had both positive and negative impacts.

Table 8. Example of an evaluation of the interaction of fish farm activity with provisioning ecosystem services.

Section	Division	Group	Class	Class type	Evaluation of interaction
Provisioning (Biotic)	Biomass	Reared aquatic animals for nutrition, materials or energy	Animals reared by in-situ aquaculture for nutritional purposes	Animals by amount, type	*Positive: Growing fish is an effective way to produce protein from feed. Negative: Fish are not able to roam freely as in nature. Feeding fish increases the load of phosphorus and nitrogen. Alleviation of impact: Fish farms are typically located in areas with a better water flow. Fish are fed according to need, as excess feed cannot be given as the operating license does not allow it.*
Provisioning (Biotic)	Biomass	Reared aquatic animals for nutrition, materials or energy	Fibres and other materials from animals grown by in-situ aquaculture for direct use or processing (excluding genetic materials)	Animals by amount, type	*Positive: The side streams of fish production, such as, fisheyes, fish blood and cleaning waste can be used for energy. Negative: efficient uses for fisheyes and blood, apart from energy, are not viable.*

According to the workshop participants, potential negative impacts on regulating ecosystem services dealt with emitted phosphorus and nitrogen (Table 9). The positive impacts observed by the workshop participants centered around the low incidence of disease and the salmon louse not inhabiting the Baltic Sea. In addition, the workshop participants emphasised the alleviation of impacts, such as, fish farming is a relatively small emitter of phosphorus and nitrogen, fry vaccinations and minimum use of antibiotics.

Table 9. Example of an evaluation of the interaction of fish farm activity with regulating and maintaining ecosystem services.

Section	Division	Group	Class	Class type	Evaluation of interaction
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	Filtration/sequestration/storage/ accumulation by micro-organisms, algae, plants, and animals	By type of living system, or by water or substance type	*Negative: fish farming increases the phosphorus and nitrogen content of the seawater and strengthens eutrophication. Alleviation of impact: the increase is observed mainly in the vicinity of the fish farm, a fish farm site increases phosphorus and nitrogen primarily during the summer. Also, the water turnover at the open sea, where the fish is grown to full size, is high.*
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Pest and disease control	Pest control (including invasive species)	By reduction in incidence, risk, area protected by type of living system	*Positive: salmon louse does not inhabit the area of concern as the Baltic Sea is a low-salted sea.* *Alleviation of impact: fry is vaccinated at the size of 15 grams. In Finland antibiotics are used only if necessary for the health of the fish and only with the permission of a veterinarian.*
Regulation & Maintenance (Biotic	Regulation of physical, chemical, biological conditions	Pest and disease control	Disease control	By reduction in incidence, risk, area protected by type of living system	*Alleviation of impact: Medicine is not generally needed. Fry is vaccinated at the size 15 grams. Antibiotics are given only if necessary and with the permission of a veterinarian. The risk of runaway fish transmitting diseases to natural fish populations is low.*
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Water conditions	Regulation of the chemical condition of salt waters by living processes	By type of living system	*Negative: the increase in phosphorus and nitrogen levels in seawater caused by the fish farm cannot be regulated by the living organisms, which influences eutrophication.* *Alleviation of impact: fish farming is a relatively small emitter of phosphorus and nitrogen.*

5.2 The case-study of wind power

The self-evaluation of businesses identified potential negative impacts as possible harmful substances in seabed sediment and Impact on fish: construction phase impacts, electromagnetic fields, light and shadow effects, underwater noise, change of habitat.

Table 5. Example of an evaluation of the interaction of windmill activity with provisioning ecosystem services.

Section	Division	Group	Class	Class type	Evaluation of interaction
Provisioning (Biotic)	Biomass	Wild plants (terrestrial and aquatic) for nutrition, materials or energy	Wild plants (terrestrial and aquatic, including fungi, algae) used for nutrition	Plants, algae by amount, type	*Negative: Possible harmful substances in seabed sediment / Impact on fish: Construction phase impacts, electromagnetic fields, light and shadow effects, underwater noise, change of habitat*
Provisioning (Biotic)	Biomass	Wild animals (terrestrial and aquatic) for nutrition, materials or energy	Wild animals (terrestrial and aquatic) used for nutritional purposes	Animals by amount, type,	*Negative: Impact on fish: Construction phase impacts, electromagnetic fields, light and shadow effects, underwater noise, change of habitat*

These were paired in the expert evaluation with the CICES classification of ecosystem services (Table 5). In this case both impacts are negative. With regulating services, it is easier to find potentially alleviating interactions between ecosystem services and the impacts of windmills (Table 6). Regulating services might diminish the potential negative impacts of windmills. The interaction should be

recognised to secure the regulating services. Also, the windmills may have potentially positive impacts on ecosystems, for example the reef effect.

Table 6. Example of an evaluation of the interaction of windmill activity with regulating and maintaining ecosystem services.

Section	Division	Group	Class	Class type	Evaluation of interaction
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	Bio-remediation by micro-organisms, algae, plants, and animals	By type of living system or by waste or subsistence type	*Alleviation of impact: Possible harmful substances in seabed sediment*
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of wastes or toxic substances of anthropogenic origin by living processes	Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	By type of living system, or by water or substance type	*Alleviation of impact: Possible harmful substances in seabed sediment*
Regulation & Maintenance (Biotic)	Transformation of biochemical or physical inputs to ecosystems	Mediation of nuisances of anthropogenic origin	Noise attenuation	By type of living system	*Alleviation of impact:* Underwater noise may affect marine wildlife
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Maintaining nursery populations and habitats (Including gene pool protection)	By amount and source	*Negative: Risk of losing benthic communities, reefs and/or sandbanks from the area* *Positive: Impact on fish: change of habitat, reef effect* *Negative: Risks for fauna: disturbance (during construction and operation), change of habitat*
Regulation & Maintenance (Biotic)	Regulation of physical, chemical, biological conditions	Water conditions	Regulation of the chemical condition of salt waters by living processes	By type of living system	*Alleviation of impact: degradation of water quality during construction phase*

These examples demonstrate the benefits of understanding the interactions between human activities and ecosystem services. We should also recognize that wind energy is one of the ecosystem services and for windmills it is a prerequisite for the whole economic activity (Table 7).

Table 7. Example of an evaluation of the interaction of windmill activity with provisioning abiotic ecosystem services.

Section	**Division**	**Group**	**Class**	**Class type**	**Evaluation of interaction**
Provisioning (Abiotic)	Non-aqueous natural abiotic ecosystem outputs	Non-mineral substances or ecosystem properties used for nutrition, materials or energy	Wind energy	Amount by type	**Essential prerequisite for windmills**

6 Conclusions and plans for future application

Recent trends of concentration of decision-making at international level are often justified by instances of evidence-based decision making. Certainly, it is good to base decisions on scientific evidence, but these arguments must also be open to critical scrutiny and broad participation.

The Sustainability Compass has been conceived as a process of social learning that triangulates existing knowledge, making most reliable knowledge and best practices naturally emerge. The scientific approach, unlike the political one, is not based on consensus, but rather on supported observations, corroboration or refutation of existing knowledge. In the same way, the scientific method considers uncertainty as valuable knowledge, which is not typically the case for political processes.

The aim of the Sustainability Compass is indeed to empower and activate citizens and organisations in local contexts and specific cases, solving in this way the challenges posed by centralised regulation and scientific processes. In fact, on the one hand purely scientific information search is often not sufficient because not all information is available from "strictly" scientific sources. A broader approach of social learning from complementary sources and data published in other kind of papers or reports is needed from different actors, such as for instance entrepreneurs, workers and acknowledged citizens.

On the other hand, complex and local contexts, very different from one another, cannot be dealt with by too simplified regulatory frameworks that are the same for all situations, large and overpopulated cities, more spread urban areas, underpopulated forest areas, or very different cultures or environments. Moreover, centralised regulatory approaches do not help the realisation of the principles of accountability and responsibility, which are inherent in good governance. In fact, the distance of the decision-maker from the citizens reduces their awareness of problems at local level and increases the risk of possible influences by other larger organization, which may jeopardise their representative power. Moreover, the high complexity and uncertainty possibly involves irreversible impacts on human and natural well-being, which can be a challenge for any decision-maker. This is why decision-making should always be based on ethical principles.

The application of the Sustainability Compass will reduce regulation and support decentralised and participatory decision-making at local level, fostering a voluntary culture of sustainability as part of everyday life.

Following the idea already foreseen in earlier research, the Sustainability Compass has been embedded in the PlanWise4Blue geoportal, in order to allow enlarged participation and a bottom-up approach. The specific description and functioning of the Sustainability Compass portal is provided in Report D T.3.2.1.

The Sustainability Compass portal provides a tool for participation, inclusion and free discussion. It also provides a tool to address socially sensitive and even politicised issues, such as the environmental impact of wind farms or the use and protection of forests. However, even when it can be used by private organisations and public institutions it is not meant for marketing or political propaganda, rather for the generation of supported knowledge, following a scientific approach. In order to increase reliability, the tool is designed to allow scientific evidence to naturally accumulate by combining different methods, theories and data from a plurality of data sources. Allowing participants to contribute with their own knowledge and experience, the Sustainability Compass acts as a framework to reward the best knowledge and solutions based on research and concrete experiences, not on the

loudest shouting. When thinking from a scientific perspective, uncertainties become useful sources of information that support decisions, rather than elements that exacerbate the debate.

In fact, the Sustainability Compass is currently being adapted within the PlanWise4Blue geoportal for functioning in the future as a parallel system of scientific validation, which could even become more reliable than traditional processes of peer reviewing, which are too often limited to a very quick methodological check. The actual realisation of such plan will depend on the possibilities for its full implementation within the geoportal.

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