1 Introduction

Marine and coastal areas are affected by intensive and increasing human use. For decades, efforts have been applied to preserving and strengthening the carrying capacity of ecosystems through sectoral regulation, such as fishing restrictions. However, coastal, and marine environments are complex socio-ecological entities (Berkes et al. 2003; Österblom and Folke, 2013) requiring holistic planning approaches to heed human pressure in a sustainable manner.

The requisite for sustainable planning is to reconcile human interests and uses targeted at marine and coastal areas with Maritime Spatial Planning (MSP) that is considered to be the most practical tool for achieving this (Ehler 2021). MSP aims to support the sustainable use and development of marine resources by outlining future directions for the blue economy (EC 2021). This planning tool is a public process driven by political will considering spatial and temporal dimensions (Douvere, 2008). The collaborative approach of MPS emphasizes engaging the stakeholders and the public in deliberative decision-making with a consensus orientation, but also and increasingly to achieve ecologically sustainable and socially just planning decisions (Emerson et al 2012; Reed, 2008). The presumption for sustainable MSP is that it entails an iterative approach to adopt objectives and means according to possible changes in the coastal or marine socio-ecological systems (Stephenson et al. 2021).

In all coastal European Union (EU) Member States, the Maritime Spatial Plans have been developed according to the EU's Integrated Maritime Policy and the Directive for Maritime Spatial Planning (2014/89/EU). MSP employs two integrated concepts, the Ecosystem-based Approach (EBA) and Land-Sea Interactions (LSI). Both EBA and LSI have been integral parts of holistic planning since the 1990s. This research examines the implementation of MSP in Finland and a co-creation process of shared knowledge across the land-sea interface involving MSP authorities and maritime stakeholders. The aim is to clarify how the co-creation process based on systemic approach can support the concrete usage and application of EBA and LSI concepts into MSP, thereby providing tools for improved governance and management to achieve full spectrum sustainability in Finnish marine and coastal areas.

Both EBA and LSI must be heeded by Member States when establishing and implementing MSP to promote sustainable use of maritime areas. A specific challenge regarding all three concepts is their abstract nature. EBA and LSI lack concrete examples in practical planning work (Douvere 2008; Morf et al. 2020). The implementation of EBA is still fragmentary; moreover, there is a lack of communication and organizational framework (Marshak et al. 2016). Mere mapping of marine ecosystem services is insufficient as different stakeholders have radically different value systems and vested interests, resulting in the ecosystem services provided by ecological systems of coastal and marine areas being variously valued ~~by various degrees~~ (Chakraborty et al. 2020; Lopes and Videira, 2017).

Moreover, MSP often focuses more on sector-specific objectives than on strategic priorities at the national level (Jones et al. 2016). MSP is considered to hold a relatively technocratic view; therefore, more attention should be dedicated to a holistic approach and fostering synergies (Stephenson et al. 2021; Depellegrin et al. 2019). A specific challenge is that while both MSP and EBA target full spectrum sustainability, they are regarded as being weak for the social-cultural pillar (Stephenson et al. 2021). Stephenson et al. (2021) argue for an adaptive approach in MSP to enable and foster sustainability.

The implementation of the EBA and LSI and creation of the comprehensive understanding is further challenged in Finland where the marine and coastal areas possess several special characteristics. The mainland shoreline is 6 800 km long and, including islands, it covers 48 000 km (Finland's environmental administration). The extensive archipelago contains some 95 000 islands and islets with a total of 2.5 percent of Finns living year-round on those islands (Finland's environmental administration). In addition, the climate conditions vary greatly from humid continental to subarctic climate as the distance between the southern and northern parts of Finnish marine areas stretches over 700 km. Marine nature is very vulnerable to any changes due to the shallow waters, low salinity, and land uplift up to one centimeter per year (Finland's environmental administration). These geographical features create a large variation in ecological conditions as well as in the operational environment of marine industries, both of which are hard to bundle together for management purposes.

In Finland, the first MSP process occurred in 2017-2021 with the Maritime Spatial Plan 2030 for Finland being approved in December 2020. MSP has been conducted in close collaboration with MSP authorities, that is, coastal regional councils and various stakeholders at the local, regional, and national level (for Finnish MSP approach see Haapasaari & van Tatenhove 2022). All maritime sectors have formed a core-group of MSP actors and have been involved in the planning process through close cooperation in various workshops and curated meetings. The collaboration process provided a platform for shared SES understanding. In our research we examined how the knowledge within the four marine sectors, fishing and fish farming, offshore wind energy, and tourism, changed towards more systemic thinking during MSP process.

The need for a locally oriented approach has been emphasized by the planning responsibility of marine areas being at the regional level, thus creating a concrete need for cross-border planning and shared understanding. The systemic approach was recognized as a tool with which to emphasize local character and the dynamic role of local actors and, in addition, to increase the social-cultural aspects of sustainability in the MSP process and to implement the intentions of the MPS Directive through a co-creative process.

2 Theoretical background of systemic approach

Several central international agreements, such as the Convention on Biological Diversity and the UN Agenda 2030 for Sustainable Development, as well as the Malawi principles, support the adaptation of EBA into planning with a more detailed approach having occurred in MSP in Europe since the 2008 MSF Directive (2008/56/EC) and 2014 MSP Directive. For example, in the Baltic Sea, the application of EBA has been under scrutiny in the Baltic Marine Environment Protection Commission (HELCOM), Baltic Sea Action Plan (HELCOM 2007, updated in 2021), as well as in MSP related projects, such as Baltic Scope (2016-2017), Pan Baltic Scope (2018-2019) and eMSP NBSR (2021-2024). EBA stands on three sustainability pillars: ecological, socio-cultural, and economic. It has evolved to become a holistic approach recognizing coupled socio-ecological systems; humans are an integral part of ecosystems. The application of EBA supports the balance between human use and productive ecosystems (AORA 2019), including environmental stewardship (Smith et al. 2017). Considering the important contribution of coastal and marine areas to the wellbeing of humanity, the adoption of EBA has been recognized as a necessary tool for their management (Foley, M. et al., 2010).

The linkage between marine and coastal social-ecological systems is evident and sustainable use and management require linkages between MSP and terrestrial planning. In the EU MSP Directive, Land-Sea Interactions (LSI) have been adopted as a concept to link the planning of marine areas to planning onshore, requiring that Member States consider LSI aspects in MSP (Jones & Kidd, 2017). Article 4 states that 'Member States shall take into account land-sea interactions' in MSP to promote sustainable use of maritime space. Prior to the MSP Directive, the LSI has been realized in territorial waters via forms of integrated coastal zone management (e.g., Beger et al., 2010; EP EC 2002; Smith et al., 2011). Recently, a more overarching approach to acknowledge and manage both complex spatial and temporal interrelationships in the land-sea continuum has been provided in a few MSP project findings in the Baltic Sea (Baltic Sea2Land, Land-Sea Act, Pan Baltic Scope). The challenge is that the MSP Directive does not provide guidance on ways to include LSI in planning.

To support the consideration of local features and a full spectrum sustainability approach of MSP in Finland, the concepts of EBA and LSI have been embedded into planning work through the introduction and adaptation of a social-ecological systems (SES) approach. According to the SES approach, all individuals, communities, and societies operate in social systems that are embedded in the biosphere and ecological systems; thus, humans all exist within SES (Berkes and Folke 1998; Berkes 2011). Furthermore, marine areas are increasingly recognized as coupled SES (Berkes et al. 2003; Österblom and Folke, 2013) in which human operations impact the marine ecosystems in multiple ways, which then create complex feedback loops back to the potentials of sustainable blue economy and, in the end, human wellbeing.

The strength of the SES approach is that it “gives equal attention to the social and the ecological system and the interlinkages between them” (Stephenson et al., 2021). Marine and coastal areas are recognized as coupled SES consisting of intensively interlinked human and ecological factors (Berkes et al, 2003; Schlüter et al. 2019). The dynamic interactions within the system are often unpredictable and small changes can lead to effects on a large scale, or the other way round (Levin et al. 2013) meaning that marine SES can experience rapid change, for example, when facing the greatest exposure to climatic change (IPCC, 2019). This renders MSP a critical tool, first, in creating an overall understanding of marine systems dynamics and, secondly, in steering the development of all marine industries and other human operations towards a more balanced future to ensure marine sustainability.

The integration of EBA into spatial planning and decision-making processes has not been fully realized and has faced substantial obstacles, particularly regarding the marine environment (Sousa and Alves, 2020). Current research indicates that the interwoven, changing, and complex nature of the marine SES needs to be better appreciated to provide potential sustainable pathways (Stenseth et al., 2020). In SES, ecological subsystems, such as a resource system, interact with resource users and their governance systems to generate outcomes at the SES level (Berkes and Folke, 1992).

There is growing recognition that the application of SES approach to policy and practice requires collaboration between researchers and practitioners holding multiple types of knowledge (Mauser et al. 2013; Roux et al. 2017). Moreover, the problems of sustainable development are intrinsically linked to the SES defined to solve them (Folke, 2016); researchers in the relevant disciplines or fields of research, as well as the societal stakeholders involved, must be considered as elements of that SES. The acquisition of systemic knowledge is an ongoing, dynamic learning process with such knowledge often being generated with and by human institutions and organizations (Schlüter et al. 2022).

The holistic nature of SES paying equal attention to the social and the ecological system as well as the interlinkages between them renders the approach ideal for the intentions of MPS Directive. To completely utilize the approach and tackle both its academic nature and the shortcomings of implemented concepts (EBA, LSI), we saw that the planning process needed to include a strong knowledge co-creation process with local and regional stakeholders. Communities that daily and for longer periods of time interact with ecosystems, possess the most important knowledge about resource and ecosystem dynamics, along with related governance practices (Folke et al, 2011).

3 Material and methods of the research

3.1 Description of the co-creation process

The MSP in Finland consists of altogether ten maritime sectors including energy production, maritime transport, maritime industry, extractive sector, fishing and fish farming, blue biotechnology, tourism, and recreation, as well as cultural heritage. Special attention is paid to the preservation, conservation, and improvement of marine nature and environment. In this research, we examine the co-creation of shared knowledge of SES among four maritime sectors: fishing, fish farming, offshore wind energy, and tourism. All these sectors were well-represented in the MSP process with them differing in nature regarding the ways in which they use the sea.

The co-creation process has been led by the MSP Coordinator and promoted by consultants with the role of delivering the analysis and facilitating stakeholder involvement. Altogether, approximately 16 maritime spatial planners and about 400 stakeholders participated in the co-creation of the shared knowledge during the vision work in the Finnish MSP. The work-period occurred during 10/2019 - 5/2020. Prior this the current state of the marine sectors was developed (see Figure 1). This description was validated in eight stakeholder workshops with focus on the possible futures and interaction between maritime sectors (from January to September 2019) and with expert interviews.

Figure 1. The vision phase of the MSP process in Finland. Our research concentrates on the co-creative phase in Fall 2019 emphasized in dark grey.

The co-creative process started by the national workshop in October 2019, where the stakeholders discussed the future threats and possibilities of their own sector, identified sector-specific information deficits, and pondered their vision for the future. Based on all collected material, the current and future state of each maritime sector was then collaboratively developed into a preliminary diagram. Contrary to the spatial mapping that is usually applied to local-level place-based studies (De Vos et al. 2019), our spatial mapping used maritime sector-specific landscape drawings, i.e., diagrams that represented land-sea interface and sections of marine environment from coastal waters to open sea areas but were not place-specific (see Figure 2).

Figure 2: An example of a sector-specific diagram (tourism) presenting future spatial and temporal activities, as well as interaction with marine ecosystems and land-sea continuum in three marine area zones – inner archipelago, outer archipelago, and open sea. Diagrams for all maritime sectors are visible in a digital Maritime Spatial Plan 2030 for Finland, www.merialuesuunnitelma.fi.

The process continued with four regional-level workshops in November 2019, where stakeholders were grouped according to the sector they represented. Each group was presented with the preliminary diagram (see Figure 2) and the participants were asked to identify key functions and infrastructure for their sector as well as possible synergies, in addition to perceived conflicts with other sectors. Stakeholders were also asked to identify ecosystem services utilized by them on each section of sea area and at the land-sea interface. The key task was to co-create a vision for each sector and then, with the help of the diagram, discuss and illustrate any needed changes for the sector and its future interaction with other actors and marine environment. The vision discussions were enhanced by a second round, in which sector-based groups were re-shuffled to allow shared cross-sectoral transdisciplinary knowledge production. In the final phase of the process during Spring 2020, the vision 2030 texts and the roadmaps to achieve the target were then collaboratively formulated with maritime spatial planners and researchers.

It was significant that the co-creation process was open to all interested parties. MSP coordination in Finland maintains the MSP Cooperation Network which is open to all. All members of the network received an invitation to the workshops. The participants represented all levels of stakeholders from the local level to the national. In addition to the reported sector-specific representatives, there were in total 36 coastal-municipal, 59 coastal-regional level, and 8 ministry-level authorities participating in the co-creation process and evaluating the aspects of fishing, fish farming, offshore wind energy, and tourism.

3.2 Analyses of the collected data

There are various methods available to analyze social or ecological systems or combinations of those with many of them having been utilized in coastal, marine, and land-use contexts (Refulio-Coronado et al. 2021). However, the challenge of any SES study is due to incoherent methodological approaches (De Vos et al. 2019). We utilized action research to examine the co-creation process as we authors participated the co-creation process in the role of MSP coordinator and consultants. The starting point was practical action, during which scientifically recorded observations were collected to supply data for the analysis. The data analysis was iterative and collaborative, with data categorized by all three authors. Any disagreements were resolved through discussions to ensure the validity of the results.

In material-gathering, we utilized participatory data collection with spatial mapping. We used indicators that were identified in an application of EBA in Finnish MSP to categorize the data (see Kostamo et al. 2020). The indicators were the sub-categories of the requirements of ecosystem-based principles defined by the HELCOM-VASAB MSP working group (HELCOM 2016, see Table 1 in Section 4). We posit that the larger the palette of indicators the participants could refer, the more systemic their approach to sustainable use of the coastal and marine area. We substantiate this claim for the following reasons: 1) The chosen indicators account the ecological aspects as well as socio-cultural and economic aspects, therefore providing a holistic representation of the Finnish marine environment and its use. 2) A more extensive indicator palette fosters nuanced discussions, allowing participants to delve into the intricacies of ecosystem services and land-sea interactions, and encouraging a systemic perspective. 3) Each indicator is closely linked to the others. Therefore, existence of indicators reflects a more thorough understanding of the interdependencies within the ecosystem and the wider land-sea interaction.

By qualitatively analyzing the variety of indicators, we have been able to detect the level of understanding related to coastal and marine ecosystems and their functioning, as well as the human impact on them. The analyses involved content analysis expressions referring to indicators found in workshop materials such as sectoral visions, diagrams, roadmaps and workshop notes. By notifying the occurrence of the indicators in the first, national workshop and in the regional workshops in the second phase, we can observe the possible development in SES knowledge.

4 Results

Table 1 collectively presents the results of the co-creation of the shared knowledge among four sectors (fishing, fish farming, offshore wind energy, and tourism). Thereafter, the results are analyzed in the following subchapters. Each starts with a short description of a sector and then summarizes the discussions both in the national and regional workshops. The main focus of the discussions are indicated and a reference provided of EBA indicators 1a-6c (Table 1).

Table 1. Collective results of fishing and fish farming (CO FISH and FI FARM), offshore wind energy (WIND), and tourism (TOUR) from national workshop WS1 and regional level workshops (WS2). The gray color indicates that a sub-indicator had been mentioned in the discussion.

4.1 Fishing and fish farming

Small-scale coastal fishing with fyke nets and nets (CO FISH) covers most fishers and represents a total of 5 percent of the commercial catch, which mainly includes Baltic herring, whitefish, pike perch, perch, and salmon. The fishing livelihood depends on the status of the marine environment and fish stocks being registered as good, with coastal fishing being considered as an integral part of Finnish cultural heritage.

Fish farming (FI FARM) consists of rainbow trout and whitefish with current activities being mainly located in the inner archipelago and coastal waters. There is a strong political will for increased domestic fish production; unfortunately, the particularly poor status of the waters has limited the growth of the industry. Our research included a total of 38 CO FISH and FI FARM representatives. In many cases, both sectors were represented by the same person.

In the national-level workshop, the group discussions (CO FISH and FI FARM) were centered around setting a position as regards the national legislation, as well as sectoral policies and strategies (EBA1a). The focus of the work was on identifying the shortcomings in information (EBA2a) and framing the sector by discussing the future threats and opportunities. CO FISH found it important to note the characteristics of the Finnish fishing environment and sustainable fishing permits regarding the current fish stocks (EBA1b). Especially political processes to manage harmful species, specifically seals and great cormorants, were at the core of the discussion (EBA2c). Overall, the focus of the discussion was more on the sector's own needs and strengths.

In the regional-level workshops, the emphasis lay on interactions with other sectors and processes, as well as with the marine environment. CO FISH and FI FARM focused on ecosystem services (EBA3a), changes therein (EBA3b), and impacts on them (EBA3c), including cumulative impacts (EBA2b). It was stated that "*Maritime spatial planning should be based on watershed planning, so that impacts on land-side would be noticed, too*." (EBA4b). Climate change with global warming was highlighted including changes in water salinity affecting fish species' viability, and the protection of fish spawning areas. Moreover, it was noted that the sectors impact nutrient flow with fishing removing nutrients in contrast to fish farming increasing them. Importantly, regional, and even local characteristics were brought to the fore (EBA1b) and land-sea interactions were discussed in detail (EBA5c). Forestry and agriculture were the key topics, as well as regional marine geodiversity issues and their role in SES.

In the last phase, both CO FISH and FI FARM in collaboration with the planners formulated vision texts and roadmaps for the sectors. Formulation included a shared understanding of linkages between social and political processes in society (EBA2c), interactions between human activities and the marine environment (EBA4b), as well as regional interdependencies between the effects of human activities at sea (EBA5b). There is a need "*to increase the holistic approach in the food industry*", "*provide climate-friendly food*" and "*strengthen the vitality of the area*". Collaboration was especially emphasized between the authorities and various marine and terrestrial sectors (EBA6c).

4.2 Offshore wind energy

Energy production activities relevant to MSP consisted of nuclear power, solar power, and most importantly, offshore wind power. The industry is still in its infancy in Finland, but the potential to build offshore wind power has increased as well as interest in doing so due to Finland's commitment to the Paris agreement on climate change and EU climate policy. In the process, we had a total of 31 WIND representatives.

In the national-level workshop, WIND mostly discussed the obstacles related to building off-shore wind power. The group was able to verify and discuss the future possibilities as well as threats of this quickly growing sector. The group also identified some shortcomings in information, some of which were complemented in the local workshops (EBA2a).

During the regional-level workshops, the discussion centered around building and financing powerlines for electricity transmission, which is seen as being the largest barrier to investing from the perspective of the energy companies (also represented in all the workshops). The powerlines for electricity transmission are also recognized as being a key issue in the planning process; this was the most deliberated topic during the process.

Unsurprisingly, participants recognized wind conditions as being equally important ecosystem services with their value for different stakeholders also being recognized and analyzed (EBA3a). Participants also acknowledged several issues concerning the ecosystems which affect the maritime ecosystem (EBA3c). Depending on the location, building offshore wind power can damage the ecosystem, such as by causing noise pollution and harming migratory birds. The participants' discussions also explored the colliding interests between local authorities' and residents' needs, as well as national interest in preventing climate change. The conflicting interests of the Defense Forces and offshore wind power was also widely discussed, especially in regions in which the conflict is the most prominent (EBA6b).

In the roadmap, interoperability, stakeholder involvement, and open communication also played a significant role in considering future steps in the field towards the vision. There are still severe shortcomings on information, especially regarding the impacts on marine ecosystems (EBA2a): "*the impact of construction on the status of the marine environment and the ecosystem is always taken into account in planning.*" Indeed, the industry sees these issues and shortcomings as being important to solve, but they merely seem to think of them as conditions to be met, not problems they actively aim to solve.

4.3 Tourism

The Finnish archipelago, coastal, and marine areas are central to the recreational use of nature and tourism (TOUR). The most diverse offer of tourism and recreation services is in the coastal area, but there are providers of tourism and recreation activities in all zones of the sea area. The main tourist destinations in the sea and archipelago are national parks as well as diverse cultural environments. In addition, nature tourism is a significant form of archipelago and coastal tourism. The main activities are hiking, swimming, boating and other water activities, fishing, and hunting. In the process, we had a total of 30 TOUR representatives.

In the national-level workshop, TOUR discussions centered around characteristics of the marine areas and the carrying capacity of the marine environment (EBA1b). Preservation of the special features of coastal areas' natural, cultural environments, and landscapes were regarded as being significant as they offer the base for the industry. Inspecting the SWOT analysis raised the need to complement the goals of sustainable tourism and increase awareness of the impact of tourism on the Baltic Sea (EBA2a). In addition, regional interdependencies between the effects of human activities at sea were noted in discussions as there was a shared understanding that any increase of maritime transport and tourism would increase the burden on the marine environment. Therefore, the baseline understanding of the sector's impact on the system was relatively high.

In the regional-level workshops, there were several discussions which analyzed marine ecosystem services and their value for different stakeholders (EBA3a). Characteristics of the marine areas and the carrying capacity of the marine environment (EBA1b) were further emphasized. It was stated that *“The whole sea area is part of nature, not just separate conservational hotspots”*. Increasing understanding was detected in the interactions between human activities and the marine environment (EBA4b) as well as regional interdependencies between the effects of human activities at sea (EBA5b): “*Tourism and cultural heritage are interlinked: old lighthouses, for example, and the good condition of nature support this package*.” One of the key topics was special coordination of human activities and biodiversity on the coasts, which are intensive areas from both perspectives.

In the last phase, TOUR together with planners formulated vision texts and roadmaps for the sectors. Information and feedback provided by stakeholders were emphasized as well as synergies with other marine industries (especially with fishing, nature conservation, and cultural heritage) (EBA6c). In addition, social and political processes that are difficult to predict (EBA 2c) were identified: *“A stable security and economic situation creates a framework for the tourism industry.”* Regional interdependencies between the effects of human activities at sea (EBA5b) were further discussed and changes in the supply and value of ecosystem services (EBA3b) were understood to be a critical factor. Furthermore, complex feedback loops were perceived (EBA4b): *“Climate change can affect both the conditions and popularity of tourism in the region”.*

4.4 Outcomes of the co-creation process

The four co-creation processes (CO FISH, FI FARM, WIND, and TOUR) reveal three outcomes when applying the SES approach to MSP. The first outcome divulged that the most important benefits of working with the diagrams were the increased shared understanding of systems dynamics within one limited SES. Table 1 reveals that especially the carrying capacity of the marine environment, social and political processes, uncertainties of data and marine ecosystem services, and their value for different stakeholders were discussed in the workshops and in an increasing manner (more in the regional than national workshop).

However, the process was not equal in all studied industries. While three of them (CO FISH, FI FARM, and TOUR) had a clear transition towards systemic thinking, the fourth industry (WIND) viewed local environmental issues as being separated from their actions and serving as mere boundary conditions for industry development.

When comparing the four industries, the other three (CO FISH, FI FARM, and TOUR) indicate a clear connection between the profitability of the industry and healthy provision of marine ecosystem services, such as fish stocks, clean water, and recreational values. The sector-specific diagrams helped to perceive the local feedback loops with both positive and negative feedback mechanisms and include these in the discussions. In contrast, the WIND sector operates more on a planetary level. Justifications of the actions seem to be related to international and national climate strategies as well as their role in fighting global warming by decreasing carbon emissions. The Baltic Sea is seen as a potential platform on which to build power stations for the cause. The industry itself does not utilize the local ecosystems or the ecosystem services they impact. The systemic feedback loops between the industry and the condition of the marine ecosystem are longer and much more complex, resulting in them being more easily ignored.

The second outcome was that the co-creation method used provided a pragmatic way of applying EBA and LSI in planning. The ecosystem services were identified by stakeholders and then concretized by analyzing the mutual interaction between humans and ecosystems. Land-

Sea Interactions, such as ecological connections between terrestrial and marine ecosystems, were defined by mapping the marine and coastal zones in which marine sectors operate. In addition, the diagrams have set the basis for understanding the interplay and links between sectors in which lie potential synergies to profit from or conflicts to solve.

We conclude that this approach provided the best available grass roots knowledge of spatial and temporal dynamics for planners to utilize in MSP. Eventually, the workshop discussions at the diagrams enabled both maritime sector stakeholders and maritime spatial planners to comprehend sector-specific needs and, more importantly, to form an overall picture of marine SES and how they can be steered through MSP.

The co-creation process produced new understanding is presented in Figure 3. In the first phase (national level workshop), two levels of knowledge were detected, 1) the governance-level knowledge offering a holistic and strategic approach on a national level, and 2) the maritime sector-level knowledge offering sectoral and linear approaches combined with a regional understanding of local stakeholders. Our results indicate that a collective understanding was formed among maritime stakeholders during the co-creation process.

Figure 3: The co-creation process and formulation of shared understanding of regional couplings and the mutual interaction of humans and ecosystems.

The third outcome was the notion that not only stakeholders but also maritime spatial planners presenting the governance level of the process developed a more systematic comprehension of the multiple values provided by coastal and marine ecosystems, as well as of the role of humans therein through the co-creation process. Knowledge of spatiotemporal human activities in the sea area and land-sea interface, as well as land-sea connections together with terrestrial and marine ecosystem functions, were dealt with not only from a broad perspective at a sea-basin level but also at a local level. This helped to change the planning approach from stable programming of marine areas to adaptive governance enhancing the collaborative bottom-up MSP approach (see Table 2). When summarizing in Table 2, we have gathered the specific factors and challenges of the Finnish MSP process that have led to the introduction of co-creative, SES-based solutions, and finally to results that we consider to be positive outcomes of the process.

Table 2: A summary of the challenges and outcomes of the MSP process.

5 Discussion

5.1. Evolved systemic thinking supports sustainable MSP

MSP is a public process requiring private partnerships to achieve more robust plans, increase acceptance of planning decisions, and empower stakeholders (Reed 2008). Emerson et al. (2012) stress the importance of pooling public and private actors' resources to solve shared challenges. Shared resources, but also shared knowledge, commitment, and motivation, can be achieved with collaborative governance (Emerson et al. 2012). A case study in Finland with local fish stakeholders shows that the motivation to participate in MSP and increasing trust levels towards maritime spatial planners are challenging to reach and maintain (Erkkilä-Välimäki et al. 2022). Despite challenges in collaboration, Erkkilä-Välimäki et al. (2022) support MSP as a joint forum for public-private interaction and developing the collective capacity to deal with challenges.

In his review of stakeholder participation in environmental management, Reed (2008) summarizes that integration of local knowledge into planning might provide a more comprehensive understanding of complex and dynamic socio-ecological systems. Stephenson et al. (2021) highlight that the “questions of stakeholder inclusivity and knowledge systems accepted as valid in the management discourse still needs to be resolved” in the application of EBA in MSP. The national general-level approach in MSP, even with the highest scientific expertise, may dismiss regional and local characteristics as well as more detailed sectoral knowledge. Socio-cultural, ecological, and even economic characteristics are place-specific; thus, indicating the need for them to be inspected in more detail and with more transparency.

Our results indicate that the intensive process with co-creation of knowledge highlighted local knowledge, and the process provided an informal learning platform to introduce challenging terminology into the discussion too. This supports the representation of marine stakeholders in MSP, thus legitimizing their experiences and knowledge in decision-making (Saunders et al. 2020). Gilek et al (2021) found a significant gap in perception of the concept of social sustainability among the planners and their potential to adopt the concept in planning. Our process engaged planners and treated them as equally essential participants of the collaborative practices as maritime stakeholders. This sensitized planners to their part in social interactions and implications, affecting the MSP practices.

Our results indicate that systemic thinking has evolved and provided a shared knowledge of sector-specific and marine environment loops at a local and regional level, especially for the cases in which the systemic positive and negative feedback loops are quick and easily detected. Vulnerability of the land-sea continuum and SES therein were highlighted. The role of collaborative practices in the Finnish MSP process has been fundamentally vital to create a shared understanding of complex coastal and marine SES for both maritime industries and maritime spatial planners. Especially the core EBA principles, mitigating the impacts of human activities and the precautionary principle, are supported by the rise of systemic thinking. The added value of collaboration with stakeholders to precaution is, for example, shared knowledge of the use of ecosystem services and their role in socio-ecological systems.

Fishing and fish farming is stigmatized in the public discourse despite the vitality and profitability of the fish industry depending on a healthy marine environment. The feedback loops are clear and easily detectable within limited SES; the co-creation process brought ecosystem functions and welfare needs, as well as the sustainable use of marine and coastal ecosystem services to the discussions. In turn, marine industries operating at a more planetary level are prone to overlook local SES and their impacts on them. Different coastal and sea uses, such as tourism, fishing, fish farming, and offshore wind farming, are integral parts of local SES. This poses a challenge for the inclusive MSP process and its planning evidence, as to whether stakeholders accept and adopt planning decisions overlooking their understanding of the relevant operational environment.

5.2. Environmental stewardship through collaborative MSP

Our findings support the viewpoint that both maritime spatial planners and maritime stakeholders can reach a comprehensive understanding of human-environment interactions and play an active role in achieving marine environment status targets. In the planning phase, it is essential to bear in mind the Marine Strategy Framework Directive (MSFD, 2008/56/EC), the environmental pillar of the EU Integrated Maritime Policy. The EBA is applied in MSFD to achieve a good environmental status. MSP can contribute to descriptors of a good marine environmental status, such as biodiversity loss, the status of commercial fish stocks, seabed destruction and disturbance, changes in the seabed's hydrographic characteristics, underwater noise, changes in marine food webs, contaminants in the marine environment, and an increase in marine litter (Kostamo et al. 2020).

The application of EBA and LSI to manage socio-ecological systems requires adaptive governance, i.e., a collaborative and flexible decision-making process that involves actors at multiple levels and is based on learning processes (Folke et al. 2005). In the co-creation process, Finnish maritime spatial planners participated in all steps together with maritime stakeholders, and they co-created the shared knowledge of SES. MSP authorities should be capable of adapting to ecosystem dynamics whether ecological, socio-cultural, or economic (see Olsson et al. 2002). We conclude that the co-creation process supported the adaptive governance of Finnish MSP, and over time, this might also positively impact the resilience of SESs (see Schultz et al. 2015). It is stated in the Malawi principles for ecosystem-approach that adaptive governance is needed to anticipate the inevitable change in ecosystems. The shared knowledge seems to support the objective of MSP of promoting the sustainable use of natural resources and the Sustainable Blue Economy in the context of socio-cultural, economic, and environmental changes.

Depending on the administrative mandate, maritime spatial plans of EU countries are legally binding, guiding, or strategic. It is noted in the strategic Finnish Maritime Spatial Plan for 2030 that "the impact of the plan arises by virtue of the planning process, in other words, through the common understanding reached by the stakeholder groups, as well as through the commitment to the plan and the ownership experienced regarding it." We argue that the collaborative co-creation process and shared knowledge as an end-result might support psychological ownership towards the Plan. The emergence of psychological ownership is supported by three interrelated routes, that is, controlling the target of ownership, acquiring intimate knowledge of that target, and investing oneself in it (Matilainen et al. 2017). It seems that the co-creation process supported at least the latter two routes. It is further noted that feelings of ownership have powerful behavioral effects, such as promoting a sense of responsibility and preserving natural resources (Matilainen et al. 2017, Preston & Gelman, 2020). This provides intriguing prospects to further evaluate in forthcoming studies. We conclude that the psychological ownership towards maritime spatial plans—at least at some levels—is essential to support the acceptance of the plan and to mitigate any conflicting issues regarding the plan and its implementation.

Renewable energy, especially offshore wind power, is seen as a major industry capable of providing a sustainable shift towards climate neutrality with current MSPs in the EU addressing the priority of establishing offshore wind plants in a sea area (EC, 2022a; b). Our results indicate that maritime sectors operating more on a planetary level may lack the understanding of or overlook their impact on the local and regional level SES. Other example of this could be maritime logistics with huge economic impact; supranational emissions targets may overlook local environmental effects such as dredging needs in fairways and ports. Complex systemic feedback loops need to be underlined and considered, and further co-creation of systemic understanding is similarly required in a transboundary manner to ensure sustainable blue economy.

The co-creation of systemic understanding could also set a solid base for sustainable ocean governance when, for example, MSP needs to recognize the conservation goal of the EU's Biodiversity Strategy for 2030 to protect nature and reverse the degradation of ecosystems (EP 2020). The requisite is to preserve at least 30 % of the marine environment, of which 10% must be strictly protected. The challenge lies especially in the remaining 20 % and finding ways to co-create sustainable local SESs there with regenerative measures. In an ideal state, a good marine environment status is achieved with the support of prosperous and active local communities.

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