Ocean ecosystem services: modeling a factor development process to create sustainable value for decisions

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Table I. Profile of panel experts

Organization	Country
AirCentre	Portugal
Autoridade Marítima Nacional	Portugal
CLS	France
Colab Atlantic	Portugal
DEIMOS	Portugal
Governo dos Açores	Portugal
I2S	Greece
IPMA	Portugal
NOVA SBE	Portugal
PML	United Kingdom
Salmon Scotland	United Kingdom
SINTEF	Norway
TERRA DUE	Italy

Table II. Stakeholders

S1: Researchers
S2: Members of the industry
S3: Members of the shipping sector
S4: Main users
S5: Main beneficiaries
S6: Principal managers
S7: Marine spatial planners
S8: Regional governor
S9: Regional administration
S10: Decision-makers
S11: Local-level administration
S12: Non-governmental organizations—NGOs
S13: Administrative bodies (local, municipal and national)
S14: Civil society
S15: Groups acting voluntarily

Table III. List of dimensions and factors	Reference (s)
D: GOVERNANCE (Direction)	
FD 1: Successful adaptation entails steering processes of change through institutions, in their broadest sense.	(Nelson et al., 2007)
FD 2: The governance of adaptation is concerned with issues of equity in the outcomes of environmental decision-making.	
FD 3: Comprehensive understanding is achieved by open, shared information sources that fill gaps and facilitate integration.	(Pahl-Wostl et al., 2007)
FD 4: Cross-sectoral analysis identifies emergent problems and integrates policy implementation.	
FD 5: Flexible and responsive to change.	(Folke et al., 2005)
FD 6: Focused holistically on social–ecological interactions.	(Görg et al., 2016)
FD 7: Well informed by a diversity of perspectives.	(Robbe et al., 2021)
FD 8: Reflective in decision-making.	(Polejack et al., 2021)
FD 9: Innovative in problem-solving.	(Falkenberg & Tubb, 2017)
FD 10: Collective aspects related to fishing behavior and attitudes that influence fishermen's involvement in local management.	(Silva et al., 2020)
FD 11: Ways that increased access enable increased development in the regions.	(O. Lee et al., 2015)
FD 12: A decentralized infrastructure on an appropriate scale has diverse sources of design, power, and delivery.	(Pahl-Wostl et al., 2007)
FD 13: Governance is polycentric and horizontal, with broad stakeholder participation.	
FD 14: Adoption of dynamic cooperation agreements that adapt to the changing needs of governance.	(Armatas et al., 2022)
D: PEOPLE (Stakeholders)	
FD 1: We have individual leadership and stakeholder dialog with a focus on social transformation.	(Olsson et al., 2004)
FD 2: I talk to my colleagues from population registry, regarding where new people have moved in.	(Nam & Pardo, 2014)
FD 3: Employ a mix of collaborative tools and spaces that considers the skillsets and competences of different target audiences.	(Rodríguez-Piñeros et al., 2022)
FD 4: Ensure that adequate training and support are in place to tackle existing barriers to inclusive cocreation processes.	(Görg et al., 2016)
D: PLANET (Environment)	
FD 1: The measurable and perceived impacts of development on subsistence harvest of fish.	(O. Lee et al., 2015)
FD 2: Fishermen are flexible to changes in the community and/or to new rules defining use and access to the resources.	(Silva et al., 2020)
FD 3: Predictable and unpredictable impacts of climate change are expected to affect marine systems and have direct effects on fish species.	(Silva et al., 2020)
FD 4: The impact of change on species on the coast.	(O. Lee et al., 2015)
D: PROFIT (Value Added)	
FD 1: Financial resources are diversified using a broad set of private and public financial instruments.	(Pahl-Wostl et al., 2007)
FD 2: Better infrastructure leads to higher flexibility and learning generating economic alternatives.	(Silva et al., 2020)
FD 3: Introducing measures for mitigating resource scarcity issues and ensuring the human, financial, and technological resources needed at the municipal level to support governance.	(Hovis et al., 2022)
D: CULTURAL (Value)	
FD 1: Promote a culture of (open) innovation and experimentation in the public sector.	(Leitheiser & Follmann, 2020)
FD 2: Make the decision-making process more visible through the use of reports.	(Bertot et al., 2010)

FD 3: Develop standards and technical regulations for ecosystem services.	(Iveson & Maalsen, 2019)
FD 4: Engage with local and supralocal knowledge-sharing networks that facilitate the acquisition and dissemination of key lessons on governance decisions.	(Arkema et al., 2015)
FD 5: Manage innovation partnerships by replacing (when possible) bureaucratic control measures with trust-based mechanisms.	(Townhill et al., 2022)
FD 6: Ensure political commitment and public sector leadership throughout the different phases of smart city transitions.	(Mejjad & Rovere, 2021)
FD 7: Introduce innovative procurement methods, such as long-flexible contracts, that fit with the implementation requirements of ocean ecosystem services projects.	(Haas et al., 2022)
FD 8: Nurture an innovative culture and experimentation in the public sector.	(Kononen et al., 2014)
D: SPATIAL (Geographic)	
FD 1: Employ a space that considers the skillsets and competences of different target audiences.	(Chambers & Evans, 2020)
FD 2: Discuss decisions with different neighborhoods in terms of impact.	(Velsberg et al., 2020)
FD 3: Identify several key capabilities that facilitate the application of geographic decisions.	(Basconi et al., 2023)
FD 4: Avoid fragmentation of local policies for the governance of ecosystem services.	(Rector et al., 2021)
FD 5: Discuss the impact of being together in specific spaces with different approaches.	(Owuor et al., 2017)
FD 6: Promote analyses focused on the role of area, place, and location.	(Li et al., 2017)
FD 7: Develop standards and technical regulations for ocean ecosystem services data collection.	(Ancona et al., 2022)
FD 8: Provide information about the spatial location for sharing decisions.	(Sousa & Alves, 2020)

Table IV. Factors: comments by experts

Factor: Successful adaptation in effect entails steering processes of change through institutions, in their broadest sense.
Comment: *Successful adaptation in effect entails steering processes of change through people.*
Factor: The governance of adaptation is concerned with issues of equity in the outcomes of environmental decision-making.
Comment: *The governance of adaptation should be concerned with issues of equity in the outcomes of environmental decision-making but seems it's not.*
Factor: Comprehensive understanding is achieved by open, shared information sources that fill gaps and facilitate integration.
Comment: *It can also be via privately owned information sources that fill gaps and facilitate integration or innovation. In this regard, the US seems to be more advanced than the EU in creating breakthrough innovations linked to science and the understanding of ecosystems. So not everything may be "open-source."*
Factor: The ways that increased access enable increased development on the regions.
Comment: *Access to what...?*
Factor: Fishermen are flexible to changes in the community and/or to new rules defining use and access to the resources.
Comment1: *It seems to me, to be more than one factor...*
Comment2: *Changes are imposed, and there is only one option besides coping with new regulations. Fishing activities are propelled by probabilities in terms of biomass captures, while agriculture is well-defined in the boundaries of the territory. So, I do not think fishermen are flexible. Even the location of aquaculture*.
Factor: The impact of the change on species on the coast.
Comment: *Do not understand this question. You mean Environment (the Public institution?) addresses the impact of changes in species on the development of the coast? If yes than I would say yes by the imposition of regulation on the costal resources.*
Factor: Financial resources are diversified using a broad set of private and public financial instruments.
Comment: *Financial resources are diversified according to a set of private and public financial instruments.*
Factor: Promotes a culture of (open) innovation and experimentation in the public sector.
Comment: *Not sure this is possible due to the lack of salary competitiveness versus the private sector. So, innovation will be more led by the private sector or eventually funded by universities with a low Return on Investment proposition. Too much money spent that delivers mediocre innovations*.
Factor: Ensuring political commitment and public sector leadership throughout the different phases of smart city transitions.
Comment: *For me it is not clear why smart cities are mentioned...*
Factor: Employing a space that considers the skillsets and competences of different target audiences.
Comment: *Identifying the needs for spaces according to the skillsets and competences of different target audiences.*

Table V. Kendall's W coefficient of Concordance (W)

Test Statistics	
N	20
Kendall's W[a]	.784
Chi-Square	658.397
df	42
Asymp. Sig.	< .001
a. Kendall's coefficient of concordance	

Table VI. Kendall's tau coefficient of concordance (T)

Confidence Intervals of Kendall's Tau_b				
	Kendall's tau_b	Significance (2-tailed)	95% Confidence Intervals (2-tailed)[a]	
			Lower	Upper
Expert A - Expert B	.672	< .001	.540	.772
a. Estimation is based on Fisher's r-to-z transformation.				

Table VII. Reliability statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
.956	42

Item-Total Statistics				
	Scale Mean If Item Deleted	Scale Variance If Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha If Item Deleted
FG1	279,65	1594,555	-1,000	,959
FG2	283,55	1423,839	1,000	,953
FG3	281,95	1536,576	,000	,957
FG4	280,50	1623,947	-1,000	,961
FG5	279,10	1507,989	1,000	,955
FG6	282,80	1565,432	-1,000	,958
FG7	284,35	1653,608	-1,000	,963
FG8	284,10	1507,989	1,000	,955
FG9	279,30	1288,958	1,000	,952
FG10	286,10	1507,989	1,000	,955
FG11	286,80	1565,432	-1,000	,958
FG12	280,10	1507,989	1,000	,955

FG13	279,00	1342,105	1,000	,952
FG14	279,00	1342,105	1,000	,952
FP1	279,80	1565,432	-1,000	,958
FP2	281,10	1507,989	1,000	,955
FP3	279,00	1342,105	1,000	,952
FP4	279,25	1479,671	1,000	,954
FPL1	281,10	1507,989	1,000	,955
FPL2	282,10	1507,989	1,000	,955
FPL3	280,25	1479,671	1,000	,954
FPL4	279,00	1342,105	1,000	,952
FPL5	279,10	1507,989	1,000	,955
FPR1	280,00	1342,105	1,000	,952
FPR2	280,25	1479,671	1,000	,954
FPR3	279,30	1288,958	1,000	,952
FC1	279,10	1507,989	1,000	,955
FC2	279,10	1507,989	1,000	,955
FC3	282,55	1423,839	1,000	,953
FC4	283,40	1451,621	1,000	,953
FC5	281,70	1396,326	1,000	,952
FC6	278,40	1451,621	1,000	,953
FC7	281,00	1342,105	1,000	,952
FC8	280,15	1315,397	1,000	,952
FS1	282,80	1565,432	-1,000	,958
FS2	281,85	1369,082	1,000	,952
FS3	281,65	1594,555	-1,000	,959
FS4	281,00	1342,105	1,000	,952
FS5	280,40	1451,621	1,000	,953
FS6	280,95	1536,576	,000	,957
FS7	283,55	1423,839	1,000	,953
FS8	281,80	1565,432	-1,000	,958

Table VIII. BOCR Metrics & Stakeholders

Category	**Stakeholders**
Benefit	S4: Main users
	S5: Main beneficiaries
Opportunity	S2: Members of the industry
	S3: Members of the shipping sector
	S7: Marine spatial planners
Cost	S6: Principal managers
	S14: Civil society
Risk	S9: Regional administration
	S13: Administrative bodies (local, municipal, national)
	S10: Decision-makers

	S11: Local-level administration
	S12: Non-governmental organizations—NGOs
	S15: Groups acting voluntarily

Table IX. Dimension & Stakeholders

Dimension	Items
Governance	S4: Main users
	S5: Main beneficiaries
	S6: Principal managers
	S9: Regional administration
	S13: Administrative bodies (local, municipal, national)
	S10: Decision-makers
	S11: Local-level administration
	S12: Non-governmental organizations—NGOs
People	S4: Main users
	S5: Main beneficiaries
	S14: Civil society
	S12: Non-governmental organizations—NGOs
	S15: Groups acting voluntarily
Planet	S4: Main users
	S5: Main beneficiaries
Profit	S6: Principal managers
Cultural	S14: Civil society
	S12: Non-governmental organizations—NGOs
Spatial	S7: Marine spatial planners

Table X. Relationships between BOCR, dimensions, factors and stakeholders

Problem	**How does adaptive governance aid sustainable decisions in marine ecosystem services?**		
Relations	**a) Benefit X Governance; b) Opportunity X Governance; c) Opportunity X People; d) Opportunity X Planet; f) Opportunity X Profit; g) Opportunity X Spatial; h) Cost X Governance; i) Cost X Cultural and j) Risk X Governance.**		
BOCR	**Dimension**	**Factor List**	**Stakeholders**
Benefit Opportunity	Governance	FD 1: Successful adaptation in effect entails steering processes of change through institutions, in their broadest sense. FD 2: The governance of adaptation is concerned with issues of equity in the outcomes of environmental decision-making. FD 3: Comprehensive understanding is achieved by open, shared information sources that fill gaps and facilitate integration. FD 4: Cross-sectoral analysis identifies emergent problems and integrates policy implementation. FD 5: Flexible and responsive to change. FD 6: Focused holistically on social–ecological interactions. FD 7: Well informed by a diversity of perspectives. FD 8: Reflective in decision-making. FD 9: Innovative in problem-solving. FD 10: Collective aspects related to fishing behavior and attitudes that influence fishermen involvement in local management. FD 11: The ways that increased access enable increased development in the regions. FD 12: A decentralized infrastructure on an appropriate scale has diverse sources of design, power, and delivery. FD 13: Governance is polycentric and horizontal, with broad stakeholder participation. FD 14: Adoption of dynamic cooperation agreements that adapt to the changing needs of governance.	S4: Main users S5: Main beneficiaries S10: Decision-makers S11: Local-level administration
Opportunity	People	FD 1: We have individual leadership and stakeholder dialog with a focus on social transformation. FD 2: I talk to my colleagues from population registry, regarding where new people have moved in. FD 3: Employ a mix of collaborative tools and spaces that considers the skillsets and competences of different target audiences. FD 4: Ensure that adequate training and support are in place to tackle existing barriers to inclusive cocreation processes.	S15: Groups acting voluntarily
	Planet	FD 1: The measurable and perceived impacts of development on subsistence harvest of fish. FD 2: Fishermen are flexible to changes in the community and/or to new rules defining use and access to the resources. FD 3: Predictable and unpredictable impacts of climate change are expected to affect marine systems and have direct effects on fish species. FD 4: The impact of change on species on the coast.	S4: Main users
	Profit	FD 1: Financial resources are diversified using a broad set of private and public financial instruments. FD 2: Better infrastructure leads to higher flexibility and learning generating economic alternatives. FD 3: Introduce measures to mitigate problems of resource scarcity and ensure that the human, financial and technological resources necessary at the municipal level are available to support governance.	S6: Principal managers
	Spatial	FD 1: Identify the needs for spaces according to the skillsets and competences of different target audiences. FD 2: Discuss decisions with different neighborhoods in terms of impact. FD 3: Identify several key capabilities that facilitate the application of geographic decisions. FD 4: Avoid fragmentation of local policies for the governance of ecosystem services. FD 5: Discuss the impact of being together in specific spaces with different approaches.	S7: Marine spatial planners

		FD 6: Promote analyses focused on the role of area, place, and location. FD 7: Develop standards and technical regulations for ocean ecosystem services data collection. FD 8: Provide information about the spatial location for sharing the decision.	
Cost	Governance	FD 1: Successful adaptation in effect entails steering processes of change through institutions, in their broadest sense. FD 2: The governance of adaptation is concerned with issues of equity in the outcomes of environmental decision-making. FD 3: Comprehensive understanding is achieved by open, shared information sources that fill gaps and facilitate integration. FD 4: Cross-sectoral analysis identifies emergent problems and integrates policy implementation. FD 5: Flexible and responsive to change. FD 6: Focused holistically on social–ecological interactions. FD 7: Well informed by a diversity of perspectives. FD 8: Reflective in decision-making. FD 9: Innovative in problem-solving. FD 10: Collective aspects related to fishing behavior and attitudes that influence fishermen's involvement in local management. FD 11: The ways that increased access enable increased development on the regions. FD 12: A decentralized infrastructure on an appropriate scale has diverse sources of design, power, and delivery. FD 13: Governance is polycentric and horizontal, with broad stakeholder participation. FD 14: Adoption of dynamic cooperation agreements that adapt to the changing needs of governance.	S6: Principal managers
	Cultural	FD 1: Cultivate a culture of (open) innovation and experimentation in the public sector. FD 2: Make the decision-making process more visible through the use of reports. FD 3: Develop standards and technical regulations for ecosystem services. FD 4: Engage with local and supralocal knowledge sharing networks that facilitate the acquisition and dissemination of key lessons on governance decisions. FD 5: Manage innovation partnerships by replacing (when possible) bureaucratic control measures with trust-based mechanisms. FD 6: Ensure political commitment and public sector leadership throughout the different phases of smart city transitions. FD 7: Introduce innovative procurement methods, such as long-flexible contracts, that fit with the implementation requirements of ocean ecosystem services projects. FD 8: Nurture an innovative culture and experimentation in the public sector.	S14: Civil society

Risk	Governance	FD 1: Successful adaptation in effect entails steering processes of change through institutions, in their broadest sense. FD 2: The governance of adaptation is concerned with issues of equity in the outcomes of environmental decision-making. FD 3: Comprehensive understanding is achieved by open, shared information sources that fill gaps and facilitate integration. FD 4: Cross-sectoral analysis identifies emergent problems and integrates policy implementation. FD 5: Flexible and responsive to change. FD 6: Focused holistically on social–ecological interactions. FD 7: Well informed by a diversity of perspectives. FD 8: Reflective in decision-making. FD 9: Innovative in problem-solving. FD 10: Collective aspects related to fishing behavior and attitudes that influence fishermen's involvement in local management. FD 11: The ways that increased access enable increased development on the regions. FD 12: A decentralized infrastructure on an appropriate scale has diverse sources of design, power, and delivery. FD 13: Governance is polycentric and horizontal, with broad stakeholder participation. FD 14: Adoption of dynamic cooperation agreements that adapt to the changing needs of governance.	S9: Regional administration S13: Administrative bodies (local, municipal, national) S10: Decision-makers S11: Local-level administration S12: Non-governmental organizations—NGOs S15: Groups acting voluntarily

Modeling a factor development process to create sustainable value for decisions on ocean ecosystem services

Abstract

Purpose - The aim of this paper is to model a process for moving toward sustainable ecosystem service decisions in a Coastal Biodiversity and discuss the directions of the process for decision-makers to apply in ocean ecosystem services.

Design/methodology/approach – After the development of theoretical approaches to understand their prospects for the future development of ecosystem services, we worked on a process for developing factors for sustainable decision-making. It uses the Delphi method to develop all the factors supported by six dimensions in two specific moments: deductive-inductive and inductive-deductive.

Findings - This process of modeling the factors expands the possibility of adaptive governance to make prior and subsequent decisions using factors related to dimensions, stakeholders and benefits, risks, opportunities, and costs.

Originality/value - This modeling process generated dimensions and factors to support adaptive governance stakeholders in making sustainable decisions in a coastal biodiversity zone.

Practical implications - This set of factors developed for adaptive governance decision-making can be applied to develop a prior alignment of stakeholder interests with sustainable practices.

Social implications - This set of factors developed with the intervention of experts reinforces the importance of sustainable collective decisions on ocean ecosystem services. This is a joint approach with participants in the NextOcean project, sponsored by the EC's Horizon 2020 program. An Earth Observation-based Consortia aim to create sustainable value for Space, Land, and Oceans.

Keywords – Ecosystem Services, Sustainable Development, Decision-Making, Governance, Marine, NextOcean, Innovation

Paper type - Research paper

1. Introduction

Considering the ecosystem services approach, several frameworks have been proposed to manage and make decisions in different contexts of governance of ecosystem services. For example, Kofinas (2009) developed a governance model to promote collaboration among stakeholders to facilitate the learning process of socio-ecological factors. Later, Ramírez-Guerrero et al. (2021) proposed a multi-criteria evaluation system to build relationships with tourism components. These authors use the model to analyze and quantify the level of tourist service offered to society. In addition, Louda et al. (2021) explore a new way to be helpful practices for better environmental governance. They combine methods in the cultural and social perspectives of society representatives.

Winkler et al. (2021) show in their research that the literature focusing on the governance of ecosystem services is limited to the general social-ecological governance approach and conclude that there are four types of governance models: scientific-technical governance (scientific and technical arguments to guide decision-making), governing strategic behavior (lobbying to influence policies and to protect particular interests), hierarchical governance (an encapsulation of the other three modes of governance) and (adaptive) collaborative governance (solutions common to all actors).

Furthermore, Folke et al. (2005) describe adaptive governance systems as often self-organizing as social networks with teams and actor groups that draw on various knowledge systems and experiences to develop a shared understanding and policies. Based on Chaffin et al. (2014), the term “adaptive governance” is not limited to the governance of social-ecological systems but is related to resilience, social-ecological systems, and environmental governance.

Moreover, Schultz et al. (2015) provide insights into the effects of adaptive governance on natural capital. They compare three well-studied initiatives, a landscape in southern Sweden, the Great Barrier Reef in Australia, and fisheries in the Southern Ocean. They found that adaptive governance developed the capacity to respond to ecosystem-wide changes in natural capital.

In addition, Fuss et al. (2019) describe three pillars for governance: 1) policy, legal, institutional and regulatory; 2) planning and decision-making processes and 3) implementation enforcement and compliance. The isolation of science disciplines and the weak integration between science, policy and society represent the main challenges for sustainable human development (Sajeva *et al.*, 2020).

Görg *et al.*, (2016) also discuss the best science–policy interfaces for European biodiversity politics. They put forward an approach to improve the interface between knowledge-holder communities and the decision-making process for ecosystem services and recommend a design for the reflexive governance of a "network of knowledge" in the context of the European Union.

Looking for the specific initiatives, some studies were carried out to support governance decisions. For example, (Silva, Pennino and Lopes, 2020) synthesize blocks of critical indicators of an individual or community's ability to build and maintain resilience in social-ecological systems (SESs), such as flexibility, the ability to learn, the ability to organize, assets, social capital, and ecological characteristics. Moreover, (Robbe *et al.*, 2021) conducted a comparative study involving 39 external experts to understand the impact of beach ecosystem services supporting coastal management in the Baltic Sea. They conclude that there is a need to enhance political interest in ecosystem services.

In addition, (Smail *et al.*, 2019) reinforce that it is important to think of the future of our blue planet and provide services by marine, coastal and inland waters to advance sustainable development. They consider it important to keep providing ecosystem service observations (ocean and coastal) to benefit society.

In this paper (Study B), we explored several factors according to the literature review based on governance of ecosystem services. This study was supported by the document (Study A) "Perspectives for future development of ecosystem services: contributions to regional applications and nurturing sustainable advances for global citizens" (Figueiredo and Cabral, 2023), to understanding thematic perspectives for the future development of solutions in ecosystem services management. Articles were selected in two groups of the main field of this research: governance and decision-making. The research in the Scopus database gave us access to different studies on governance ecosystem services and ocean governance ecosystem services, including models, factors, indicators, and frameworks to support our study. We use all the articles to create a list of factors to be applied in a governance of ocean ecosystem services in the Azores, Portugal. Figure 1 provides an overview of the Azores region.

Figure 1. Overview of the Azores Archipelago

Source: MODIS image from NASA's TERRA Satellite

The factors identified in the literature review followed the Delphi method to validate all relevant factors in decision-making in ocean ecosystem services. We followed two types of Delphi method: policy Delphi (lobbyist approach) and decision Delphi (decision-makers) according to Paré *et al.*, (2013). The study was based on the case study, NextOcean project, funded by the European Union, Horizon 2020. We composed the panel with 20 different profiles in three multi-rounds: 1) factor identification; 2) factor generation and 3) factor refinement to answer the question:

RQ: How does adaptive governance aid sustainable decisions in marine ecosystem services**?**

The aim of this paper is to model a process for moving toward sustainable ecosystem service decisions in a Coastal Biodiversity area. In terms of the value of the study, we identify the limitations of face-to-face developing using feedback on a single-case study (NextOcean Project) and discuss the directions of the process for decision-makers to apply in ocean ecosystem services. In addition, the exploration of multiple factors in the literature on the governance of ecosystem services is important and relevant to the advancement of science as it allows for a more comprehensive, interconnected and policy-relevant understanding of this critical area, ultimately contributing to more effective and sustainable management of ecosystem services.

This study brings together a range of disciplinary approaches to contribute to socio-economic development and ecosystem services, especially ocean ecosystem services. Through the proposed model, it seeks to contribute to the balance between research and the development of practical and political solutions for the improvement of civil society and the organisations that impact it. It allows management, carried out through adaptive governance, to improve the supply of natural resources and ecosystem services needed by all human beings. One of the SDG's specific objectives is to consider sustainable adaptive governance decisions to maintain and restore water-related ecosystem services. It seeks to create value from ocean ecosystems in planning, processes, and organisational strategies to improve quality of life.

The sustainable value of ocean ecosystem services is of paramount importance as it guides decisions critical to the health and sustainability of our planet. Oceans are a life-supporting force, offering resources like fish, clean water, and coastal protection, while also regulating climate and carbon cycles. Recognizing and preserving the sustainable value of these services underscores the need to make informed and responsible choices when it comes to activities such as fishing, shipping, and coastal development.

The relevance of considering the sustainable value in decisions related to ocean ecosystem services cannot be overstated. Oceans are a vital component of our planet's life support system, providing resources such as seafood, transportation routes, and carbon sequestration, while also supporting biodiversity and climate regulation. Recognizing the sustainable value of these services is essential because it drives us to make choices that ensure the long-term health of these ecosystems and the well-being of both human and natural communities.

The paper is organized as follows: section 1 refers to the introduction and presents the overview of the study. Section 2 shows the theorical background in the main field of the study. Section 3 describes the methodology applied in the study to identify and validate the factors. Section 4 present the results. Section 5 shows the discussion and implications. Section 6 gives the limitation and future studies. Finally, the last section shows the conclusion.

2. Conceptual Foundations

The "Ecosystem Services Governance" is seen as an interface between the social and the ecological, a way of influencing the trajectory of existing seagrass ecosystem services (SESs), (Carl Kraft and Crandall, 2020). This trajectory has been the subject of discussion by coastal communities that depend on fishing and need to make sustainable future decisions to adapt to social and ecological changes (Silva, Pennino and Lopes, 2020).

For example, climate change raises several discussions in terms of future decisions and possible impacts on the production of sustainable ecosystem services around the world (Wang *et al.*, 2016). This discussion has been approached diffusely in terms of the use and abuse of ecosystems, creating the need for adaptation and new methods for future decisions embedded in a set of actors involved in the "decision- ecosystem" (Folke *et al.*, 2005). Also, there is now an increasing number of studies on the "adaptive governance" field for ecosystem service management, after being reviewed in the scientific literature (Schultz *et al.*, 2015).

Some governance methods consider economic and non-economic, monetary and non-monetary models to try to value natural assets and thus regulate their use in the context of decisions on ecosystem services (Sajeva *et al.*, 2020). However, the meaning of "value" is applied as a holistic concept that can include social, ecological and economic values (Jobstvogt *et al.*, 2014).

At this point, a real need for management arises, in addition to a greater political interest in evaluating ecosystem services in terms of decisions and impacts (Robbe *et al.*, 2021). For instance, the "Blue Planet" initiative provides us with the opportunity to understand the way decisions are taken considering the oceans, marine and coastal—ocean and society—showing that observation of the value chain can be groups in six societal drives: 1) information needs; 2) observations and data; 3) products; 4) decision support tools; 5) knowledge, and 6) evidence-based decisions (Smail *et al.*, 2019).

However, although we know that oceans provide diverse and important ecosystem services to society, ensuring the sustainability of these services depends on collaborative data collection to support complex ocean governance decisions (Polejack, Gruber and Wisz, 2021). The connection between planning and coastal policy management can benefit from data and information on the impact of policy decisions (Milon and Alvarez, 2019), especially when the ability of natural systems to function optimally has been reduced, increasing the vulnerability of regions and local communities through the loss of ecosystem services (Ateweberhan *et al.*, 2018).

Globally, studies are being carried out on ecosystem services provided and human welfare benefits, the value of which is inadequately incorporated into decision-making, but the challenge remains regarding which options can best support policy decisions of marine and coastal ecosystem services (Fernandes *et al.*, 2016). In addition, while there is a growing body of scientific literature, assessments of the direction and magnitude of the anticipated economic change remain limited in terms of the economic effects of the ocean (Falkenberg and Tubb, 2017).

In fact, coastal waters around the world are experiencing increasing demand for their diverse benefits for humans from specific sectors such as fisheries and transport or ecosystem services, as well as renewable energy and offshore aquaculture (White, Halpern and Kappel, 2012). Even though there is awareness of this demand, no coastal and marine planning process has applied a framework to create scenarios and design a management plan for decision-making (Arkema *et al.*, 2015).

Coastal and tropical habitats provide a diverse range of valuable ecosystem services that humans depend on for a living (zu Ermgassen *et al.*, 2021). In addition, they provide benefits to people, habitats for fisheries target species, and opportunities for tourism and recreation (Wyatt *et al.*, 2017).

These services are perceived in the context of the marine environment as biological productivity of high economic value, collaborating with human activity in multiple sectors, among them shipping, aggregate extraction, and fishing (Lemasson *et al.*, 2021). On the other hand, approaches using "green infrastructure" for the protection of coastal communities have been growing in the scientific community, and limiting decision-makers in establishing coastal protection strategies (Ruckelshaus *et al.*, 2016).

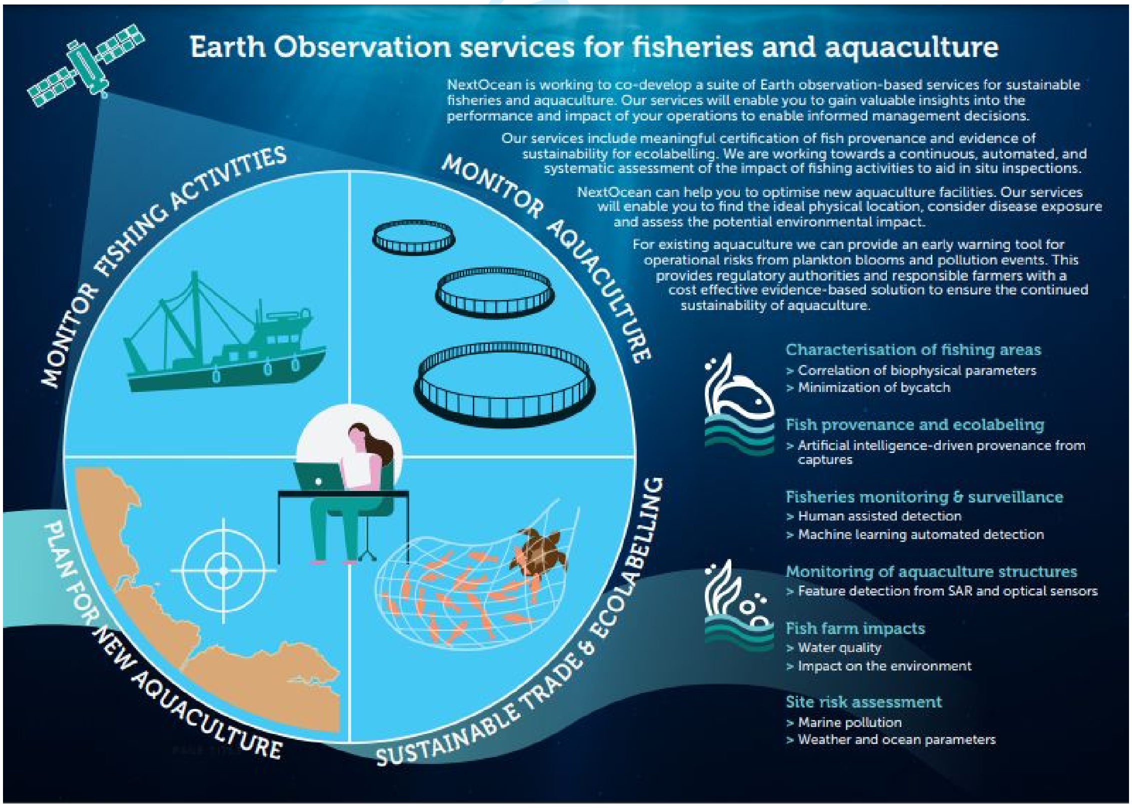
While we have a growing number of nations oriented towards reducing conflicts over space and protecting ecosystem services, coastal and ocean planning demand interventions to simplify a complex decision-making process involving multiple actors, objectives, and uncertain outcomes (Verutes *et al.*, 2017). Thus, we need to develop approaches that capture multiple interactions between people and ecosystems within a real-world planning process (Arkema *et al.*, 2019).

3. Methodology

3.1 Case study

The Next Generation of Fishing and Aquaculture Services— "NextOcean" (NextOcean project) has been proposed by a consortium of companies, research institutions, a business school and a buyer's group (alpha and beta users) supporting the development of (co-designing) six commercially oriented, operational and innovative services based on the Earth observation during a 36-month period. It targets fishing and aquaculture by proposing Earth observation (EO) commercial services for the public and private sectors, delivering economic, social and policy value to European citizens and creating a new market of product and services. It builds on past activities, proposing an integrated solution to address four user scenarios: 1) monitoring fishing activities and impact; 2) minimization of bycatch and ecolabeling; 3) monitoring aquaculture impacts; and 4) new fish farms. The case study is presented to test the evaluation of the framework (see Figure 2).

Figure 2 Overview of the NextOcean services



Source: https://www.nextocean.eu/

The services provided by NextOcean are based on the technology readiness level (TRL) range (5–8) and have been tested in pre-operational settings to be suited for go-to-market. TRL is a systematic method for assessing the maturity of a technology or innovation, developed by the National Aeronautics and Space Administration (NASA) for application in space exploration and aerospace projects.

The provided services are based on initial scenarios as follows: a) monitoring of fishing activities and their impact; b) sustainable trade, ecolabeling and minimization of bycatch; c) aquaculture monitoring; d) new aquaculture; e) characterization of fishing and aquaculture areas; f) fish provenance and ecolabeling; g) monitoring and surveillance of fisheries; h) site risk assessment; i) fish farm impacts; and j) monitoring of aquaculture structure.

The expert committee of the NextOcean projectprovided feedback on the framework. The project is conducted in collaboration with private companies, universities, and public agencies, and has defined service requirements and developed six Earth observation services. The team on this project (the panel of experts) were selected according to their expertise in the field of ocean ecosystem services and come from different companies, universities and positions with more than 15 years working and leading projects in the space sector.

3.2 Delphi Method

The Delphi method provides a robust solution to help conduct the research with consistency and rigor, to identify factors to support the adaptative governance decisions in this context (Takamura and Tone, 2003). Our focus is to capitalize on the experiences of different experts in the ocean ecosystem services and space projects (Earth observation).

The factors proposed were based on the deliberated observations of the real world and the literature review and followed two types of Delphi method: policy Delphi (lobbyists approach) and decision Delphi (decision-makers) (Paré *et al.*, 2013). It was a reflective modeling process where the constructs are factors that support "ocean governance" to make decisions on sustainable ecosystem services in the Azores, Portugal.

The online process was supported by interviews, surveys and workshops (Nakatsu and Iacovou, 2009). The procedures to identify the factors followed three phases: the first phase aims to identify the factors; the second phase establishes the generations of factors and dimensions; and in the last phase, the factors are refined to support future sustainable decisions (Hair *et al.*, 2019). We followed the scale-based surveying procedure according to (Czakon, Klimas and Mariani, 2020)

3.2.1 Panel Selection

The starting point of the panel is based on the different ratings published by (Paré *et al.*, 2013), about several studies using Delphi method to compose the panel size: six or less experts (n = 1 study); between seven and 13 experts (n = 2 studies); between 14 and 30 experts (n = 19 studies); between 31 and 60 experts (n = 10 studies) and over 60 experts (three studies). In our study, we followed these explicit principles for expert selection for the optimal size of a Delphi panel to have a clear selection process for criteria (Rowe and Wright, 2001).

i. number of experts between five and 20 (report response rate to initial call for participation);
ii. demographics and profiles of experts;
iii. ensure anonymity of participants;
iv. experts with knowledge of the domain;
v. heterogeneous experts;
vi. generate the rounds (≥ 3) until stability of the results is achieved;
vii. aggregate the final forecast by weighting all the experts' estimates;
viii. Kendall's coefficients of concordance (according to the responses of all panel members);
ix. pretest task instructions.

In this study, the experts were composed of different profiles (Table I) to minimize the "halo effect." All experts recommended keeping three drives in the group: 1) influence of the future of the Earth observations industry; 2) global-local thinking, and 3) conditions for co-creating solutions.

[Please insert Table I here]

3.2.2 Application Process

The application of the Delphi method followed the normal multi-round methodology (Nakatsu and Iacovou, 2009):

1) factor generation: In round 1 (deductive stage) several factors, dimensions and stakeholders were identified in the literature review based on the governance of the ecosystem services field (Walsh *et al.*, 2016). The idea was to review previously

developed frameworks and descriptions/definitions of the dimension in the Scopus database, considering relevant academic journals papers published in the field of study. The terms “framework,” “scale,” “factors,” “items,” “dimension,” “constructs,” “ecosystem services,” “ocean,” “governance,” “decision,” “questionnaire,” and combinations thereof were used.

2) factor reduction: In round 2 (the inductive stage), the individual list (online format) was sent to five experts to examine and/or describe the meaning of factors received. Then, all the responses were summarized and shared in an anonymous panel in a consolidated list of factors with their opinions. The consensus of the responses was developed according to input revised after the feedback provided by experts. The opinions were collected via controlled feedback. This was a moment for experts to make comments and input and validate a consolidated list of factors.

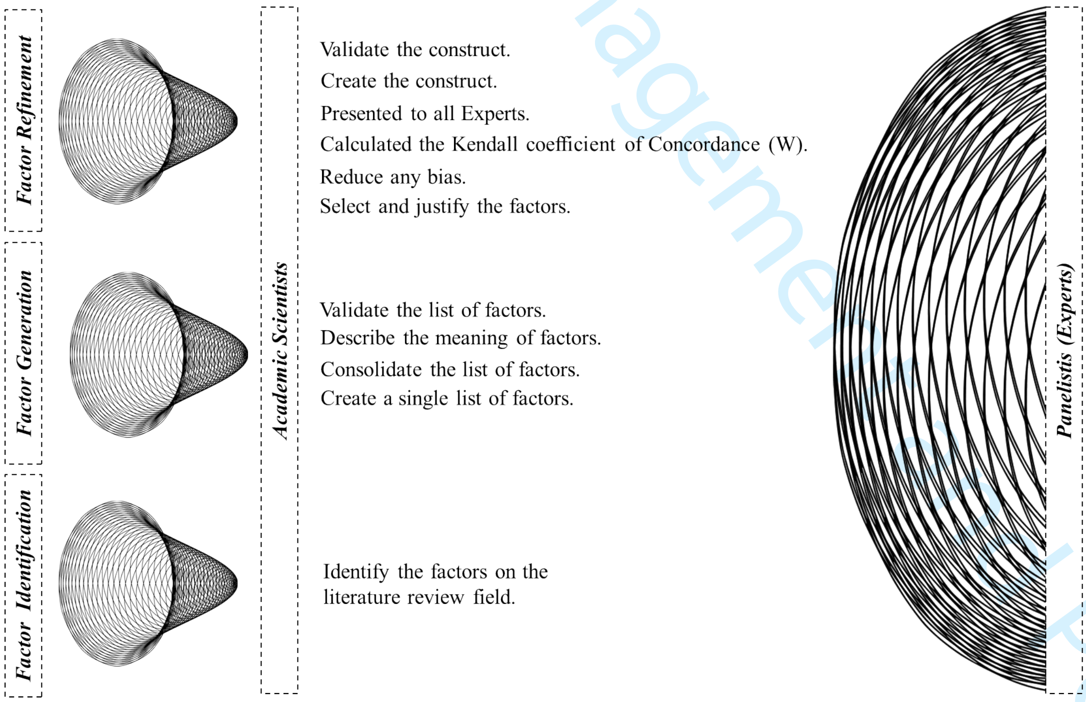
3) factor refinement: In round 3, we had the opportunity to submit the six dimensions associated with the factors to the panel of experts from Portugal in CISTI'2023—18th Iberian Conference on Information Systems and Technologies (Marine Ecosystem Services: Dimensions for Sustainable Decisions). The idea was to get feedback about the dimensions to answer the problem of the study. The results of this event promoted a second opportunity to share all the factors with experts from universities in Finland, France, Portugal, Spain, and Belgium (labs and research centers) at the IWS2023—11th International Week of Sustainability (Modeling a factor development process for sustainable decisions in a marine ecosystem services).

In round 4, after the two “conference” phases, the clear narrowing down instructions were provided to the same group of experts from the second phase (Appendix 2). We sent the consolidated list (online format) for rating (Gustafson, Shukla, Delbecq, and Walster, 1973): “Select the 10 items you feel are most important. Assign a value of 10 to the most important. Assign the value of 9 to the next most important, and so on, until the tenth item (the least important of the ten) is assigned a value of 1” (p. 98). After that, their input was consolidated into a single panel of ocean factors associated with the six dimensions.

To follow all the steps of the process, including moments for the experts to make comments, opportunities to justify the dimension, and clarifying the progress of the

Delphi method, we developed a controlled feedback process based on four steps and three phases, (Figure 3):

Figure 3: Control Feedback Process



4. Results

4.1 Factor Generation

A total of 252 studies was identified according to the keywords in the query process. After that, the abstracts and introduction were read individually by the researcher with a view to possible relevant contributions in terms of content. Irrelevant studies were eliminated in the cross-checking process (Czakon, Klimas and Mariani, 2020). With a literature review of the field of this study, a list of stakeholders was determined (Table II). The fifteen stakeholders identified are crucial for making well-informed, fair, and sustainable choices in terms of governance of ocean ecosystem services.

[Please insert Table II here]

The factors and descriptions followed the initial definitions of "governance": "The structures and processes by which people in societies make decisions and share power, creating the conditions for ordered rule and collective action, or institutions of social coordination," (Schultz *et al.*, 2015) and "adaptive governance": "Refers to flexible and learning-based collaborations and decision-making processes involving both state and nonstate actors, often at multiple levels, with the aim to adaptively negotiate and coordinate management of social–ecological systems and ecosystem services across landscapes and seascapes" (Pahl-Wostl *et al.*, 2007); (Chaffin, Gosnell and Cosens, 2014); (Folke *et al.*, 2005).

The six dimensions (governance, people, planet, profit, cultural and spatial) were associated with the factors for the reflective modeling process where the study constructs were created (van Bueren. *et al,* 2023). The list of factors and dimensions determined in (Table 3) help the governance of ocean ecosystem services to apply a specific model to analyze future decisions before moving forward with the implementation of a project.

[Please insert Table III here]

4.2 Factor Reduction

This stage gives experts an opportunity to think about which factors were most important for the field of the study. After this stage, we decided to eliminate redundancy to create a single list of factors. In the end, we had a list of factors which had been revised by all the experts. This phase employs a co-creation process to help identify the best factors to represent the framework proposed in the study (Table IV).

[Please insert Table IV here]

The list was used to support the discussions of the next step (factor refinement) in two international and scientific events.

4.3 Factor Refinement

The goal was to recognize relevant factors to the field of the modeling process proposed in this study and reduce the effect of noise in the communication process. During the process, the experts were totally free to add any factor that was not included on the list. After that the "factors refined by experts concluded" were identified and sent to the experts in random order to reduce any bias (Schmidt, 1997). At this moment, we checked if any experts would like to refine any factor developed/selected by another expert.

With the feedback provided by the experts, we calculated Kendall's W coefficient of concordance (Table V) and Kendall's tau coefficient of concordance (Table VI) for the panel to check if the expert evaluation had produced rankings which were independent of one another (Legendre, 2005). The Kendall's W coefficient of concordance and Kendall's tau coefficient are statistical tools used to analyze ranked data. While Kendall's W assesses agreement or concordance among multiple raters, Kendall's tau measures the association between two ranked variables. This is the null hypothesis of Kendall's test. The formula for Kendall's coefficient is:

τ = *(Number of concordant pairs - Number of discordant pairs) / (Total number of pairs)*

[Please insert Table V here]

The results demonstrate a strong correlation (0.784) between the forty-two factors (df), as indicated by the Kendall's W test applied to twenty experts (N) with a level of significance of < 0.001.

[Please insert Table VI here]

The results demonstrate a strong correlation (0.672) between the feedback of two experts (A and B) as indicated by Kendall's tau test applied to forty-two factors (N), with a level of significance of < 0.001.

Additionally, the reliability of internal consistency (Table VII) was evaluated by assessing measurements from a single test comprising multiple items that aimed to measure the constructs. It means that different items in the test are correlated and provide consistent measures between them.

[Please insert Table VII here]

Before moving to conclude the refinement process, we used the BOCR metrics (benefits, opportunities, costs, and risks) to create the artificial intelligence relationships with stakeholders (Saaty, 1996). The BOCR metrics and stakeholders are closely linked, as the interests and perspectives of stakeholders play a vital role in defining the assessment of the benefits, opportunities, costs and risks associated with a project or decision. Considering stakeholder input and concerns within the BOCR analysis is key to making informed and balanced decisions that align with the broader interests of all stakeholders involved.

[Please insert Table VIII here]

In addition, using the same model BOCR metrics (benefits, opportunities, costs, and risks), we created the relationship between dimension and stakeholders. The relationship between dimensions and stakeholders involves recognizing how different stakeholder groups are interconnected with various dimensions, assessing their impacts on those dimensions, and striving to strike a balance that aligns with the diverse interests and concerns of stakeholders across economic, social, environmental, legal, and ethical dimensions.

[Please insert Table IX here]

Finally, the relationships between BOCR, dimensions, factors and stakeholders were developed as the final (Table X). The relationship between BOCR, dimensions, factors, and stakeholders are integral to comprehensive decision-making. Stakeholder interests and concerns are closely tied to how benefits, opportunities, costs, and risks are assessed across different dimensions and factors, and effective decision-making strives to address these interrelated aspects in a balanced manner.

[Please insert Table X here]

5 Discussion and Implications

5.1 Discussion

In this study, we worked on a process for support decisions in a Coastal Biodiversity and discuss the directions for decision-makers to apply in ocean ecosystem services. After the development of theoretical approaches to understand their prospects for the future development of ecosystem services, we worked on a factors for sustainable decision-making framework. This set of factors developed for adaptive governance decision-making can be applied to develop a prior alignment of stakeholder interests with sustainable practices. Sustainable development practices play a crucial role in improving and preserving ecosystem services, promoting responsible resource management, biodiversity conservation and climate resilience.

To have the initial theorical approach, we identified several frameworks proposed to manage and make decisions in different contexts of governance of ecosystem services (Kofinas, 2009). During the theoretical approach, we realized that the literature focusing on ecosystem services is limited in general governance with socio-ecological approaches (Winkler *et al.*, 2021). We also realized that adaptive governance systems often selforganize as social networks with teams and groups of actors who draw on various knowledge systems and experiences to develop a common understanding and policies. (Folke *et al.*, 2005).

In general terms, we described that the best scientific interfaces for European biodiversity policy present an approach to improve the interface between knowledge-holding communities and the decision-making process on ecosystem services in the context of the European Union. (Görg *et al.*, 2016). In addition, to support governance decisions on ecosystem services, specific initiatives have been developed to synthesise blocks of critical indicators of an individual or community's capacity to build and maintain resilience (Silva, Pennino and Lopes, 2020).

The studies carried out and mentioned allow us to address the results of the research question in the discussion. Based on adaptive governance theorical approach, in the context of RQ, our study developed a set of factors to support sustainable decision-making in ocean ecosystem services.

In detail, the results suggest that set of factors developed with the intervention of experts reinforces the importance of sustainable collective decisions on ocean ecosystem services. This is a joint approach with participants in the NextOcean project, sponsored by the EC's Horizon 2020 program. An Earth Observation-based Consortia aim to create sustainable value for Space, Land, and Oceans.

Our research methodology was shaped by insights from a panel of 20 experts deeply involved in the NextOcean project funded by Horizon 2020. In pursuit of our research goals, we adhered to a systematic three-step process. Initially, we conducted an exhaustive literature review to identify pertinent factors. Subsequently, we solicited expert judgments grounded in these factors, and finally, we employed statistical parameters to efficiently consolidate the expert viewpoints.

Drawing on insights from the literature review, we identified and organized six key dimensions to underpin the factors essential for our study. These dimensions encompassed governance (direction), people (stakeholders), planet (environment), profit (value added), cultural (value), and spatial (geographic) considerations. Subsequently, we applied the Delphi method to validate the factors identified in the literature, specifically focusing on their relevance in the context of decision-making for ocean ecosystem services. Notably, our Delphi approach encompassed two distinct variations: the policy Delphi, akin to a lobbyists' perspective, and the decision Delphi, tailored for decision-makers, following the framework proposed by (Paré *et al.*, 2013). Our expert panel participated in a multi-round process consisting of three phases: 1) factor identification; 2) factor generation; and 3) factor refinement, all aimed at addressing the central research question on the role of adaptive governance in promoting sustainable decisions within marine ecosystem services.

Sustainable development and its positive impact on ecosystem services is realized by implementing sustainable adaptive governance practices. This governance collaborates with the oceans to manage the provision of a wide range of ecosystem services, including food provision, climate regulation and support for biodiversity. Sustainable management ensures the responsible use of marine resources, while maintaining the health and resilience of ocean ecosystems, supported by governance policies.

Finally, this study was conducted in the context of the NextOcean project, an initiative funded by the European Union under Horizon 2020 in the field of sustainable decision.

5.2 Ocean Ecosystem Services Implication

5.2.1 Governance

Successful adaptation involves a multifaceted approach to navigating the intricate processes of change through various institutions, considering their broadest implications. At the core of this endeavor is the governance of adaptation and a deep concern with ensuring equity in the outcomes of environmental decision-making. The governance model thrives on a comprehensive understanding fostered by open, shared information sources that bridge gaps and facilitate seamless integration. It also embraces cross-sectoral analysis, adept at identifying emergent challenges and seamlessly integrating policy implementation.

5.2.2 People

Within the organization, people take a holistic approach to promoting social transformation. This approach revolves around individual leadership and the promotion of meaningful dialogues with stakeholders, both of which are fundamental to the mission. To enhance collective efforts, they use a versatile set of collaborative tools and create spaces that consider the diverse skills and competencies of the target audiences. Successful transformation requires removing any barriers that impede co-creation processes.

5.2.3 Planet

In the context of coastal communities, it is crucial to understand the complex dynamics of development, climate change and their interlinked effects on fish stocks. We need to consider the measurable and perceptible impacts of development on subsistence fish harvests. Furthermore, it is crucial to recognize that fishermen exhibit a remarkable degree of flexibility when faced with changes in their communities or new regulations governing resource use and access. However, the impending specter of climate change introduces a new layer of uncertainty, with predictable and unpredictable impacts that are expected to have repercussions on marine systems, directly influencing various fish species. Consequently, the implications of these changes on the coastal ecosystem, particularly on the well-being of fish species, are becoming increasingly significant and deserve careful consideration in our efforts to ensure sustainable coastal livelihoods.

5.2.4 Profit

To foster sustainable development in a community, a multifaceted approach is essential. Financial resources play a pivotal role in this process and diversifying them through a comprehensive array of both private and public financial instruments is key. This diversification not only enhances financial stability but also provides a broader foundation for growth. Improved infrastructure is another critical factor as it leads to higher flexibility and encourages continuous learning, thereby generating a myriad of economic alternatives for the community. However, it is equally important to introduce measures aimed at mitigating problems associated with resource scarcity. Ensuring that the necessary human, financial, and technological resources are readily available at the municipal level is fundamental to supporting effective governance. This holistic approach, involving financial diversification, infrastructure enhancement, and resource management, lays the groundwork for a resilient and prosperous community.

5.2.5 Cultural

Fostering innovation and experimentation within the public sector is pivotal for progress. To achieve this, it is essential to cultivate a culture of open innovation that encourages creative thinking and risk-taking. One way to make the decision-making process more transparent is by utilizing reports that shed light on the rationale behind choices. Furthermore, the development of standards and technical regulations for ecosystem services ensures clarity and consistency in governance efforts. Effective knowledge-sharing networks, both local and supralocal, play a vital role in acquiring and disseminating valuable lessons in governance. In managing innovation partnerships, replacing bureaucratic controls with trust-based mechanisms can catalyze collaboration and innovation.

5.2.6 Spatial

In the realm of urban planning and resource management, a holistic approach is essential to address the diverse needs and competences of various target audiences. Identifying these needs requires careful consideration of skillsets and competences, ensuring that spaces are tailored to meet the specific requirements of different communities. Moreover, it is crucial to engage in inclusive discussions with different neighborhoods to assess the potential impact of decisions. This collaborative approach not only prevents fragmentation of local policies governing ecosystem services but also promotes unity among diverse groups sharing specific spaces. To facilitate such decisions, key capabilities related to geographic analysis play a pivotal role. By developing standards and technical regulations for ocean ecosystem services data collection, valuable information about spatial locations can be shared, fostering informed, equitable, and sustainable decision-making processes. Ultimately, this approach encourages analyses that focus on the intrinsic role of area, place, and location, enabling communities to thrive harmoniously within their shared environments.

6. Limitation and Future Studies

Considering the limitations, future studies could use another database to widen the view in terms of the studies, factors, dimensions, and other additional information to maintain the evolution of this process in ocean ecosystem services decision-making. Another limitation arose in the number of projects and experts defining the factors. This may prevent the opportunity to have more impact in terms of future decisions if more sources are used in the market. In addition, time and the access to experts during this modeling process demonstrates a limitation, as does the time for feedback.

We envision that future studies will build upon the knowledge and understanding generated in this research, utilizing our constructs (dimensions and factors) as valuable tools for assessing risks and engaging stakeholders in decision-making processes. Our hope is that this work will inform and guide key decision-makers in their efforts to address critical challenges in the realm of ocean ecosystem services.

Finally, future studies should count on more experts and encompass different projects in various fields of ecosystem services and compare the results in terms of previous and future decisions.

7. Conclusion

The primary aim of this study was to develop a factor modeling process for decision-making within the domain of coastal biodiversity. We employed an interpretive structural modeling approach, integrating Delphi to incorporate both qualitative and quantitative data feedback while minimizing potential biases in the analysis. Additionally, our modeling process facilitated the synthesis of BOCR metrics (benefits, opportunities, costs, and risks) to establish connections with stakeholders (Saaty, 1996). Furthermore, using the same BOCR framework, we established associations between dimensions and stakeholders. These intricate relationships linking BOCR, dimensions, factors, and stakeholders were crafted to bring new value to the research.

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[Please insert Appendix I here]

[Please insert Appendix II here]

AUTHORS' CORRECTIONS AND IMPROVEMENTS

(Based on the comments from the Editor-in-Chief)

PAPER TITLE:

Modeling a factor development process to create sustainable value for decisions on ocean ecosystem services

Dear Guest Editor
Luis F. Martinez, Ph.D
Sustainability Accounting, Management and Policy Journal
Special Issue on "Sustainability, innovation, value creation, and decision making"

Thank you for the opportunity to submit a revised version of our paper to *Sustainability Accounting, Management and Policy Journal.*

Below, we outline the modifications made to the manuscript in response to the suggestions provided by the Editor-in-Chief.

We believe that we have successfully addressed the comments from the Editor-in-Chief and hope that the revised version of the paper meets the expectations. If more revisions are considered necessary, please do not hesitate to contact us.

Yours sincerely,

The authors

Comments to the Editor-in-Chief: 1) Either a reference to 'Study A' needs to be added in the reference list (as a working paper if it is not yet published) and the text in the paper changed to that reference (rather than it being referred to as Study A) or the reference to Study A in the text needs to be removed al together.
Authors: *We corrected the text in **1.Introduction:*** This study was supported by the document (Study A) “Perspectives for future development of ecosystem services: contributions to regional applications and nurturing sustainable advances for global citizens” (Figueiredo and Cabral, 2023). *We added the reference in the **reference list**. Thanks.* Figueiredo, R. and Cabral, P. (2023). Perspectives for future development of ecosystem services: contributions to regional applications and nurturing sustainable advances for global citizens. *Manuscript submitted for publication.*

Comments to the Editor-in-Chief: 2) Clarifying the link to the journal scope (particularly how paper link to sustainable development).
Authors: *We've presented our clarification. We included on the **1. Introduction**. Thank you very much.* This study brings together a range of disciplinary approaches to contribute to socio-economic development and ecosystem services, especially ocean ecosystem services. Through the proposed model, it seeks to contribute to the balance between research and the development of practical and political solutions for the improvement of civil society and the organisations that impact it. It allows management, carried out through adaptive governance, to improve the supply of natural resources and ecosystem services needed by all human beings. One of the SDG's specific objectives is to consider sustainable adaptive governance decisions to maintain and restore water-related ecosystem services. It seeks to create value from ocean ecosystems in planning, processes and organisational strategies to improve quality of life.