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Recycling data for Marine Spatial Planning: A review of maritime plans in Europe

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Abstract

The ecosystem-based approach to marine spatial planning (MSP) is attracting increasing attention due to the requirements of Directive 2014/89/EU. To date, research on the ecosystem-based approach has focused mainly on the methods used to set up studies to assess the impact of human marine activities on ecosystems. This article presents a review of European marine plans, focusing in particular on the data and maps used to translate MSP. This study should contribute to our understanding of the notion of entanglement in planning. We draw on critical data studies, and in particular on the theory of intra-action and the concept of information in-formation, to understand the biases of data and maps. We used a method based on a content analysis to study maritime plans in Europe with regard to four main indicators enabling us to evaluate data and map uses in MSPs in relation to the ecosystem-based approach. Overall, our results suggest that the ecosystem approach is poorly transcribed on maps due to a lack of suitable data sets, geotechnological constraints, or political decisions. In particular, we observe a recycling of data for planning purposes. Our research has highlighted the importance of studying the entire data lifecycle, from production to display, in order to have a holistic vision of MSP.

Keywords

Data; Marine Spatial Planning; Maps; Ecosystem-based approach

1 INTRODUCTION

The management of marine areas is increasingly reliant on environmental data, but environmental activists have recently observed that data is being withheld by some governments1, which hampers evidence-based decision-making for the conservation of marine ecosystems. Despite European

1 https://bloomassociation.org/un-ete-meurtrier

directives like 2008/56/EC2, establishing a strategic framework for the sea, and 2014/89/EU3, for marine spatial planning (MSP), which demonstrate the importance that governments place on the protection and sustainability of the marine ecosystem (Guinan et al., 2021), there remain gaps in the availability and accessibility of data. Initiatives such as the European Marine Observation and Data Network (EMODnet) and European Ocean Observing System (EuroGOOS) aim to improve data access and sharing, but issues are still present in terms of data coverage, quality and harmonisation (Martín Míguez et al., 2019).

Unfortunately, tools like EMODnet, which focus on spatial data, often overlook non-spatial data, meaning the information required for marine planning is often incomplete (Holzhüter et al., 2019). The MSP process requires 'reliable', 'evidence based' data, i.e. the 'best available data' (Directive 2014/89/EU), since it is, in theory, an evidence-based process (MSP Data Study, 2016). However, the inconsistency of ecological indicators between EU member states and the absence of cross-border harmonisation hinder effective implementation of MSP (Stamoulis & Delevaux, 2015). It is essential that these problems are addressed by analysing the data used in existing European marine plans, to allow evidence-based policies to be implemented for sustainable marine management.

This study focuses on the data used in MSP, as examined through planning documents. The data lifecycle is traced by studying the maps, sources and proposed analyses in the plans. For this article, the term 'lifecycle' refers to the genealogy of data, from production to representation on maps. Since datafication is now a widespread phenomenon, the quality and amount of data at each phase of the MSP process must be questioned (Holzhüter et al., 2019), to understand the knowledge produced by MSP data (who produces it, how it is produced and for what purpose) while analysing the power dynamics that influence planning. The hypothesis is that if the complex interaction between human activities and the marine environment cannot be captured by studying the data, it may not meet the environmental protection goals set by the European directive. However, if data is only used later in the planning process, it may merely serve to justify political decisions (Batty, 2022).

The study contributes to the critical literature on MSP by addressing the quality and relevance of the data used. It questions whether the data effectively represents the multidimensional relationships in marine environments and discusses unfixed spatial boundaries. This article is divided into five sections. Section 2 addresses gaps in the literature. Section 3 describes the methodology and offers a justification of the focus on European planning documents to carry out a comparative study based on the common requirements set out in Directive 2014/89/EU. An explanation is also given for the focus on environmental data in this paper rather than any other data available for MSPs. Section 4 details the results. Section 5 discusses the entanglement of digital and data governance in marine planning, and section 6 is the conclusion.

2 USE OF DATA IN MARINE SPATIAL PLANNING: QUANTIFYING MARINE ISSSUES WITH DATA

2.1 Data integration and quality issues in MSP

Data harmonisation has been the focus of many recent studies and is often discussed in scientific publications as being an urgent necessity to fulfil MSP objectives (Ehler, 2008; Hattam et al., 2015; Holzhüter et al., 2019; MSP Data Study, 2016; Stamoulis & Delevaux, 2015). Strain et al. (2006) suggested that spatial information plays a significant role in decision-making since it provides the geographical context for plans. Results reported by Holzhüter et al. (2019) and Schaefer & Barale

2 Directive establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)., 2008/56/EC (2008). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32008L0056

3 Directive establishing a framework for maritime spatial planning (MSP Directive)., no 2014/89/EU (2014). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0089

(2011) suggest that the temporal dimension is also important for managing human activities at sea, since both the ecosystem and human activities are subject to seasonal shifts and adjustments are therefore required to ensure compatibility. The three-dimensional aspect of marine space must also be taken into account, which further complicates the management of marine space and reinforces the importance of geographical information. It is also essential to consider the temporal dimension of activities at sea. In a 2014 paper, Shucksmith and Kelly reported on the limited implementation of spatial and temporal aspects of the dataset used for MSP. In spite of these findings, the inclusion of spatial and temporal aspects in datasets remains limited in practice. Various studies have examined the data used in MSP and revealed significant gaps and disparities in the processing of data for planning purposes between countries (e.g. Shepperson et al., 2018; Trouillet, 2019, 2020). These studies reveal the growing importance of data in planning and reinforce the need to improve our understanding of how data is produced and used.

The number of multinational projects involving MSP data studies has increased over the last five years, but few researchers have addressed the issue of the quality of the data used. UNESCO recently compiled a report of the marine environment in the Mediterranean based on a survey of the stakeholders involved, which highlights gaps in the data relating to various activities and spatial representations (UNESCO-IOC, 2021). The eMSP-NBSR project has also conducted a survey on the use of data and information to better understand the consistency and limitations of the data used in MSP for the Baltic Sea and Northern European countries, and discuss improvements to it (Lequesne and Souf, 2023). This survey reinforces the importance of data in planning. Both the UNESCO survey and the eMSP-NBSR project demonstrate that there are major disparities between countries in the way data is handled for planning purposes.

These studies on the data used for planning purposes are valuable as a snapshot of how data is used, but do not provide an understanding of the power-knowledge relationships at work in the data production, and should therefore be extended. For instance, Batty (2022) reveals that (urban) planning is based only on downstream data processes and not upstream ones, and encourages a change in this practice to fulfil planning requirements, which would suggest the need for a similar, more thorough investigation of this aspect as it relates to marine planning. Critical data studies have also shown that data processing is never neutral but influenced by multiple choices from data collection to dissemination (Dalton & Thatcher, 2014; Kitchin, 2021). In terms of MSP, some of the critical data studies on which it is based focus on a single activity, indicating the influence of knowledge production and a ‘missing layer’ (i.e. a lack of data for certain marine activities which are therefore not taken into account when planning) (St. Martin & Hall-Arber, 2008). The absence of information relating to various specific activities is well documented in the literature (e.g. fishing, as studied by Leroy, 2018 and Trouillet, 2019). Some studies of data used in MSP have focused on environmental data (McGowan et al., 2013; Ryan et al., 2018; Weatherdon et al., 2015), questioning its quality and usage. Environmental data is of particular interest in terms of MSP goals, as it must enable ‘ecosystem and biodiversity conservation’ (paragraph 1, Directive 2014/89/EU) and ensure that “the collective pressure of all activities is kept within levels compatible with the achievement of good environmental status, and that the capacity of marine ecosystems to respond to human-induced changes is not compromised, while contributing to the sustainable use of marine goods and services by present and future generations” (paragraph 14, Directive 2014/89/EU). Data quality issues should be addressed by documenting the internal and external quality of data (Devilliers & Jeansoulin, 2006), which has so far eluded analyses of environmental data in planning. The ‘internal’ quality of data refers to its properties and characteristics, measured by the difference between the data that should be produced and the data that is actually produced. The ‘external’ quality is the alignment of data with usage needs, measured by the difference between the necessary or ideal data, and the data that is actually produced. In addition to data quality, other studies have looked at the production of data more suited to the challenges faced by MSP and at data harmonisation (Dosell et al., 2021; Guinan et al., 2021; Holzhüter et al., 2019), but again, only

limited examples are given, and these do not cover the whole range of issues potentially linked to data production for planning purposes.

2.2 Intra-action as the foundation for ecosystem interconnection

Academic research has focused on the 'ecosystem-based' approach promoted by the MSP directive (e.g. Domínguez-Tejo et al., 2016; Douvere, 2008; Douvere & Ehler, 2009; Gilliland & Laffoley, 2008), which in theory fulfils the need for a balanced approach between environmental conservation and the development of offshore activities. In practice, Domínguez-Tejo et al. (2016) point out in a comparative study that the relevant aspects are rarely considered in an ecosystem-based approach, in particular the assessment of human activity pressures, but also social values and non-market activities. Schwartz-Belkin and Portman (2023) provide a literature review specific to the ecosystem-based management approach and the challenges posed by limitations of the data available. The authors identify geospatial technologies that can help navigate the challenges of MSP. The research for the present study extends to the environmental data used in MSP, through the concept of an ecosystem. We do this by exploring the theoretical framework of intra-action, as articulated by Barad (2007). This framework provides new insights to understand the term 'ecosystem' as the construction of environmental data layers and the dynamic relationships between human and non-human actors. Intra-action, as a concept, moves beyond the traditional view of interaction, where entities are assumed to pre-exist in their relationships. Instead, intra-action posits that entities emerge through specific engagements or 'intra-actions' – relations that enact their properties and boundaries.

Barad's theory, grounded in quantum physics and philosophical inquiry, challenges the notion of independent relata (objects, entities or agents) that come into interaction. Instead, Barad argues that entities take on their properties through specific intra-actions. For example, in quantum experiments, particles like electrons do not pre-exist as entities with definite properties such as position or momentum. These properties emerge through measurement, with some attributes (e.g. position) becoming determinate while others (e.g. momentum) being excluded. This principle, known as complementarity, illustrates that properties are not intrinsic to particles but are enacted through their entanglements within experimental setups (Hollin et al., 2017). As Barad states, "Relata do not preexist relations; rather, relata-within-phenomena emerge through specific intra-actions." (Barad, 2007, p. 140). Applied to ecosystems, this principle suggests that the elements of an ecosystem (species, habitats, human activities, technologies, etc.) do not exist as static, isolated entities, but emerge through their dynamic relationships. This has profound implications for how we understand and manage marine systems under the MSP framework. Intra-action offers a theoretical lens to deepen our understanding of an ecosystem-based approach by emphasising the co-constitution of human and non-human actors. For instance, marine planning traditionally addresses human-environment interactions, such as the impact of fishing or offshore energy infrastructure on marine ecosystems. In contrast, intra-action highlights how these relationships actively shape the entities involved. A fishing vessel, for example, is not merely an external actor imposing pressure on fish populations. Instead, its practices, technologies, and impacts are co-constituted through its entanglement with the marine environment, regulatory frameworks, and societal needs.

In MSP, the aim of the ecosystem-based approach is to handle the various uses of marine space (fishing, energy, conservation, transport, etc.) in an integrated manner, while considering the underlying ecological interactions (e.g. the trophic relationships between species, ocean current movements and biogeochemical cycles). Intra-action complements this by adding a deeper theoretical dimension, emphasising that these elements and interactions are not pre-given, but are dynamically constituted through their relationships. Kaufmann and Leese (2021) introduce the concept of 'information in-formation' to describe how environmental data emerges from the entanglements of human and non-human activities. This aligns with Barad's agential realism, which insists that scientific practices, such as data collection and interpretation, actively participate in creating the phenomena they describe. Applying intra-action to marine planning enables a shift

beyond the traditional conceptions of human-environment interaction and recognises how relationships between humans, nature and technology are intertwined (Lehman, 2016).

Intra-action and the ecosystem-based approach converge in their recognition of the dynamic, interdependent relationships within marine systems. While the ecosystem-based approach emphasises interconnection, intra-action underscores the co-constitution and continuous flux of these relationships. This understanding enhances our ability to navigate with complexities of MSP, providing a robust framework for integrating human and ecological dimensions in a more holistic and adaptative manner. When applied to European MSP, it provides a basis of common environmental requirements for conducting a comparative study.

3 MATERIALS AND METHODS

The method used for this research is a content analysis of the maritime plans in Europe. A comparative analysis of all the plans falling within the scope of Directive 2014/89/EU for the first MSP cycle was carried out. This method should be considered in the light of the theoretical framework developed - the intra-action approach - to understand how data is produced in the ecosystem-based system promoted by the European directive.

3.1 Indicators

Barad's theory (2007) was applied to establish whether the data used is in line with the ecosystem-based approach required by the MSP directive. In accordance with the findings of Barad (2007) and Kaufmann and Leese (2021), it was considered essential to carefully analyse the specifics of the relationships between data and its lifecycle, and to employ the concept of 'information in-information' (Kaufmann and Leese, 2021), to describe the entanglement of data in planning. Information in-formation refers to a continuous process of formation and transformation of structures, whether biological, social or technological. Unlike a static conception of information where it is perceived as a fixed set of data, the concept of 'in-formation' creates a dynamic that shapes and restructures systems. By applying the concept of 'in-formation' to the MSP context, a holistic view of the processes that shape interactions between marine environments and human activities can be created to better understand how these systems are structured and adapt in space and time. This approach enables us to grasp the complexity of ecological dynamics and their relationships with social and economic dynamics. By exploring what it means to form information in the context of developing a policy for managing marine space, from an ecosystem-based perspective in particular, it should be possible to show how the interactions between data and humans generate knowledge and action.

The ecosystem-based approach involves integrated management of the ecosystems, including all their ecological components and interactions with human activities, while respecting the ecological limits of the system. One key aspect of the ecosystem-based approach in Europe is the integration of ecosystem services, i.e. the benefits that humans derive from ecosystems (resources such as fisheries, the regulation of ecological processes, support for basic ecological functions, the cultural and aesthetic value of ecosystems, etc.). In the context of MSP, the assessment and mapping of these services enables us to understand and visualise how marine ecosystems support critical socio-economic functions. Directive 2014/89/EU promotes an integrated cross-sectoral, cross-border approach. The use of an ecosystem-based approach (paragraph 14) is intended to help promote the sustainable development and growth of marine and coastal economies and the sustainable use of marine and coastal resources. The MSP directive also mentions (paragraph 13) the pressures on ecosystems and resources resulting from human activities, climate change and natural risks. It encourages consideration of land-sea interactions and human and non-human interactions (paragraph 16). The MSP should also take into account the temporal aspect of activities and, in particular, any possible long-term variations (paragraph 19). To this end, the governments responsible for implementing MSP must base their plans on 'reliable data […] [and] use of the best available data and information by encouraging relevant stakeholders to share information and [use]

existing instruments and tools for data collection' (paragraph 24). The approach used in this study is based primarily on three key aspects: (1) knowledge of ecosystems and the variations they may undergo; (2) the superposition of data to assess interactions; (3) the use of impact indicators derived from this data. These three data evaluation points enable documentation of the interactions between natural environments and between human and non-human aspects of marine space. Analysing the diversity of available data should enable us to assess the potential differences that exist in data production. However, there are significant challenges involved in representing marine ecosystems in map form. While mapping species and habitats is a relatively well-established practice, mapping ecosystems as a whole is more complex, because it involves not just the biological composition of an area but also the interactions between different biotic and abiotic components and their spatial-temporal dynamics. This process is subjective because ecosystems are not static entities, they are in perpetual reconfiguration, which makes cartographic representation less straightforward.

Documenting ecosystems and the parameters that influence them reveals the 'information in-formation' where certain information, taken independently, would be interpreted differently. The impact indicator approach facilitates the documentation of data entanglement as it is produced by combining different types of data to assess the overall position. The study of data production based on environmental data is of particular interest since this aspect of offshore planning is indicated in the text of the MSP directive. The method has been used previously in comparative studies in Europe and beyond (e.g. Trouillet, 2020). Based on this premise, three questions were determined with reference to the ecosystem-based approach as framed by MSP framework:

- Question 1 (Q1): What types of data are available to map ecosystems?
- Question 2 (Q2): Is there any data available on map entanglements (or intra-action)?
- Question 3 (Q3): Can the data produced support a multidimensional approach?

By studying this in terms of the information available on European marine plans and documenting how the data is used, documentation maps in particular, and by looking specifically at the data used - which must facilitate fulfilment of the directive's objectives - the aim is to understand which human or technical factors influence MSP. The three questions developed by analysing the corpus were broken down into a number of indicators (Table 1):

Question	Coding	Label	Comment	Indicator	Value	Explanation
Q1	I1	Ecosystem representation	Factual assessment of whether data is available to represent ecosystems	Are ecosystem areas documented?		
				Yes	2	The entire marine zone is documented
				Partially	1	Only certain areas are mentioned. Mostly, the plan consists of zoning, and some parts of the maritime area have no assigned zoning.
				No	0	No mention of ecosystems

Q2	I2	Data overlay	Creation of new information ('information in-formation')	Is there any data overlay?		
				Yes, resulting in a new layer of information	2	Information is generated and displayed from data overlay. On the maps, a reference to the overlapping of two layers of data clearly appears as the result of a new layer of information on the maritime space.
				Yes, but it does not result in a new layer of information	1	Information from the overlay data is not mentioned. On the maps, the overlapping of various data can be seen but this does not result in a new interpretation or analysis of the maritime space. E.g. overlapping zoning on a map.
				No	0	No overlaying information. The maps do not overlay information; each layer is analysed independently of the others.
	I3	Indicator resulting from the combination of several data items	Highlighting the co-construction relationships (intra-action)	Are there any indicators of impact on the marine area?		
				Yes	2	An impact assessment is carried out for all activities presented in the document. This does not guarantee that it is complete, but it does include all the activities presented in the document.
				Partially	1	Impact indicator not established for all activities. Only some of the activities are taken into account in the impact assessment.
				No	0	There is no indication of impact assessment on the marine area
Q3	I4	Potential conflicts documented	Multidimensional approach to offshore activities	Is a multidimensional approach to marine space documented ?		

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				Yes	2	The multidimensional approach concerns the entire marine area
				Partially	1	The multidimensional approach concerns only part of the marine area or some of the marine activities
				No	0	There is no multidimensional approach documented in the document

TABLE 1 – Indicators applied to European MSP initiatives

The four indicators were applied to the corpus by analysing the maps of the marine plans. This approach aimed to document the answers to the three main questions as factually as possible and to draw general conclusions. While this method evaluated the data used for MSP, it does not assess the effectiveness of the various approaches. For instance, it does not question whether the entire area is documented, albeit with average-quality data, nor whether only a portion is documented but with high-quality data. The objective is broader: to understand how ecosystems are characterised within the MSP process.

3.2 Corpus

Since the intention was to compare different marine plans, only plans drawn up in response to the MSP directive were considered. A corpus of marine plans based on the scope of this framework was created in 2021 for this study. Plans were selected on the basis of the census carried out by the European Commission within the framework of the European MSP Platform[4], an information and communication website designed to offer support to all EU member states in their implementation of MSP, which existed prior to 2022 (details in Annex 1). The MSP directive required all EU coastal member states to draw up an intersectoral plan for their marine areas by 2021. The main advantage of this method is that the MSP directive calls for a certain homogenisation of plans with a view to meeting the requirements at least, which for the purposes of this study enabled the application of an analysis grid that should be compatible with the various plans. Conversely, the main limitation is that the plans cannot summarise all the documents produced as part of the planning exercise. Some elements may therefore have been overlooked in the present analysis.

The inclusion of the United Kingdom on the European MSP Platform and in this corpus is worth mentioning here, despite its withdrawal from the EU. The development plans for the UK's seaboards formerly fell under the purview of the MSP directive. Norway, on the other hand, is not a member of the EU and is not obligated to comply with the aforementioned directive. Nevertheless it complies with approximately 95% of EU directives through other European environmental policies, which raises pertinent questions as to why it is excluded from the corpus. To maintain coherence, the corpus is aligned with the European MSP Platform in its pre-2022 form, choosing to exclude Norway but include the United Kingdom in the analytical framework.

The corpus was made up of the most tangible elements of planning documentation, maps in particular, to identify the data used. In observing the planning documents, the maps contained in them were analysed with the aim of tracing them back to the data. Consequently, the corpus is made up of 38 planning documents from 23 countries (finalised or under development). Each country is responsible for developing its own marine plan; translating the marine plans drafted in different European languages was a laborious task, especially those containing graphic materials such as maps, where contextual understanding is crucial. Although it was theoretically possible to attempt

4 https://maritime-spatial-planning.test.ec.europa.eu/

translation, the results were often too imprecise to be reliable, particularly in the case of automated translation, as many of the documents were neither in French nor in English. This applied to 19 plans from 12 countries, making their content difficult to interpret accurately. Consequently, the analysis grid has been used with 19 marine plans from the 11 countries that were intelligible to us.

4 RESULTS

This study is an in-depth examination of the operational component of MSP at a significant juncture, but is not intended to be exhaustive. From the vast amount of documentation compiled, we have opted to provide a synthesis of the results in this section and include detailed listings in the annexes. The outline results of the analysis of 19 marine planning documents appear below (Table 2 and Annex 2). These results focus solely on trends and overall proportions rather than a thorough statistical analysis, which would lack significance due to the limited number of MSPs involved:

- Indicator I1: Marine ecosystems are documented for the entire planning area for 8 of the 19 MSP initiatives and are partially documented in 11 MSP initiatives in the maps published, notably the ones corresponding to protection zones.

For clarity, the result is illustrated with examples. All the plans and maps mentioned in the results section are detailed in Annexes 1 and 2. A comparison of the marine ecosystem mapping data for Ireland and the Netherlands revealed significant disparities. Ireland benefits from the support of exhaustive coverage of its exclusive economic zone, as illustrated on the associated geoportal (https://atlas.marine.ie) used to produce the maps. The online atlas also revealed the diversity and richness of the available datasets, ranging from biodiversity to climate change and environmental monitoring. In the Netherlands, on the other hand, only areas of ecological interest were mapped in the environmental part of the MSP, Natura 2000 in particular (Fig.1). Closer observation reveals that this data was not specifically produced for planning purposes but taken from other management projects.

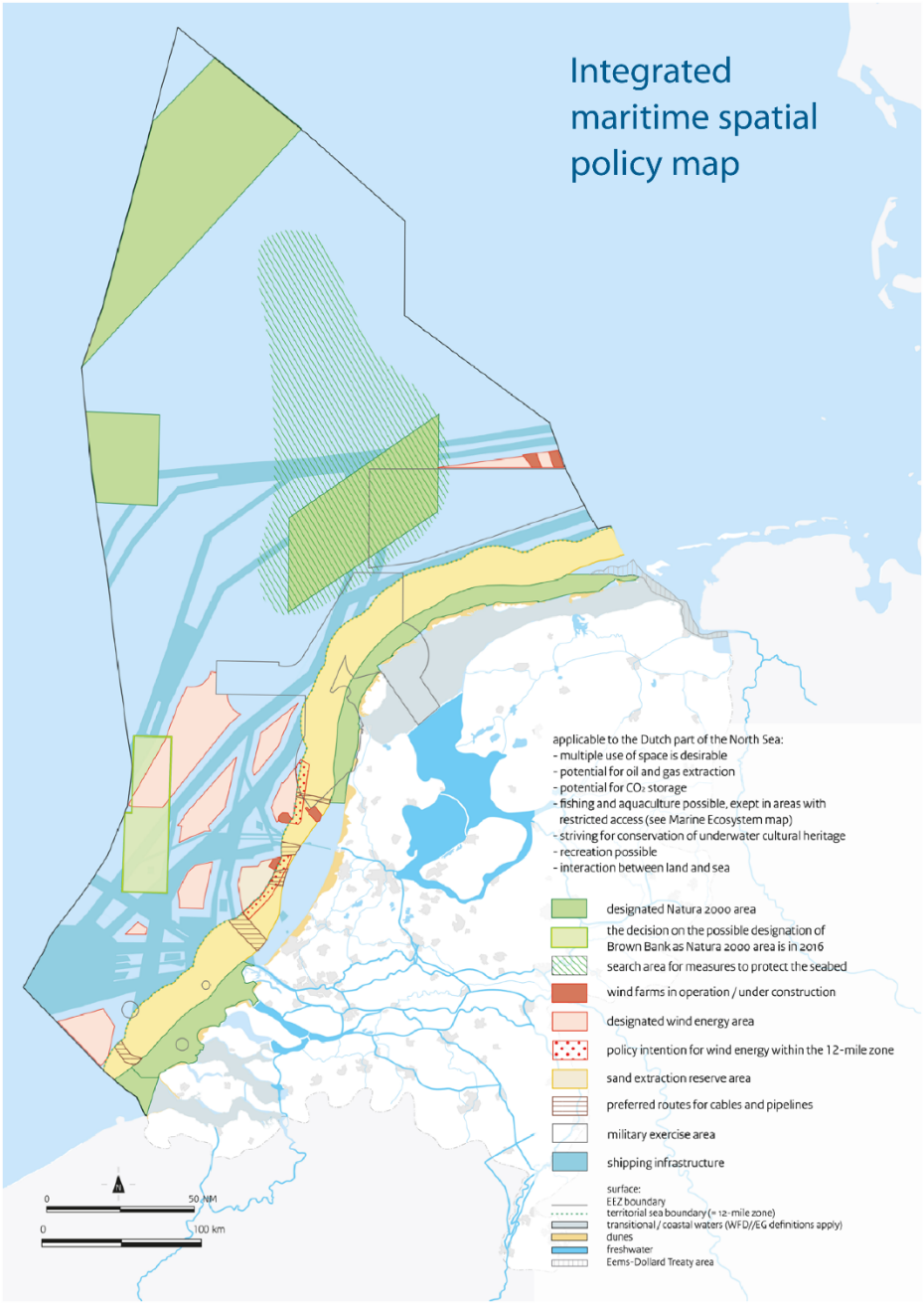

FIGURE 1 – Netherlands' integrated maritime spatial policy map

Looking closely at the data sources, it is clear for both Ireland and the Netherlands that the data comes from various government bodies, not necessarily produced for planning purposes and often taken from other projects and recycled for MSP purposes. It is also important to note that access to metadata, which is essential for understanding how data is produced, is often hindered by a lack of translation or an uneven multilingual implementation, limiting its usability for the authors of this paper. This situation was particularly challenging for understanding the choices and processes involved in the production and representation of data.

- Indicator I2: in 9 of the 19 MSP initiatives, the plans use a combination of data related to ecosystems and human activities to generate new information as the basis for an ecosystem-based approach. In 10 MSP initiatives, the use of data related to ecosystems and human activities only resulted in a graphical overlay of information and did not generate any new information.

Taking Bulgaria as an example to explain this result, the data made available to document ecosystems was treated as zoning. The map in the MSP document shows an overlay of certain zonings but does not result in any new information (Fig. 2).

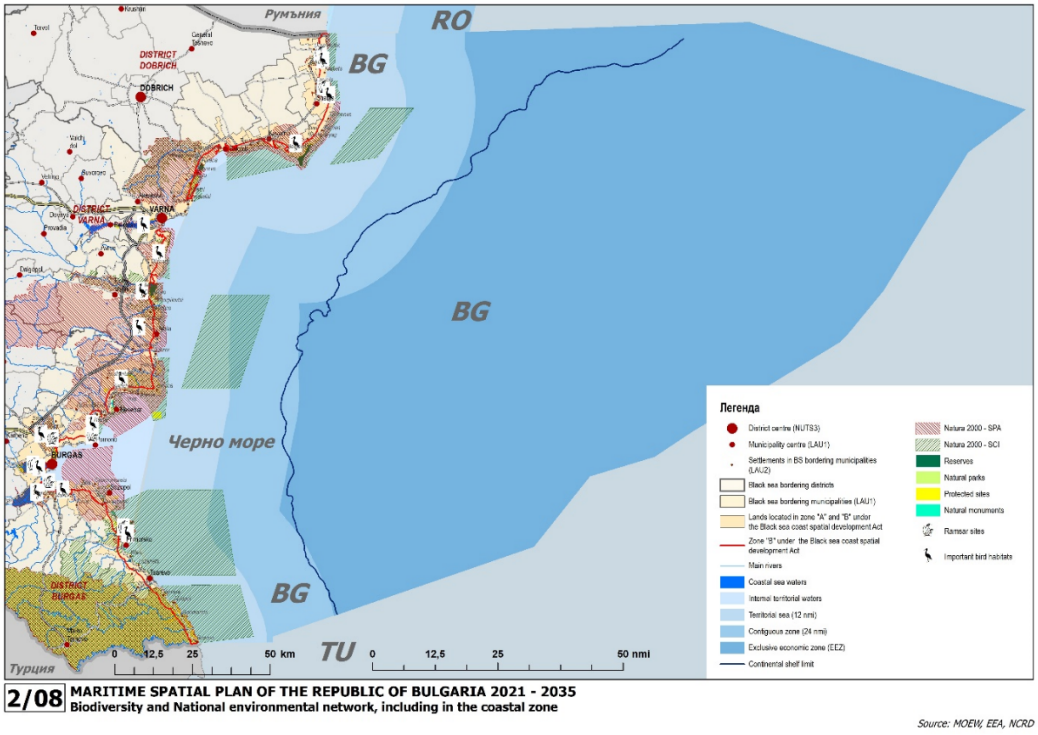

FIGURE 2 – Map of the Bulgaria Marine Spatial Plan

The map is mainly descriptive and the lack of information resulting from the overlapping of zones illustrates the difficulty of incorporating all the dimensions of marine areas. One explanation for this could be the lack of information on the overlaid zones due to missing datasets, but may also be the result of representation choices. Since we were not able to access the metadata when this analysis was carried out (the document was not finalised at that time), no significant correlation can be noted.

- Indicator I3: in 8 of the 19 MSP initiatives, the choice of an ecosystem-based approach led to the creation of map-based impact indicators between data on natural ecosystems and human activities. In 11 MSP initiatives, the document did not establish impact indicators cartographically.

The French Mediterranean coast is a good example of this indicator, where local authorities employed an independent consulting firm to devise a system for assessing the impact of marine activities. The approach used is detailed in the annex to the planning document; data creation is determined from the scale used to assess impacts in relation to the actions set out in the plan. This impact assessment method is limited since some data was incomplete or unavailable. According to the MSP document notes, for example, little is known about the distribution of marine mammals in the Mediterranean by the *Office Français de la Biodiversité* (French National Institute for Biodiversity), which provided the data for MSP. The lack of available datasets means the impact cannot be assessed quantitatively. In this case, the lack of information means that no indicators can be mapped (Fig. 3).

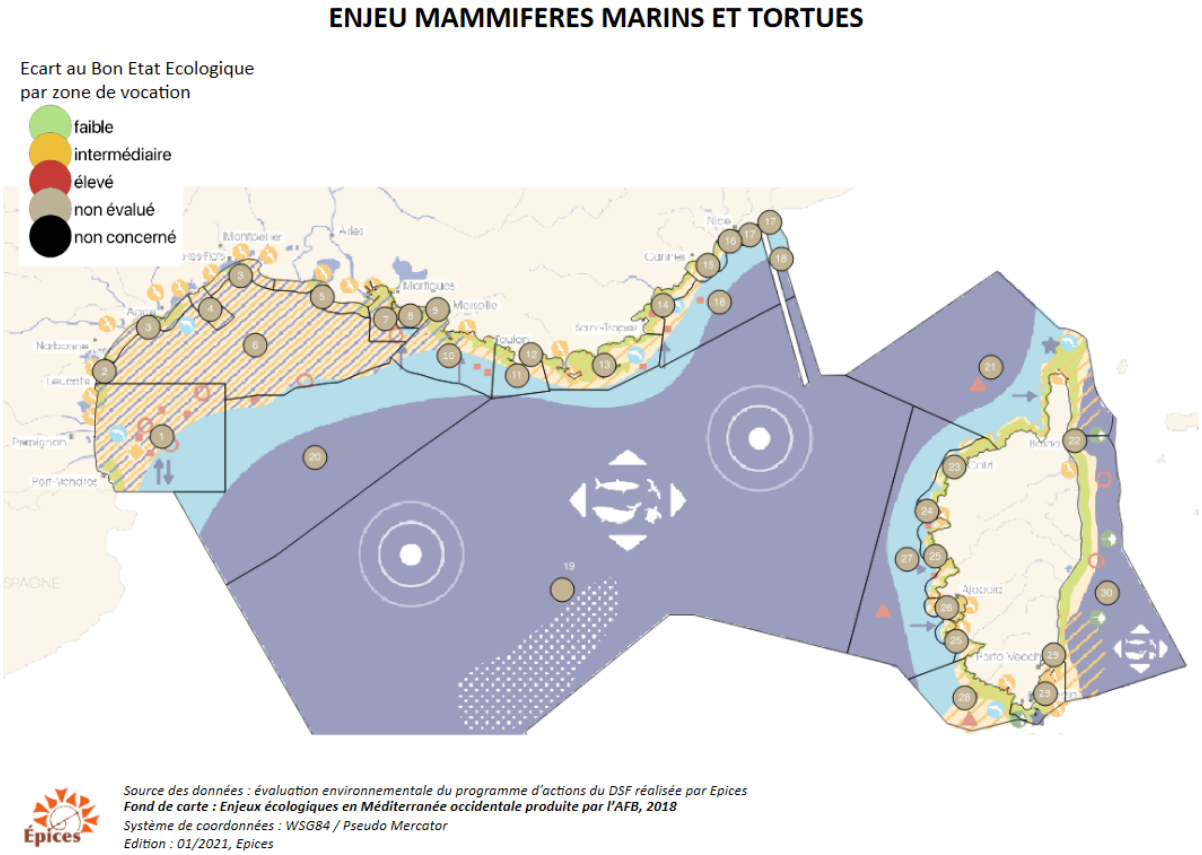

FIGURE 3 – Environmental impact assessment on Mediterranean marine mammals

- Indicator I4: the 19 MSP initiatives can provide only partial multidimensional mapping, for various reasons: not all human activities are included; certain marine biological areas are missing; one of the multidimensional variables of maritime space is absent (e.g. depth or time variable).

Wales is used to illustrate this indicator. The MSP data was supplied by the government for a specific purpose, most of it having been produced for the Marine and Coastal Access Act 2009. Once again, it is unclear whether comprehensive multidimensional aspects of the marine space are unavailable due to a lack of specific data creation, processing, representation choices, or the technological limitations of the geoportals associated with marine plans (Davret et al., 2023).

Country	Plan Area	I1	I2	I3	I4
Finland	EEZ	●	●	●	●
Ireland	EEZ	●	●	●	●
Latvia	EEZ	●	●	●	●
France	Mediterranean sea	●	●	●	●
France	Easter English Channel – North Sea	●	●	●	●
France	North Atlantic – Western English Channel	●	●	●	●
France	South Atlantic	●	●	●	●
Bulgaria	EEZ	●	●	●	●
United Kingdom	East England	●	●		●
United Kingdom	Northern Ireland	●	●		●
United Kingdom	Scotland	●	●		●
United Kingdom	South England	●	●		●
United Kingdom	Wales	●	●		●
Germany	Baltic Sea	●	●		●
Germany	North Sea	●	●		●
Belgium	EEZ	●	●		●
Denmark	EEZ	●	●		●
Malta	EEZ	●	●		●
Netherlands	EEZ	●	●		●

●	Yes
●	Partially
	No

TABLE 2 – Results of 19 MSP initiatives analysis (details in Annex 2)

As highlighted in Table 2, our analysis of 19 MSP documents from around Europe reveals that an ecosystem-based approach to marine spaces is often incomplete, particularly in terms of mapping. From the data shown in Table 2, it is apparent that given the multidimensional nature of marine space, a wide range of data is required (such as spatial sea bottom and surface data, temporal data, etc.). However, these requirements are likely to encounter limitations in terms of techniques, knowledge, tools or the media used to transcribe them.

Table 2, which answers our three main questions, demonstrates that:

- (Q1) Plans with detailed ecosystem mapping tend to use data that highlights the spatial variability of ecosystems, while those with partial mapping often use fragmented data, including zoning data;
- (Q2) Plans that incorporate data overlay to generate new information generally provide mapped impact indicators, unlike maps that overlay data without creating new information;
- (Q3) Data manipulated and used in the plans we examined does not allow for a completely multidimensional approach, and the limitations inherent to this problem, such as technological constraints, data production, processing and representation choice, often remain unidentified.

In general, these results indicate that there are gaps in ecosystem-based approaches, particularly in terms of mapping. Although marine ecosystems are documented comprehensively in some plans, others are only partially documented, underscoring the disparities between MSPs. While some initiatives effectively integrate data from ecosystems and human activities to generate new information and impact indicators, others simply overlay data without creating any meaningful new insights. Data limitations and technological constraints often impede a comprehensive multidimensional approach to MSP, emphasising the need to improve data accessibility, comprehensiveness and integration for more effective marine planning.

This result highlights the differences in availability and nature of the environmental data used in different European countries, and the challenges associated with understanding data production in the context of maritime planning.

5 DISCUSSION

This study examines a variety of aspects relevant to MSP, focusing on the analysis of data used in the planning process. This reinforces the intra-action theory and demonstrates the benefit of examining the data lifecycle in critical data studies to better understand how marine space is governed. A lack of data transparency or completeness reveals the limits of evidence-based governance policies.

5.1 Examining data quality through map-making

Interestingly, the results of our analysis of the data approach to marine planning reveal that, beyond the factual responses to the indicators, the majority of data was produced by government agencies responsible for previous management projects and rarely for planning purposes specifically, as observed from the sources and year of creation attributed to the data used in the plans we analysed. It is clear that data production analysis is highly dependent on information processing, representation and dissemination choices. In the absence of systematic and intelligible access to all metadata, it is difficult to distinguish particular stages of the data lifecycle. These findings raise questions about the quality and completeness of the data used to achieve the ambitious objectives of the ecosystem-based approach. The results reinforce the need to reflect on the analysis and evaluation of data, from any pre-processing carried out to decisions on how to present it for specific purposes such as planning.

The results from the review of plans reveal significant gaps in ecosystem mapping: based on our indicators, ecosystem mapping is often partial (11 cases out of 19); the combination of information does not lead to new information (10 cases out of 19); the multidimensional approach is flawed (all cases). This weakness is often the result of technical constraints, poor data availability and conscious or unconscious political choices. The findings highlight the limits of the 'evidence' available to guide planning decisions in 'evidence-based' planning.

Critical studies are used to discuss the relationships between decision-making and data. As Gregg (2015) points out in reference to the 'spectacle of data', data visualisation can be a 'fantasy of command and control through seeing' (p. 1) by delivering an ordered and prescriptive vision of space. MSP maps can actually be an effective tool of governance and power. They are not neutral representations of reality, but shaped by political choices and specific interests. Consequently, maps can hide or marginalise certain claims when used for marine space, while favouring others (Bridge et al., 2013). Similarly, McCarthy & Thatcher (2019) point out that it is mostly collective claims and informal use that are missing from maps due to lack of data. Finally, two ways of assessing the effect that maps and, by extension, the data used in maps, can have on the public stand out: (1) according to Li (2014), Scott (1998) and Wood & Fels (1992), maps are a tool or power in themselves, or (2) maps do nothing in themselves; it depends on how people use them (Fogelman & Bassett, 2017; Kitchin & Dodge, 2007, 2014). In line with McCarthy & Thatcher (2019) and Kitchin & Dodge (2007), we argue that maps are dependent on the social network in which they operate and where they evolve, but are also heavily constrained by the data and geotechnologies used.

The desired outcome was to trace the lifecycle of the data used for planning, but difficulties were encountered in accessing the metadata, mainly because the planning process was still underway at the time and not all the planning geoportals were available. The thing that stands out overall is that the ecosystem-based approach advocated and expected by MSP is based on data collected for the purpose, i.e. collected on an ad-hoc basis, not intended to incorporate all the parameters needed to represent the marine space (the temporal or seasonal dimension, for example), and not data collected automatically on a regular basis (e.g. fishing activity, which appears as automatically-collected

data), which is not produced with planning in mind. High-frequency and automated data is often collected for monitoring purposes, not management purposes (Said & Trouillet, 2020), which means that planning decisions are made without the benefit of data created specifically to meet their needs and subsequently justified with pre-existing data.

This article does not suggest that data recycling is inherently positive or negative; on the contrary, it acknowledges the existence of data recycling in marine planning and goes on to discuss the limits of this recycling with particular reference to the use of management data, which serves a different purpose to that of planning. While it is unrealistic to expect all the data to be high quality, it is nevertheless counter-productive to use management data (e.g. fish stock data) to plan activities. Our findings tend to support the theory put forward by Batty (2018, 2022), which raises the same issue for urban planning, deploring the fact that planning is based on downstream data rather than upstream data.

There are clear discrepancies between MSP requirements and the data actually used, as evidenced by the results (Q1), revealing that ecosystems are only partially documented in 11 out of 19 cases. Evidence-based planning requires a meticulous approach to produce adequate data to address spatial management challenges, which is not the case, according to our results. This would suggest that the limitations of bioeconomic data which fails to capture the complexity of socio-spatial relationships, such as leisure activities, should be acknowledged. The results of this study reveal inconsistencies between MSP requirements and the data used, as illustrated in the Maltese and Danish MSPs, where zoning plans do not fully capture the true environmental situation. It is also important to be aware of potential biases related to data collection (Trouillet, 2019), especially the 'internal' and 'external' quality of the data (David & Fasquel, 1997; Devillers & Jeansoulin, 2006). External data quality depends on its suitability for the project requirements, as defined by Wang and Strong (1996), and in this respect the MSP data is hampered by gaps on two levels: (1) the time constraint imposed for production of the first plans (Directive 2014/89/EU in place in 2014 for implementation by 2021 at the latest), which is the focus of this paper; (2) not all sea activities are monitored in a way that is conducive to data generation, referred to by St. Martin & Hall-Arber (2008) as the 'missing layer' with particular reference to activities such as small-scale fishing and the social, cultural, and sentimental aspects of marine space. This aspect of planning has recently been the subject of other studies (e.g. Flannery et al., 2022; Gee et al., 2017; Ntona & Schröder, 2020; Pennino et al., 2021), demonstrating the incompleteness of planning approaches that fail to mention these aspects of marine areas. Despite the importance of non-spatial data, as highlighted by Shucksmith and Kelly (2014), the academic literature often focuses on spatial data. This gap underscores the need for a more holistic approach to data collection and use in planning.

Within the context of an ecosystem-based approach, it is important to highlight the limitations of this approach. Ecosystem mapping, as typically interpreted in MSP, cannot fully capture the complex and dynamic relationships that underpin marine ecosystems. The ecological interactions between species are rarely comprehensively integrated into the datasets used for marine planning, making any attempt at ecosystem mapping inherently partial and incomplete. The challenge lies in the very nature of the ecosystem-based approach, which aims to integrate a broad range of dimensions, but in practice is constrained by the difficulty of obtaining sufficiently comprehensive data to represent the complexity of ecological interactions. Therefore, the concept of an ecosystem-based approach, in its strictest sense, should be reconsidered to focus on more specific representations, such as habitat or species mapping, while acknowledging that the full complexity of marine ecosystems exceeds what can be spatially represented with current data. This suggests that the ecosystem-based concept in MSP should be redefined to emphasise more tangible and measurable relationships between different elements, while being realistic about the limitations of available data.

5.2 Reading MSP through intra-action theory

This article illustrates several important aspects of ecosystem-based planning. First, the inconsistency in marine plans both across borders and within national boundaries. This divergence between national policies and the absence of harmonisation between regional plans is indicative of the challenges attached to establishing a coherent management plan for marine ecosystems. One example is the discrepancy between the MSPs of Belgium and the North French Coast, which share a border. The vocation of the French side of the border is to promote shipping, fishing, harbours and offshore energy, while that of Belgium is to create a large marine protection zone that does not continue on the French side and ends abruptly where the two EEZs meet. Discontinuities such as these are a problem but are also indicative of the autonomy and responsibility of different countries. Second, the findings point to a disparity in the data used to develop the MSPs. The integration of data from different sources is achieved effectively in some plans to generate new information, but in others the data is simply overlaid without creating any significant new knowledge (Q2). In 9 out of 19 cases new information is created from data overlay, but in 10 of the 19 plans no new information is created by combining the data. This cumulative use of data underlines the importance of considering not only the availability of data but also its interpretation and integration to gain an overall understanding of marine space. Third, the ecosystem-based approach to MSP reveals complex interactions between data, human and non-human actors and the resulting policies. These mutual relationships result in the notion of intra-action, which underlines the constant dynamics that exist between the different elements of marine systems. Only 8 out of 19 plans provide a mapped assessment of impacts, although these plans are based on available data, which, as mentioned above, is highly dependent on quality and processing.

These results tend to support the Kaufmann and Leese (2021) concept of information in-formation to understand the data lifecycle and the numerous trajectories that data can take, depending on its interactions and intra-action with human and non-human actors, as theorised by Barad (2007). The notion of intra-action is especially significant in relation to MSP, because unlike interaction it is defined by a constant dynamic movement that acts mutually between the components of a system. When planning the multiuse of marine space, therefore, each element becomes linked to another and the inner relationship between the ‘node’ of activity is difficult to understand. This notion seems particularly relevant for dynamic and mobile spaces such as marine space. In this context, the concept of digital ecology (Turnbull et al., 2023) adds another layer to the discussion. Digital ecology enables an alternative concept of governance operations and the interactions between data, digital technologies and ecological systems. It views data as the co-constituent elements of a network of entangled interactions, where the collection and analysis of data and its use in MSP are no longer perceived as a neutral or purely technocratic process.

As McCarthy & Thatcher (2019) point out, critical data studies are essential to understand governance because they help to unveil the ‘hidden technocracy’ (Obermeyer, 1995). In this regard, digital ecologies reveal the ethical and political implications of technological choices and the data systems underlying environmental governance, highlighting which aspects are included or excluded in the decision-making process. With digital ecology we can view digital entanglement as a precondition for intra-actions between data and actors, both human and non-human. This aligns with Lupton’s (2016) view that it is difficult to understand the entanglement between data and society, as data acts on society and, conversely, society acts on data through various assemblages (Kaufmann & Leese, 2021). This perspective sheds light on new ways of approaching marine space governance, promoting more equitable and transparent governance by using data critically within the framework of digital ecologies. Our approach introduces a new perspective to the data lifecycle, which is traditionally viewed through the different phases of the data - from production to deletion. It is essential to also consider the lifecycle in the context of entanglement with both human and non-human factors.

Finally, this study reveals the importance of understanding the data used and its impact on decision-making. The number of plans analysed for this study was limited; more research is needed for a thorough analysis of power-knowledge relationships and consideration of the varied journeys of datasets to better understand their role in the policy-making process and marine space governance. The absence of undigitised datasets (Gautreau, 2021) and social dimensions (Cornu et al., 2014; Gee et al., 2017) in MSP raises questions about how representative and inclusive planning can be, especially in developing countries where even greater attention is required (Trouillet et al., 2023).

6 CONCLUSION

This study demonstrates that the ecosystem-based approach expected for MSP relies on fragmented and often incomplete data, lacking critical parameters such as the temporal dimension. Data that is collected on a regular, automated basis is often repurposed to fit planning needs in ways that distort its original intent, raising serious concerns about its validity. Our research reveals that where data is not explicitly designed for planning, it results in significant gaps in multidimensional plans, particularly in the marine context, which limits their overall effectiveness. While the MSP directive calls for the use of the 'best available data', our findings indicate that the notion of 'availability' often translates into a reliance on recycled or repurposed datasets that were not originally intended for MSP. As a result, plans are shaped by technical constraints, data availability, and political choices in terms of ecosystem mapping and the representation of marine activities.

These biases in data use and mapping underscore critical issues of governance and information justice, highlighting the need for a more nuanced approach to data and its role in decision-making for marine planning. Specifically, while the use of the best available data is a pragmatic and necessary starting point, our analysis suggests that it is not always sufficient to address the complexity and multidimensionality of MSP. This underscores a clear need to produce data specifically tailored for planning purposes, ensuring that it better supports multidimensional objectives and reduces the risks of exclusion or misrepresentation.

The current lifecycle of data, from production through interpretation to deletion, tends to exclude stakeholders, which is a major issue for the inclusivity and legitimacy required for MSP. By rethinking the way data is produced and integrated into planning processes, it could become a powerful tool not only for improving the technical quality of plans but also for fostering stakeholder participation and enhancing the overall legitimacy of MSP initiatives.

This Europe-wide examination that should have produced a common framework from Directive 2014/89/EU to compare data production for the different plans, was in practice limited by inability to interpret the plans not written in English and limited access to databases. Despite the limitations - the restricted number of plans analysed and the difficulties in tracing the data lifecycle via the marine plan - we believe this work has contributed by highlighting the various strategies used to develop an ecosystem-based approach. The conclusions are also limited by having targeted only plans devised in the European context, where there is a certain degree of homogenisation in spite of the findings; the results may well have been different if the study had been carried out at international level.

This paper underscores the crucial role that data plays in marine planning, revealing that it is not just a way of viewing government engagement with marine space and economic visions for it, but also a means by which the engagement and visions are shaped, because data is subject to restricted access and therefore not easily questioned (McCarthy and Thatcher, 2019). The findings reveal that, contrary to the ideal of an 'evidence-based' approach, MSP seems to be driven more by political decisions justified *a posteriori* than by the data available (Batty, 2022), since the data available or used may be only partial. However, the plans are still needed. This validates our hypothesis based on analysis of the first round of MSP. In addition, data deserts are hidden or at least not explained, and the processing algorithms are not explained or justified, let alone discussed.

More research is needed to investigate the production of maps for MSP, such as those used to translate the MSP into visual form in Europe. Once a map has been produced, it is already too late to question the information, and above all the data. However, in practice, spatialising information often helps assess whether the data is adequate or not. This suggests a need to develop upstream research to understand the relationships between states, technologies, and MSP to facilitate thorough investigation of the mapping process, which is one of the main action drivers for governments that implement marine spatial plans.

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A ANNEX 1

European Marine Spatial Plan (source : European MSP Platform[5], 2022)

Country	Plan area	Document	Materials available in French or in English	URL (verified in December 2022)
Belgium	North Sea	Plan	Yes	https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/19094275/Summary%20Marine%20Spatial%20Plan.pdf
Bulgaria	EEZ	Draft document	Yes	https://www.mrrb.bg/en/the-draft-maritime-spatial-plan-of-the-republic-of-bulgaria-2021-2035-has-been-finally-adopted-by-the-national-expert-council-on-spatial-planning-and-regional-policy/
Croatia	No comprehensive national plan	No access	No information	No information
Cyprus	EEZ	In progress	No information	No information
Denmark	EEZ	Plan	Yes	https://havplan.dk/en/page/info
Estonia	Estonian Maritime Act	In progress	No information	No information
Estonia	Marine space plan of Hiiu Island	Plan	No	https://maakonnaplaneering.ee/et/hiiu-maakonnaga-piirneva-mereala-maakonnaplaneering
Estonia	Marine Spatial Plan of the bay area of Pärnu	Plan	No	https://maakonnaplaneering.ee/143
Finland	EEZ	Plan	Yes	https://meriskenaariot.info/merialuesuunnitelma/wp-content/uploads/2020/10/Finnish-Maritime-Spatial-Plan-2030-Marking-Card-Library.pdf
France	South Atlantic	Plan	Yes	https://www.dirm.sud-atlantique.developpement-durable.gouv.fr/volet-strategique-du-dsf-la-strategie-de-facade-r812.html
France	North Atlantic – Western English Channel	Plan	Yes	https://www.dirm.nord-atlantique-manche-ouest.developpement-durable.gouv.fr/strategie-de-facade-maritime-nord-atlantique-a1070.html
France	Easter English Channel – North Sea	Plan	Yes	https://www.dirm.memn.developpement-durable.gouv.fr/document-synthetique-sfm-a953.html
France	Mediterranean sea	Plan	Yes	https://www.dirm.mediterranee.developpement-durable.gouv.fr/document-strategique-de-facade-mediterranee-r335.html?lang=fr
Germany	Marine Spatial Plan for the territorial sea - Schleswig- Holstein	Plan	No	https://www.schleswig-holstein.de/DE/fachinhalte/L/landesplanung_raumordnung/allgemein/landesplanung_aufgaben_instrumente
Germany	Marine Spatial Plan for the territorial sea of the Baltic Sea -	Plan	No	https://www.regierung-mv.de/Landesregierung/em/

5 https://maritime-spatial-planning.test.ec.europa.eu/msp-practice/countries

	Mecklenburg Vorpommern			
Germany	Marine Spatial Plan for the territorial sea North Sea - Lower Saxony	Plan	No	https://www.ml.niedersachsen.de/landesraumordnungsprogramm/landes-raumordnungsprogramm-niedersachsen-5062.html (consulté le 07/2022)
Germany	Marine Spatial Plan for the Baltic - EEZ	Plan	No	https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/Maritime_Spatial_Plan_2021/_Anlagen/Downloads/ROP_2021/Maritime_Spatial_Plan_2021.pdf;jsessionid=9748926EA6168E5946581B0FE1875E99.live11291?__blob=publicationFile&v=5
Germany	Marine Spatial Plan for the North Sea - EEZ	Plan	Yes	https://www.bsh.de/EN/TOPICS/Offshore/Maritime_spatial_planning/Maritime_Spatial_Plan_2021/_Anlagen/Downloads/ROP_2021/Maritime_Spatial_Plan_2021.pdf;jsessionid=9748926EA6168E5946581B0FE1875E99.live11291?__blob=publicationFile&v=5
Greece	No information	No access	No information	No information
Ireland	EEZ	Plan	Yes	https://www.gov.ie/en/publication/a4a9a-national-marine-planning-framework/
Italia	No information	No access	No information	No information
Lithuania	EEZ	Plan	Yes	https://www.tpdris.lt/lt_LT/web/guest/sarasas
Latvia	The entire part of the Baltic Sea Baltic Sea under the jurisdiction of the Republic of Latvia up to the outer limit of the exclusive economic zone.	Plan	Yes	https://drive.google.com/file/d/1mKigVjv6N03cjgPkwR5RSItcQezsn5zY/view
Malta	Maltese marine waters up to the 25 nautical miles of the conservation area fisheries management	Plan	Yes	https://www.pa.org.mt/en/strategic-plan-details/strategic%20plan%20for%20the%20environment%20and%20development
Netherlands	EEZ	Plan	Yes	https://www.government.nl/documents/policy-notes/2015/12/15/policy-document-on-the-north-sea-2016-2021
Poland	EEZ	Plan	No	https://polishmsp.eu/
Portugal	EEZ	Plan	No	https://www.psoem.pt
Romania	EEZ	In progress	No information	No information
Slovenia	EEZ	Plan	No	https://dokumentipis.mop.gov.si/javno/veljavni/PPP2192/1/English/MSP_Slovenia.pdf
Spain	EEZ	Plan	No	https://www.miteco.gob.es/content/dam/miteco/es/costas/participacion-publica/resumenejecutivo-poem_tcm30-529000.pdf

Sweden	Gulf of Bothnia ; North Bothnia; North Kvarken; South Bothnia Bothnia	Plan	No	https://www.havochvatten.se/
Sweden	Northern Baltic Sea and south of Kvarken ; Central Baltic Sea; South-east Baltic Sea ; Southern Baltic Sea ; South-west Baltic Sea and the Sound	Plan	No	https://www.havochvatten.se/
Sweden	North Pacific and South Pacific	Plan	No	https://www.havochvatten.se/
United Kingdom	East England	Plan	Yes	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/312496/east-plan.pdf
United Kingdom	South England	Plan	Yes	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/726867/South_Marine_Plan_2018.pdf
United Kingdom	Northern Ireland	Plan	Yes	https://www.daera-ni.gov.uk/articles/marine-plan-northern-ireland
United Kingdom	Scotland	Plan	Yes	https://www.gov.scot/publications/scotlands-national-marine-plan-9781784128555/
United Kingdom	Wales	Plan	Yes	https://www.gov.wales/sites/default/files/publications/2019-11/welsh-national-marine-plan-document_0.pdf

B ANNEX 2

Analysis 19 MSP initiatives

Country	**Plan area**	**I1**	**I2**	**I3**	**I4**
Belgium	EEZ	1	1	0	1
Bulgaria	EEZ	1	1	2	1
Denmark	EEZ	1	1	0	1
Finland	EEZ	2	2	2	1
France	South Atlantic	1	2	2	1
France	North Atlantic – Western English Channel	1	2	2	1
France	Easter English Channel – North Sea	1	2	2	1
France	Mediterranean sea	1	2	2	1
Germany	Baltic sea	1	2	0	1
Germany	North Sea	1	2	0	1
Ireland	EEZ	2	2	2	1
Latvia	EEZ	2	2	2	1
Malta	EEZ	1	1	0	1
Netherlands	ZEE	1	1	0	1
United Kingdom	East England	2	1	0	1
United Kingdom	South England	2	1	0	1
United Kingdom	Northern Ireland	2	1	0	1
United Kingdom	Scotland	2	1	0	1
United Kingdom	Wales	2	1	0	1

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