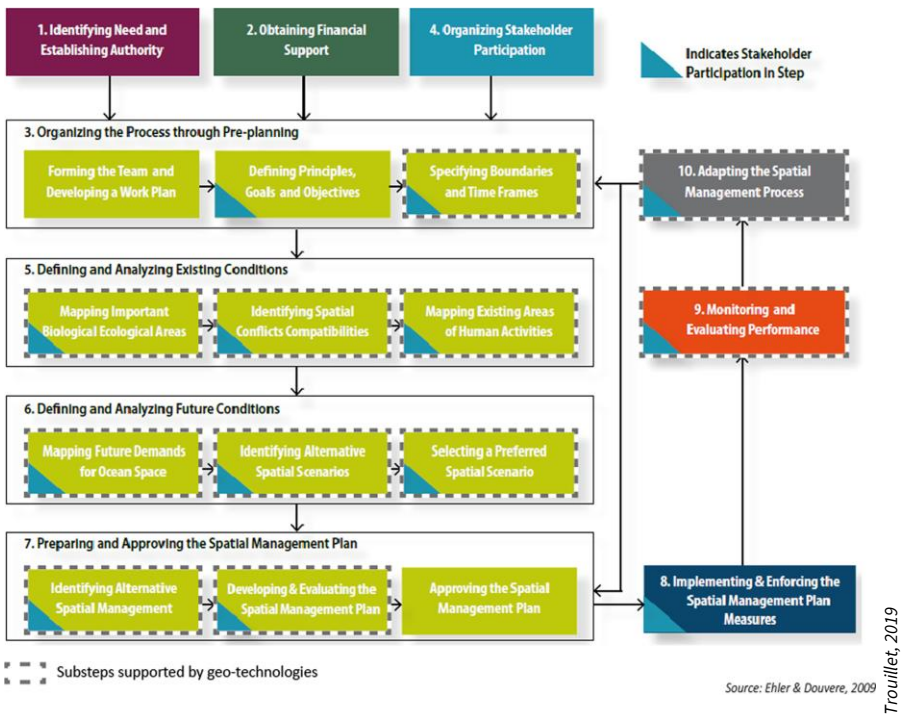
How can digital transformation improve Marine Spatial Planning in the Atlantic space?

Context

Over the past twenty years, sectoral maritime management measures have little by little given way to integrated marine governance models known as Marine Spatial Planning (MSP). This integrative paradigm could be defined as *"(…) a public process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that usually have been specified through a political process"* (Ehler & Douvere, 2009). To achieve its objectives of organizing the sharing of maritime space in order to develop blue economy combined with social considerations while ensuring the conservation of ecosystems, MSP relies heavily on geographic information and the linked technologies for guiding decisions (Iglesias-Campos *et al.*, 2021). These technologies which refer to methods and tools that allow to collect, process, analyze, map and share geographic information (e.g., spatial database management systems, mapping tools, geovisualization tools, geographic information systems (GIS), models, geoportals, spatial data infrastructures) are from now on ubiquitous and becoming central to territorial planning processes. The current digital transformation actually led to transforming the way planning is approached and carried out by modernizing and democratizing it (Boland *et al.*, 2022; Potts, 2020). Indeed, the adoption and implementation of digital geo-technologies can significantly enhance MSP, but also raise new challenges and issues.

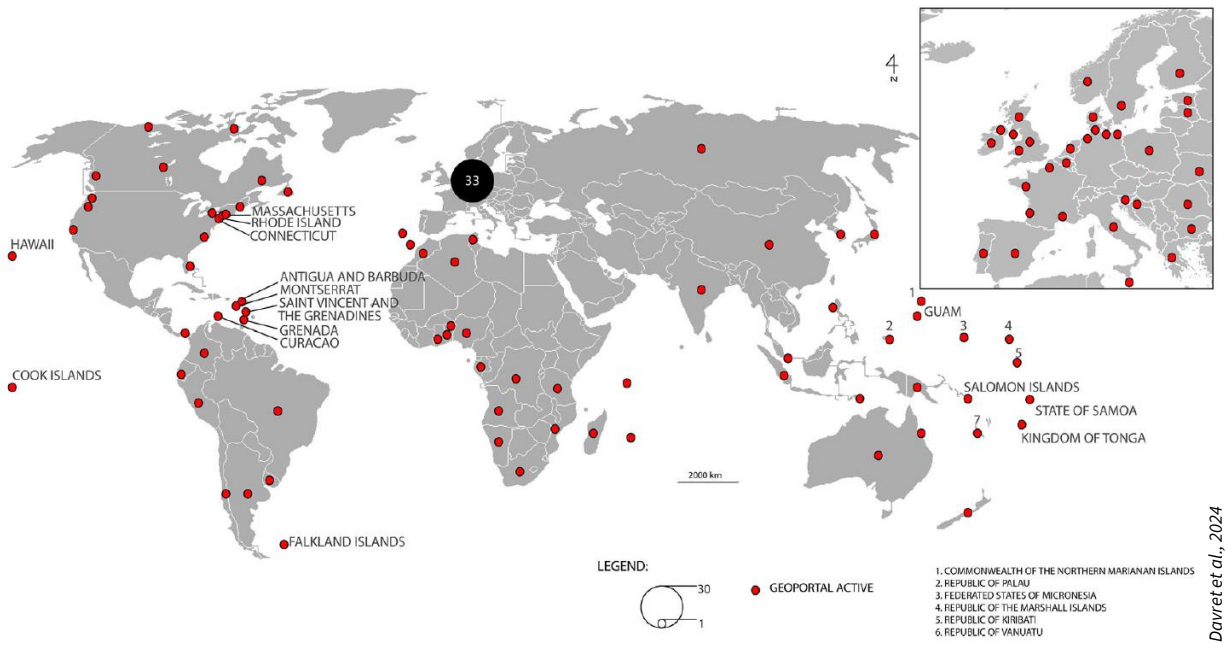


ROLE PLAYED BY DIGITAL GEO-TECHNOLOGIES THROUGHOUT MSP PROCESSES

Benefits of digital transformation in MSP

For the past decades, the digital transformation has led to the emergence of various socio-technical systems revolutionizing the way of capturing, storing, managing, processing, analyzing, visualizing and sharing big data (Kitchin, 2014). New technologies allow now to reinforce each stage of the data life cycle supplying a lot of material supporting MSP processes, and leading to a deep digitalization of marine governance. Hence, for example the spread of automatic geopositioning systems as well as drone or satellite-based devices could provide widespread near real-time monitoring and surveillance of human activities and marine environment for cost-effective. Digital geo-technologies also enable the integration and the management of vast amounts of heterogeneous data from various sources which could be used to develop simulation and modeling approaches in order to predict and anticipate the effects of different management scenarios. Likewise, combining data Geographic Information Systems software allows planners to visualize spatial data, create maps and perform spatial analysis for example to identify spatial patterns and relationships, potential conflicts between uses, ecologically sensitive areas or the most suitable areas for the development of new marine activities. Moreover, the recent development of artificial intelligence, machine learning and digital twins has heightened and optimized analysis capabilities of such tools.

Besides providing a more holistic understanding of the marine space, digital platforms, such as interactive mapping tools, online forums or social media, enable also broader public active participation and stakeholder engagement in MSP processes. For example, many marine geoportals have been developed, especially around Atlantic space, allowing users to visualize and explore all the gathered data, occasionally examine different scenarios and understand the implications of proposed plans and more rarely even to drop off their own contributions, supplying new information, including from the public as crowdsourcing. These digital platforms facilitate thereby communication, collaboration, and ultimately consensus-building among relevant parties of the MSP (planners, policymakers, local and national authorities, intergovernmental organizations, economic stakeholders, non-governmental organization, scientists and experts).



MARINE GEOPORTALS AROUND THE WORLD

Finally, digital transformation offers significant opportunities to improve the effectiveness, transparency, efficiency, responsiveness and inclusiveness of MSP. By supplying accurate mapping, tools to integrate data, analytical and predictive approaches, and participatory platforms, digital geo-technologies provide valuable insights of complex marine spaces and could guide planners toward rational, relevant and evidence-based choices, for optimizing space and resource allocation and therefore achieving MSP objectives.

Challenges and limitations of digital transformation in MSP

However, beyond this positivist vision of the digital turn of MSP, lie various challenges and limitations highlighted throughout the processes. The first challenge concerns the digital data itself. Actually, despite the deluge of data currently underway, many aspects remain in the blind spots of data collection systems or common repositories, which focus mainly on ecological and economic considerations (St. Martin & Hall-Arber, 2008). Thereby, most of the time, cultural or identity dimensions are not yet well documented, and therefore are not, or only partially, taken into account in MSP decision-making processes. In the same way, non-scientific knowledge, particularly local or indigenous knowledge, is often only marginally mobilized (Said & Trouillet, 2020). Another limitation comes from the data frameworks which are usually implemented at national scale. Therefore, the spatial discontinuity across boundaries makes transnational MSP very difficult. In the same way, the shoreline appears as a major discontinuity while sea and land are most of the time separated in different data infrastructures. Finally, in spite of some high-frequency automatic data collection systems, the temporality remains also a weak point of marine databases. It makes it difficult to accurately represent some species or highly mobile activities, such as recreational boating or certain types of fisheries, which have significant seasonal variations.

The second challenge refers to the way in which geo-technologies are used in MSP processes. Assuming that decision-process do not like emptiness, the lack or incompleteness of data regularly leads to distort datasets from their original purpose, based on the principle of the “best available data”. As these data were designed, collected and structured for a specific purpose, they do not always provide a relevant answer to the question asked. In that case the “best available data” could unfortunately become the “b-a-d data” and can mislead the planners. In the same way, although the quality of the data used is examined in technical considerations (resolution, consistency, date, metadata, etc.) its external quality (the adequacy of data to address an issue or a question) is in general poorly documented. Thus, although the MSP process is intended to be totally objective making evidence-based choices with the support of digital datasets assumed to be representatives and reliable, from the construction of these datasets to their dissemination (geo-technologies used, collection protocol, metrics, processing methods, mode of visualization, forms of dissemination, etc.), they are actually far from neutral, and above all the result a succession of technical choices (Trouillet *et al*., 2023). This ubiquity of these digital geo-technologies could finally lead to “technicalizing” the exchanges between stakeholders, influencing political decisions, and legitimizing decisions through technology rather than consensus-building, confiscating a part of the collective process (Davret *et al*., 2024).

Finally, a third challenge should be highlighted. It is not necessarily due to the digital turn of MSP, but the latter seems to have amplified it: the information challenges (Trouillet, 2019). Indeed, due to the predominance of rationalist and technical approaches, there is an unequal distribution of the benefits of MSP and the dominance of certain interests to the detriment of others in the processes. Whereas in MSP the political decisions are mainly based on what (and how) appears in the digital datasets, there is a gap between the stakeholders who have the capacity to collect, process and build digital data (even to complete the public authorities’ datasets) which enable them to be (well) represented in the process and those who don't (digital divide, lack of resources, etc.).

Recommendations

Digital transformation has already improved and continues strengthen many aspects of MSP processes. Indeed, by providing solid data collection and processing tools suppling constantly improving participative platforms to inform and include all the stakeholders of MSP, the digital geo-technologies represent reliable solutions for achieving MSP objectives. Nevertheless, the digital turn of MSP also raises new challenges and issues. To address these challenges, some technical and organizational recommendations could be suggested at the scale of the Atlantic space:

- Adopt international (or at least interoperable) data harmonization and standardization in the whole Atlantic space to harmonize the marine datasets (for limiting spatial discontinuities) and data processing (methods, metrics, etc.) without making the process too uniform, so that it can still be adapted to local issues.

- Agree to introduce external qualification of the data even if this means rejecting some available data and having to collect new sets (relaxing of the principle of "best available data"). Beyond data, adopt a critical approach of data processing, metrics and representation methods used in MSP processes.

- Invest in geospatial data collection to fill data gaps and complete fragmentary datasets in order to visualize the "invisible" (cultural considerations, small fisheries, recreational boating, temporal and seasonal aspects, etc.): improve the policy-science dialogue and support volunteered geographic information and validated crowdsourcing.

- Maintain and even develop open data dealing with confidentiality, security, sovereignty and private rights limitations.

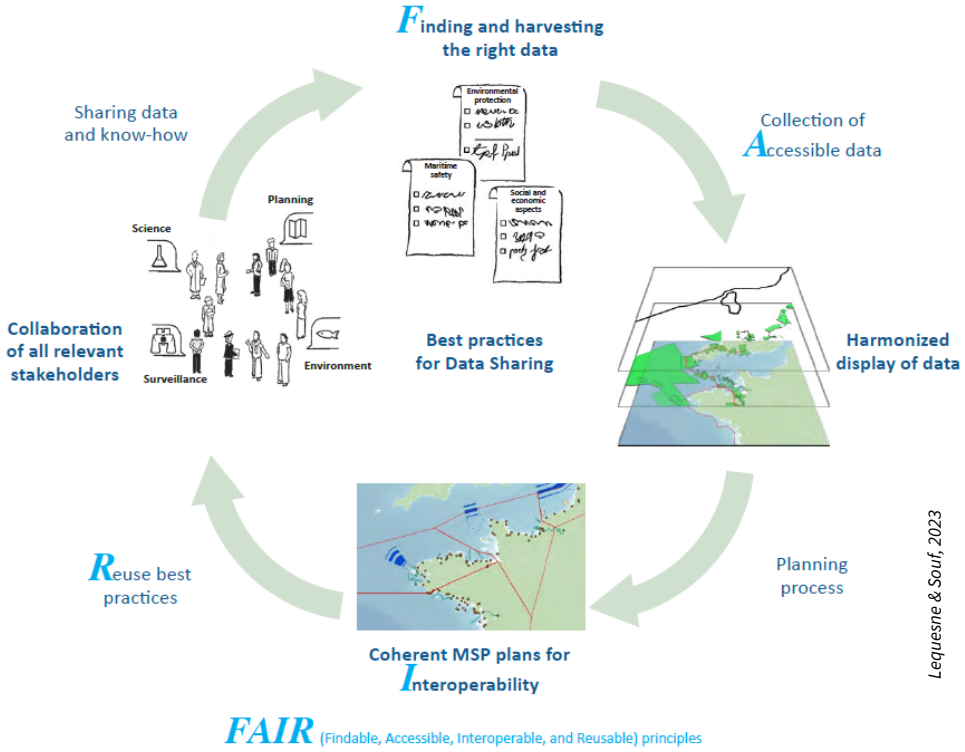
- Conform MSP source and output data with FAIR (Findable, Accessible, Interoperable and Reusable) principles (Wilkison *et al.*, 2016).

- Use new technological developments in data science, whether for big data processing with artificial intelligence to gain a clearer insight of complex marine environments, or for the representation of these data in the form of digital twins to facilitate understanding and encourage public participation.

- Develop self-engagement and participatory functionalities in the marine geospatial platforms to be more inclusive and to attract more public attention.

- Encourage public authorities to take into account the information challenges. As the use of geo-technologies reinforces power relations, reduce the digital divide and balance the weight of the stakeholders by providing the weakest with the data and tools they need to represent themselves correctly in the MSP processes.

- Put data and digital geo-technologies into perspective to consider them only as perfectible supports for enlighten the discussions and exchanges. The latter must remain at the heart of the MSP processes in order to achieve a collective consensus-building, instead of basing and legitimizing political decisions solely on data derived from a succession of technical choices, that are at least partial and sometimes even biased.



OPTIMAL DATA SHARING AND KEY STEPS FOR EFFECTIVE DATA UTILIZATION WITHIN MSP

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