New Needs and New Tools for Marine Management

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1 THE CHALLENGE

Huge changes are taking place in the governance of the oceans. The implementation of the UNCLOS agreement is creating new rules in what concerns the national responsibility for large areas of the seafloor. Maritime transportation is continuously increasing as the most cost-effective solution for international trade, creating virtual ocean highways. Growing energy demands, and the need to decarbonize the economy are leading to the installation of large power systems close to the coasts, competing with the traditional uses of the ocean, like fisheries or leisure.

During the XX Century marine management was mainly based on a project-by-project or permit-by permit approach (Douvere, 2008), with no explicit incorporation of the interplay between the different values in stake. Marine spatial planning (MSP) is emerging as a tool to support the implementation of an ecosystem approach to marine management, supporting ocean governance. It intends to provide legal certainty and predictability for the public and the private use of the ocean and help to quantify the consequences of alternative management strategies.

The development of GIS-based MSP is growing fast but it is still strongly constrained by large gaps in baseline data, time and space heterogeneity between the different data sources, and the limitation of the physical, chemical and biological models to reflect natural processes. Economic and social constraints are also a major question in the decision process and its trade-off with the environmental values is dependent on political strategies. While we are not able to mathematically model the complexity of socio-environmental systems, management decisions cannot be reduced to algorithms to be applied by IT systems. Nevertheless, there is an increase role for spatially-explicit systems as the backbone of the marine management decision systems. The on-going international initiative to define significant Marine Protected Areas is the opportunity to put extra emphasis on the development of spatially explicit systems as the basic infrastructure for adaptive management and public participation.

2 TERRITORIAL MANAGEMENT OF OCEAN AREAS

Major differences exist between spatial planning on land and spatial planning on sea. Differences relate with the true three-dimensional nature of marine environment, the different level of scientific knowledge concerning interrelationships between ecosystems and between them and the highly variable ocean environment, the stronger interconnection between ecosystems forced by the ocean circulation, the difficulty of maintaining long term monitoring strategies, and the large time scales of most processes. The rapid development of satellite platforms to provide continuous monitoring of the atmosphere and land areas faces additional difficulties in what concerns ocean areas where it is mainly limited to surface observations.

The fast development of spatially-explicit systems for territorial management was fostered by the possibility of such systems to visualize the consequences of alternative management policies, and the associated uncertainties. Presently they are the only realistic approach to develop awareness from the citizens and, ultimately, to enforce public policies. The use of spatial analysis techniques for territorial management in land is a well-established approach. It is expectable that the same approach could be extended from shore to the coastal areas and, ultimately, to the deep ocean.

One of the crucial differences between territorial management on land and in the ocean concerns the different level of awareness of the consequences of management decisions. The ocean cannot be directly visualized by humans as is the case of forests or coastal areas; actions taken on a specific place have fast consequences on distant spots. This gives

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increased role to sophisticated spatial representation that will replace the direct visualization of the marine landscape.

3 DEALING WITH PRESSURES AND FEED-BACKS

One of the advantages of spatially-explicit systems to support marine spatial planning is the possibility to analyze alternative management scenarios. Properly parameterized, such a system can allow a robust evaluation of the sensitivity of the environment to pressures, incorporate information concerning the frequency of their occurrence, and consider multiple pressures with complex feedbacks acting at the same time and referring either to space-based concepts (e.g. habitats) or to moving agents (e.g. populations). We must also keep in mind that while physical factors are easily expressed in a quantitative way, the measure of ecosystem sensitivity is mainly the object of expert assessment mostly qualitative (Stelzenmüller et al., 2010).

Lets consider for example the three main pressures identified by Stelzenmüller et al., (2010) for studies conducted in the North Sea: demersal fishing, hydrocarbon industry, and aggregate dredging. They have different spatial and temporal impacts, complex exploration patterns and large unknowns on the connection between actions and effects. Fishing has a wide spreading widespread impact on marine habitats, while the focus of the activity is focused on "stocks" this meaning on explorable fish populations, which move continuously in the water column, spawning, ageing and interacting with other species and the physical environment. Hydrocarbon exploration is a technological intensive operation, which deeply affects the seafloor in very limited areas, but has side effects during exploration and exploitation. Aggregate dredging is a more localized activity, being its effects essentially related with sediment plumes driven by oceanographic processes and the possible destruction of small size but highly valued habitats.

Habitat mapping is missing in the majority of the ocean space. Scientific knowledge is focused on a few "hot spots", critical species or interactions. Socio-economic data are lacking even in rich and well organized countries. Therefore, pragmatism led to the development of systems with a limited focus or a specific area (Caldow et al., 2015). Such systems must be viewed as "preliminary". Future developments must be rooted on solid science, dense baseline data, efficient monitoring strategies and, most importantly, scrutiny by organizations and citizens.

4 DEALING WITH COMPETING NEEDS

The use of spatially-explicit marine management tools is seen as a key factor to reduce conflicts between competing management goals, decrease incompatibilities between different uses, and ensure the long-term stability of the marine system (Douvere and Ehler, 2009; Gimpel et al., 2015). However, its true implementation asks for significant progresses in the knowledge of the ocean environment, the capacity to monitor main environmental deep sea processes, the resolution of conflicts between incompatible uses of the ocean and the development of complex economic and ecological assessment tools to support the participation of stakeholders in the decision processes. GIS-like technologies are a core part of this effort.

Here, there is an important distinction between technological tools to display observations, scientific interpretations or regulatory instruments, and organize public participation, from technological tools needed to support the action of planners in the establishment of these regulatory instruments.

Display capabilities must be able to allow stakeholders a virtual view of the processes taking place in the deep ocean either obtained from sensors and mobile platforms, or synthetized from indirect information. The heterogeneity of the distribution of environmental values must be described at a proper scale, and the existence of distant connections between geochemical and biological processes must be clearly addressed.

Tools for decision making are often based on the use of multi-criteria evaluation (MCE) techniques (Gimpel et al., 2015) that must also take into consideration data incompleteness and limitations of available models (Marshall et al., 2014).

5 GIS PLATFORMS AS PARTICIPATORY PLATFORMS

Ocean governance must deal with the socio-ecological system. Even well informed planning strategies can be ineffective if citizens are not involved in all phases of understanding, planning and enforcing. The ‘human dimension’ (Baldwin and Mahon, 2015) of this process asks for the development of participatory platforms able to cope with the scale, the complexity, and the impact of political decisions. Experts are no longer seen as the only actors of public policies, but at the most as moderators of the decision process. A participatory GIS platform must be able to provide both understandable and accessible information to stakeholders, allow easy comparison between alternative strategies, and so promoting transparency and collaboration in decision-making (Baldwin and Mahon, 2015, Strickland-Munro, 2016, Pierre et al., 2017).

This is an area where novelty is needed, which can contribute for the development of both marine and IT literacy.

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BRIEF BIOGRAPHY

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