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The international legal framework for the management of the global oceans social-ecological system

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ABSTRACT

This paper evaluates the international agreements in place for the protection of the environment and the regulation of human activities taking place in world's oceans and seas. 500 multilateral agreements were reviewed against a framework of reference, grounded on the theoretical approaches of Adaptive Management and Transition Management. According to this framework, oceans complex systems management should: (1) consider the global oceans as a Social-Ecological System (SES); (2) aim to achieve or maintain their ecological resilience; and (3) implement iterative, learning-based management strategies, supported by science-based advice to policy and management. The results show that the present international legal framework for the global oceans does not require countries to adopt an adaptive, complex systems approach for global oceans ecological resilience. Instead, this study supports the perspective of a double fragmentation among international agreements. First, global agreements focus on issue-based objectives for determined human activities, ecological components or anthropogenic pressures. Second, regional agreements have a wider scope, but also a varying level of inclusion of ecological resilience considerations. There is the need to foster the inclusion of such an approach into existing and future international agreements and their implementation, including through soft-law, project-based initiatives at global and regional scales.

1. Introduction

Oceans play a major role in global material and energy cycles [7]. Their interactions with atmospheric and terrestrial systems contribute to the regulation of global weather and climate, where water, carbon and oxygen cycles determine the transfer of heat and energy throughout the globe.

Global-scale phenomena challenge the health of global oceans, almost half of which are affected by multiple human stressors [17]. Global climate warming alters physical, chemical, and biological properties of the ocean, impacting on ocean productivity and food services globally such that fish stocks are declining, potentially at an irreversible pace [20,26]. Ocean habitats and biodiversity continue to be lost or degraded [20]. Moreover, pollution of the oceans caused by human activities, including the dumping of waste, is a serious problem affecting not only coastal areas but also open oceans.

These problems are global: as showed by Halpern et al. [17], anthropogenic pressures affect almost any point in the ocean surface. Moreover, both climate related and anthropogenic challenges have an impact on the relations between oceans and the biosphere, and their capacity to regulate global weather and climate. For this reason, a global perspective is needed to tackle these problems. In the last decades, several scientific approaches have emerged that consider human and ecological systems as complex, adaptive systems, thereby interacting in non-linear, path dependent ways, with feedback loops and unpredictable effects also across scales [2,19,22,24,29]. The most notable example is the ecosystem approach (or ecosystem-based management), which has been advocated at international level as the best strategy to cope with a changing climate, protect the global oceans and manage human activities in a sustainable way ([18]; for a review of the implementation, see Arkema et al. [1]).

Accordingly, complexity approaches started to be introduced also into the texts of international agreements aiming at the protection of the ocean environment and regulation of maritime activities. A considerable number of international agreements are today in place, regulating these issues at varying scales, from global to ocean basin, to regional and local levels. Several voices in the literature point to the fact that this legal framework is fragmented [11,32,33], inadequate to tackle the challenges of managing the oceans [37], and in need of a paradigm shift [3,11,27] to promote the safeguard of global ocean ecological structure and processes, and human communities depending on the ecosystem services generated by them. This view is shared also by the UN Secretary General, who raised the need for a better horizontal and vertical integration among levels of ocean governance to foster the implementation of an ecosystem approach to global oceans ([36]

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UN Secretary General Report, 2006).

There are several analyses in the literature, investigating this fragmentation from different perspectives [3,11,14,15,21,23,31,38]. However, an analysis is missing of the international legal framework for the management of the global oceans system, from the perspective of complex human and ecological systems.

The purpose of this paper is to present the results of such an evaluation, and assess whether a comprehensive legal framework is in place requiring a complex systems approach to the assessment and management of the global oceans. For this purpose, a framework for ocean assessment and management was developed, which is presented in Section 2. Section 3 presents the methodology used to select and analyse the international environmental agreements, while Section 4 presents the results of the analysis.

2. A framework for the assessment and management of ocean complex systems

For the purposes of this evaluation, reference is made to a framework for the management of marine complex systems, which was developed and previously used to analyse the European Union ocean legislation [5]. The framework combines useful insights from two promising conceptual and methodological frameworks for sustainability of complex, adaptive systems [10]: Adaptive Management (AM) and Transition Management (TM). More specifically, if taken individually, both AM and TM have limitations, which may be overcome by their combination, as illustrated in Table 1.

The framework is articulated into three components. The first component is the Social-Ecological System (SES) and Socio-Technical Systems (STS) as the units of management. A SES is defined as a bio-geophysical unit and its associated social actors and institutions [16]. Examples of marine SESs in the scientific literature include marine reserves [30] and the notion of Large Marine Ecosystems (LMEs). Developed in the USA in the 1990s [34], the notion of LMEs is adopted today by international bodies, such as the United Nations Environment Programme (UNEP) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, as a theoretical foundation for global marine assessment and management. A limitation of theoretical and practical approaches for ocean assessment and management, based on the tenets of AM, lies in their limited capacity to characterize the complexity of human systems. Although humans are conceived as integral parts of SESs, fundamental components of human systems, such as socio-economic patterns of production, distribution and consumption of goods and services, actors behaviour and the role of institutions and rules, are often neglected (for example, see Atkins et al. [2], and the work of TEEB [35]). The framework overcomes this limitation, by adopting the conceptualization of human systems of TM, as composed of Socio-Technical Systems (STSs), actors and institutions. STSs are defined by TM as socio-economic systems of production and consumption of goods or services, necessary to fulfil societal functions [13]. Actors have a primary role as producers or consumers inside a STS, which in turn shapes their preferences. Moreover, institutions and rules are embedded in artefacts, while giving a context for actors' behaviour [13].

The second component is the ecological resilience as the objective of management. Ecological resilience is defined by AM as the ability of a system to withstand shocks, maintain stability during disturbances and rebuild itself when required [6]. It is determined by specific groups of species, whose functions, such as their role in the trophic web, support essential processes and sustain ecosystem services [19]. To characterize ecological resilience, it is necessary to identify key system components and interactions, such as diversity, variability and redundancy of biological communities [4]. Thresholds shall be assigned to these components, which act as stability limits, and mark the points beyond which regime shifts occur [9]. As it is impossible to have a complete understanding of the system, such thresholds must be considered as hypotheses on the status of the system [12], to be challenged and updated through monitoring. A weakness of TM is that it considers nature as a provider of resources and recycler of pollutants, and tends to overlook ecological boundaries and limits to growth [8,28]). Consequently, transitions triggered by TM may not be in line with ecological resilience considerations. For example, a transition of the fisheries sector of a country towards a new set of total allowable catches of certain species may have the desired positive effects on ecological diversity and resilience of a marine SES, while at the same time trigger unbalances in the trophic webs of another marine SES, with negative impacts on ecological resilience. The framework overcomes this limitation, by suggesting that ecological resilience should be placed at the core of the vision for transitions of a particular sector. In this way, it is possible to have an increased coordination of management among sectors, and the desired transition of unsustainable sectors will benefit SES ecological resilience.

The third component of the framework relates to the management process. Both AM and TM acknowledge from the outset the impossibility to have a full knowledge of the system, and require managers to base decisions on the best available scientific knowledge, and to experiment with policies, introducing iteration and learning. Hence, complex systems management should be articulated into four phases:

1. Scoping – definition of the system to manage, and its initial assessment;
2. Envisioning – setting of targets and objectives of management; development of indicators and evaluation and selection of management strategies;
3. Implementing – implementation of the management strategy; and
4. Evaluating – monitoring of the effects of the management strategy on the system and in relation to the achievement of the objectives. The results of monitoring will be the basis for a new initial assessment for the next cycle of policy.

3. Methodology

The research presented in this paper analyses the text of the international agreements in place for the global oceans. The reason for this choice lays in the fact that international agreements are the main instrument for the creation of a binding regime of rights and obligations among sovereign states, which assures continuity and avoids ad hoc or arbitrary behaviour [21]. Consequently, other components of global oceans governance, such as informal rules and customary principles, and the rules and working practice of

Table 1
A framework for marine complex systems management.

Unit of management	Social-Ecological System [AM], including connected Socio-Technical Systems [TM]
Objectives of management	Achieve or maintain the ecological resilience [AM], in coordination with transitions of unsustainable Socio-Technical Systems [TM]
Structure of management	Iterative, learning-based policy cycle, based on thorough knowledge and understanding of the system [AM and TM]