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SPATIAL MANAGEMENT OF NEAR SHORE COASTAL AREAS: THE USE OF MARINE PROTECTED AREAS (MPAS) IN A FISHERIES MANAGEMENT CONTEXT

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ABSTRACT. – Coastal uses have deeply evolved these last decades and high anthropogenic pressures on coastal ecosystems have affected the sustainability of these areas with respect to the services and the resources they may provide. Traditional fisheries management has failed to avoid overexploitation of most coastal marine resources. Management measures based on an Integrated Coastal Zone Management (ICZM) are thus required. Spatial management covers various ranges of properties that may enhance usual regulatory means. If spatial considerations are explicitly integrated in fisheries management, the latter may contribute to zoning design in order to balance the economic, social and biological values of natural marine resources. While traditional fisheries management approaches protect resource based on population numbers, Marine Protected Areas (MPAs) protect ecosystem in space. Besides their ecological effects on fish assemblages within its boundaries, MPAs can enhance adjacent artisanal fisheries. MPAs can thus ensure the sustainability of fisheries and at the same time maintain non-fisheries benefits of marine ecosystems to society.

INTRODUCTION

Over the past thirty years, increased flows of population worldwide led to high anthropogenic pressure on coastal areas. Pressure on coastal ecosystems led to degradations affecting the sustainability of these areas and their ability to provide goods and services. Coastal ecosystems offer regulatory services as many other ecosystems such as flood and drought mitigation, erosion prevention, waste decomposition and recycling, denitrification, or nutrient regeneration (Norberg 1999). Coastal resources comprise a broad range of natural non renewable and renewable resources (e.g., waters, fishes, forests, minerals, flora and fauna), and social resources relying on criteria such as landscapes, aesthetic appreciations, cultural and patrimonial goods.

Uses of coastal resource have deeply evolved these last decades and traditional fisheries management has failed to avoid overexploitation of most of these resources (Lauck *et al*. 1998, Castilla 2000). A possible way out would be new fisheries management measures and practices within an Integrated Coastal Zone Management (ICZM) system. A balance needs to be investigated between coastal zone development and protection (Gallagher *et al*. 2004) through the concepts of sustainable development and ICZM[1]. ICZM must ensure multi-sectoral planning while allowing participation and conflict mediation (Christie 2005), and must generate social and environmental benefits that are equitably generated among constituencies (Christie *et al.* 2005).

The aim of this paper is to capture and provide insights on the concept of spatial management of coastal areas in a fisheries management context through a survey of recent studies. We first describe what is embodied by coastal marine resources and conventional regulatory means for fisheries, and review these means as opposed to spatial management features. Then, we discuss the expected benefits of a spatial approach and we finally highlight how Marine Protected Areas (MPAs) could be a spatial management tool for fisheries management.

[1] We refer respectively to sustainable development (Brundtland 1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" underlining also the intergenerational issue; and to ICZM, through the seminal work by (Cicin-Sain & Knecht 1998), as "a continuous and dynamic process by which decisions are taken for the sustainable use, development and protection of coastal and marine areas and resources".

COASTAL MARINE RESOURCES AND SPATIAL MANAGEMENT

Exploitation and conservation of coastal marine resources depend on economic and institutional features, which are: (1) the economic attributes that commonly classify goods and services in private, pure public or collective, mixed public (as Common-Pool Resources, CPRs) or merit goods, i.e. rivalry and exclusion; (2) the property regimes denoting "the decision-making arrangements that define the conditions of access to, allocation of, and control over a range of benefits" arising from goods or services (Steins & Edwards 1999); (3) the property rights and their allocation under the property regimes as "social institutions that have evolved as a means of enforcing claims" on benefit streams brought by goods or services (Steins & Edwards 1999), i.e. open access, public property, common property, and private property; (4) institutional arrangements towards resource exploitation and use leading to the setup of use rights for collective goods as CPRs (Ostrom 1990).

Coastal ecosystem goods and services tend to fall into categories of open access and pure public services (Chee 2004), whereas many users think they can acquire private property rights on CPRs through labour and harvesting (Haddad 2003). Without clearly defined property rights, overexploitation may arise while agents exploit resources beyond sustainable biological and economic yields following a myopic rule (Hardin 1968, Ostrom 1990, Ostrom *et al.* 1994). Because of market failures, negative externalities between users and social costs are at stake (Pigou 1920, Coase 1960) and require regulatory policies and management devices.

Coastal resources are managed by conventional instruments in terms of business sector regulation or institutional arrangements. These instruments cover a broad range of rules, laws, economic instruments (i.e. voluntary agreements, taxes and subsidies, rights allocation) and community-based management (Abdullah *et al.* 1998, Wiber *et al.* 2004, Charles 2006) to ensure efficient exploitation and equity between agents (Beger *et al.* 2005, White *et al.* 2005). However, these tools do not generally include spatial components or are not driven by spatial requirements. We believe that some of these policy issues should be analysed with such a perspective.

Spatial management opens up new possibilities in terms of regulatory means. First, spatial information includes the ecological, economical and social management components and can be gained towards resource dynamics (e.g. population dynamics, home range characteristics) and social dynamics (e.g. harvesters' behaviour or other users' behaviour). Geographical Information Systems (GISs) and spatial models are effective tools to help proper design of spatial management measures (Wilen 2000, Gourmelon & Robin 2005). Second, spatial management eases collective action while geographical proximity relationships enable positive externalities (Mollard & Torre 2004). Finally, spatial zoning is implemented as a tool to deal with opposite activities and conflict mitigation (Bohnsack 1996, 1998), and to provide various gains in use management. A spatial frame facilitates beneficiaries identification and ensures that activities are maintained or developed within the whole managed area.

THE SPATIAL COMPONENT IN FISHERIES MANAGEMENT

The general objective of fisheries management is fisheries sustainability (i.e. to provide food and to maintain related economic activities) while protecting fish populations (i.e. to provide conditions guaranteeing marine resources renewal). Various regulatory measures are usually implemented to achieve the desired goals of productivity and sustainability, but traditional fisheries management has generally failed to prevent massive overfishing at a global level (Russ 2002).

Traditional fisheries management still mostly relies on single-species stock assessments, even though more holistic approaches such as multispecies and ecosystem approach have been recognized as necessary to appraise consequences of fishing on resources and ecosystems. Management regulations may include spatial and temporal controls on catch or nominal effort, commonly supplemented with gear restrictions or size limits (Holland & Brazee 1996, Holland 2003). Technical measures such as gear restrictions or size limits protect resources based on population numbers by allowing a sufficient fraction of the population to reach maturity and to reproduce.

Traditional spatial and temporal fisheries management scales can be implicitly considered through allocation of quota to regions or to fleet sectors with different distributions (Babcock *et al.* 2005). There are stock assessments that consider fleets under the form of functional units that correspond to different areas, e.g. the Norway lobster in the Bay of Biscay (Anonymous 2006). When addressing problems associated with size selection and by-catch issues, the spatial delimitation of stock units, species ranges, nursery and fishing grounds, and also political juridictions, is common practice (Clay 1996). These traditional spatial approaches of fisheries management (e.g. control of fishing effort) are typically implemented over large spatial scales and are single-species oriented (Palumbi 2004). Most countries continue to follow these approaches and manage inshore areas and marine resources on a sector-by-sector regulatory basis (Ehler 2003). It may be applicable for single-species management; however it must be broader in ICZM processes where interactions need to be taken into account and where multispecies and multiple-use management have to be effective. Multispecies stock assessment models highlight the need for comprehensive analysis of the overall management system as opposed to single-species assessments of particular management measures for individual species (ICES 2006).

Besides direct effects on fished species, there are numerous indirect effects of fisheries affecting the whole ecosystem. The use of some fishing gears can induce habitat degradation. While managing fisheries, protecting habitat may provide a significant value, either by increasing fishery productivity through higher growth or lower natural mortality of commercial stocks, or by protecting non-commercial species (Holland 2003). Bringing these considerations into fisheries management could thus ensure the sustainability of fisheries and at the same time maintain non-fisheries benefits of marine ecosystems to society (Babcock *et al.* 2005), e.g. by the means of ecosystem conservation which can be attractive for non-extractive uses such as tourism and scuba-diving.

On coastal areas, where most fisheries are multi-specific and where there is substantial spatial heterogeneity in the distribution of species and markedly different selectivity or productivity across species, the potential of area closures for resolving overexploitation has been shown in several instances (Pelletier & Magal 1996, Holland 2003). However, many of the models used in this purpose may not be appropriate for policy evaluation (Pelletier & Mahévas 2005). Spatial zoning of coastal areas, including establishment of MPAs or areas where destructive fishing gears are prohibited (e.g. by the use of artificial reefs), may thus become a prime management tool (Babcock *et al.* 2005), especially whilst indirect impacts of fishing are an important issue (Hilborn *et al.* 2004).

If space is explicitly integrated in fisheries assessment and management, it will facilitate the consideration of all fishery components (see http://www.ifremer.fr/isis-fish for an example of such model) and provide a more comprehensive appraisal of fisheries dynamics. Spatial management can thus contribute to spatial zoning designed to balance the economic, social and biological values of natural marine resources. The integration of space in fisheries management include (1) how fish and fishermen cover space and how decision makers behave over space; and, (2) how management systems can integrate the ecological and social mobility with "spatial characteristics of the resource base as well as spatial dimensions of the exploiting industry" (Sanchirico & Wilen 1999, 2005, Pelletier & Mahévas 2005).

THE USE OF MARINE PROTECTED AREAS IN FISHERIES MANAGEMENT

MPAs may be strictly no-take zones where uses are not allowed, either extractive or non-extractive. Some others allow restricted uses such as traditional fisheries or scuba-diving. Most of the MPAs combine both within a spatial zoning. Zones (Fig.1) may be respectively dedicated to (i) strict conservation with controlled access by permits ; (ii) acting as a buffer zone that can be used for research, education or traditional uses; (iii) non-consumptive uses; and (iv) to limited consumptive uses (Agardy *et al.* 2003). Control access to the different zones must be established for each user group. A license can be delivered with or without access fees and in the case of extractive uses, with or without quotas. The institution of use rights for specific users can then be investigated. All these regulation means must be combined with the establishment of conspicuous borders to reduce possible impacts of incidental intrusions, with public information and with a voluntary and participative involvement of local communities and different users.

The spatial approach and usually the permanency of MPAs often make it easier to directly identify their beneficiaries than it is for other fisheries policies. Zoning can allow coexistence and must be established according to the management goals of the MPA (Claudet & Pelletier 2004). Compliance with the spatial zoning regulations depends on the users understanding about their goals to ensure the orderly and sustainable use of marine resources (Bohnsack 1996). Spatial zoning and in particular MPAs can only be implemented effectively with the support of local communities. If compliance is good, additional management costs will not be high to ensure the zoning enforcement.

While traditional fisheries management approaches provide a refuge based on population numbers, MPAs provide a refuge in space. MPAs are implemented over smaller spatial scales and are ecosystem-oriented; they jointly

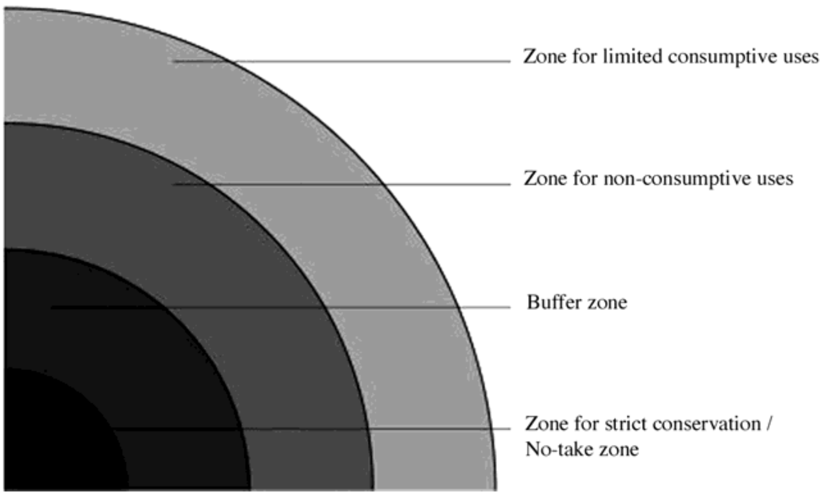

Fig. 1. – Generic zoning in a multiple-use MPA (from Agardy *et al.* 2003).

aim at managing and protecting the associated habitat and other components of the ecosystem. Recent studies and reviews have shown that MPAs can be effective at restoring fish size structure (Claudet *et al.* 2006), at increasing abundances of species targeted by fishery or by aquarium trade (Micheli *et al.* 2004) and that these relative impacts are independent of the size of the MPA (Halpern 2003). Responses to protection present a gradation through time, the most exploited species responding faster (Claudet *et al.* 2006). Besides these ecological effects of MPAs on fish assemblages within the restricted zones, MPAs can enhance adjacent artisanal fisheries, although empirical demonstrations are still scarce (Russ *et al.* 2004, McClanahan & Mangi 2000). The potential benefits of MPAs on fisheries are increased catches from 50% to 90% percent (Russ *et al.* 2004), increased size of fished species (Roberts *et al.* 2001) or reduced fishing effort.

CONCLUSION

We have investigated the issue of a spatial approach in coastal areas and natural resource management. We have provided insights on spatial management requirements and its implementation in fisheries management through the use of MPAs. Spatial management is an alternative providing space related incentives to users.

As a result, MPAs can be seen as a spatial and ecosystem approach to fisheries management. This implicitly means that the value of the whole ecosystem is greater than the sum of its parts and that the ecosystem provides goods and services other than fish. There is also the recognition of the indirect effects of fisheries and of the existing uncertainty in predicting that harvest will cause population collapse. Geographically specified and being an integration of information from a wide range of disciplines, they can take into account both the ecosystem knowledge and the uncertainties. Their ideally adaptive management considers multiple external influences and strives to balance diverse ecological, economic and societal objectives.

Nevertheless, the efficiency of any conventional or spatial management measures depends on the institutional contexts in which they are implemented as underlined in fisheries management, i.e. on the actual enforcement and combination of measures (OECD 1997). Furthermore, it appears that positive assessments on resource conservation and efficiency may coexist with negative impacts on equity (Rey-Valette & Cunningham 2002). Policy assessments highlight the need for preliminary and explicit definition of the management objectives (Rey-Valette & Cunningham 2002, Claudet & Pelletier 2004). Panayoutou (1982) and Laubstein (1993) insist also on the irreversibility of the delays when reduced effort is required; measures are usually implemented when the overexploitation process is already effective.

Future research should involve the study of joint management tools including the terrestrial and the marine parts of the whole coastal area. One of the main ICZM principles is spatial integration, bringing together management issues dealing with the land side of the coastal zone (including up-river issues related to watersheds and river basins), and issues related to its marine part (Cicin-Sain & Belfiore 2005). In addition, new users need to be incorporated in management processes, such as users attracted by the ecosystem values and NGOs dealing with conservation issues.

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