



Identifying multiple-use conflicts prior to marine spatial planning: A case study of A multi-legislative estuary in Brazil



Luana Prestrelo ^{1,*}, e Marcelo Vianna

Universidade Federal do Rio de Janeiro (UFRJ)-Departamento de Biologia Marinha, CCS-Centro de Ciências da Saúde, Bloco A, sala ss-054, 21949-900 Rio de Janeiro, RJ, Brazil

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ABSTRACT

Marine spatial planning (MSP) is essential to solve spatial multiple-use problems, but first it is necessary to identify and map all existing uses, regulations and conflicts. Use conflicts related to the multi-legislative governance, neglect of fishermen's interests, and intensifying industrial growth due to economic development were identified for in a multiple-use Brazilian estuary. Overlaps between areas that are presently used for fishing and areas that are subject to regulations prohibiting this activity were analyzed. Information on regulations establishing no-fishing zones, the most important fishing sites and fishing records were gathered and superimposed using a GIS dataset. Main fishing zones were located within prohibited fishing areas. Regulations limiting fishing activity govern navigation routes and pipeline safety zone, whereas environmental law restrictions were less important. Due to economic and industrial development, oil and gas distribution and harbor construction projects are increasing, aggravating use conflicts and jeopardizing fishing activity. Legislation fragments usable fishing areas forcing fishers to operate within prohibited zones. Neglect of fishermen's interests, and their exclusion on the decision-making process led to a legislative scenario that reduce fishing legal zone to few areas, which in most cases fisherman are not even aware were they are, being the main reasons for fisher's failure to comply with the current regulations, increasing the number of infractions and the marginalization of fishermen. Future studies on multiple-use coastal areas subject to multiple jurisdictions should focus on all uses, not only environmental, to better understand spatial conflicts and to establish a realistic MSP embracing fisheries management, environmental conservation and economic development.

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1. Introduction

Human pressure in coastal areas is increasing worldwide, depleting natural resources and biodiversity as a consequence of human occupation and its associated activities [1–4]. Estuaries are the most densely populated coastal systems and are the sites of many of the world's largest cities, making them the most vulnerable and heavily impacted aquatic ecosystem [5,6]. Their high productivity and natural resources make estuaries suitable for most human activities and ideal sites for settlement and urban and industrial development, with resulting high socio-economic dependence on the available resources and increasing anthropogenic pressure [3,5]. Multiple uses of the same area by different sectors

can cause many conflicts, mostly resulting from the need to use the same space for different purposes. Different estuarine activities such as fishing, navigation, harbors, transport/navigation, occur in the same space and at the same time, so the resulting conflicts are more noticeable than in other marine systems [5–7] and can be environmental, political or social. Lack of appropriate management policies such as zoning and allocation of competing activities may increase estuarine impacts [3,8].

In developing countries, environmental impacts and multiple-use conflicts are exacerbated by their often rapid and uncontrolled economic and population growth. The need for estuarine exploitation related to economic development, added to the low priority given to environmental conservation and heavy socio-economic dependence on natural resources, lead to environmental degradation and affect productive estuarine-dependent sectors [6,8]. Due to the complexity of the estuarine system and its enormous socio-economic importance and direct influence on people's livelihood, user-user conflicts (the overlap between different competing resource users, see [2,9]) need to be assessed in a

* Corresponding author.

E-mail address: luanaprestrelo@gmail.com (L. Prestrelo).

¹ Present address: Fundação Instituto de Pesca do Estado do Rio de Janeiro (FIPERJ). Escritório Regional Norte Fluminense II. Rua Julio Olivier, 128, Centro, Macaé. Rio de Janeiro, Brazil.

multi-sectoral, multi-organizational and multiuser subject. Unfortunately, environmental managers and ecologists may have little familiarity with these complex multidisciplinary questions [5]. Conventional coastal fragmented governance and policies have proceeded by separating all use activities into independent sector-management approaches, driven by a variety of political considerations and with different objectives according to each stakeholder [10,11]. Thus, traditional coastal management is limited to solving within-sector issues and incapable of resolving multi-sectoral use interactions, resulting in gaps, overlaps, conflicts and failures in governance of the common resources as pressures increase during economic development [12–14]. In developing countries this scenario is aggravated by the unstable and fragmented institutions and by inadequate environmental and socio-economic policies [15,16]. Changes in traditional management strategies need to include social, economic and environmental issues, and to consider the marine space, policies, and strategies to identify critical use conflicts and establish management priorities [2,4,6,9].

One of the most important socio-economic activities in developing countries estuaries is small-scale fisheries (SSF), which provide many people with employment, food security, family income and social stability, so estuarine management and conservation strategies should consider it [15–18]. SSF are limited by their simple technology and small boats, are highly associated with areas adjacent to fishermen communities, and operates anywhere that fish are present within the shallow, sheltered, highly productive estuarine waters, sharing its use with recreational sailing and transport boats, industrial vessels, navigation channels, and pipelines [7,19]. These features make SSF heavily dependent on conditions in the estuarine system and the available coastal fishing zones [3,20] and most vulnerable to multiple-use conflicts. Even though SSF are important for the sustainability of coastal resources, they face considerable problems and many developing countries are no longer capable of meeting the socio-economic demands, due to a political inability to manage multiple-use conflicts and the excessive neglect of these fisheries [15,21–23]. The main problem facing SSF in developing countries is lack of participation by fishermen in decision-making, due to their poverty, marginalization and lack of political influence [21]. Management approaches need to change in order to overcome these vulnerabilities [15].

The first step to manage multiple-use areas is to identify all multiple-sector uses and conflicts to than incorporate the marine spatial planning (MSP) process. MSP is helpful in meeting this requirement, since the planning process can identify and assist coastal conflicts, the interaction of human activities, and their cumulative impacts, and has been applied with high priority, especially to conflicts among multiple users [2,4,9,13,24]. MSP integrates the spatial features of marine and social systems, and can be used to analyze and integrate aspects of ecology (natural resources) and socio-economics (human uses) to determine efficient strategies for sustainable development and allocate marine resource users through a political process that improves long-term decision making [2,4,12,25]. One important component to be considered in MSP is the zoning process, which defines and maps use zones according to their users [2,26,27]. Combining these two strategies makes it possible to incorporate spatial aspects through the identification and allocation of conflicting human activities use areas, their distribution and the spatial segregation of incompatible users, to establish regulations within zones, and reduce multiple-use conflicts to accomplish management ecological and socio-economic goals [11,12,19,27]. Despite the importance of MSP and zoning for coastal and SSF management, few studies have addressed its application in bays and estuaries [9].

MSP must consider the spatial scale of the resources as well as

the social and governmental legislative structure in developing a locally based policy [12,13]. The lack of tools to establish integrated management intensifies the overlap of human activities, increasing multiple-use conflicts and reducing the links among those responsible for multi-sector coastal uses [10]. The need to incorporate the human aspects into fishery management stems from its failures, neglect, and the disparity between social and economic development, which are exacerbated in developing countries where SSF lack appropriate management and regulation [22,28]. The importance of taking into account the local knowledge of fishermen in reaching management decisions, the incorporation of local knowledge into MSP, the potential of this knowledge to fill gaps in quantitative scientific knowledge, and fishermen's direct interest in and need to continue fishing activity are widely understood [18,20,23,29,30]. Challenges in using local knowledge in developing management projects include a lack of confidence in it, because it is by nature subjective, qualitative, and difficult to validate; the differences in the use of language by fishermen and by scientists; and the fear of diminishing scientific knowledge [20,31]. On the other hand politicians, fishermen and other stakeholders usually find scientific reports difficult to interpret because of their complexity [3,15].

In this study, gaps in the steps taken in the development of MSP during the initial stages of mapping conflict zones were identified. These omissions stem from a lack of prior evaluation of non-environmental legislation that integrates spatial-use conflicts in an estuary and jeopardizes SSF activities and income, due to a top-down policy and neglected regulation of fisheries. In view of the present situation of multi-use conflicts existing in a multi-jurisdictional and highly impacted estuary in Rio de Janeiro State, Brazil, it became a good example of developing countries' deficient SSF coastal management, misleading spatial aspects of multiple-use conflicts. The present study aimed to identify other sources of conflicts with fishing users, in addition to those that arise from environmental considerations; to determine the impacts of these conflicts on the local SSF activity; and to suggest possible strategies to reduce conflicts in cases where use zones overlap. AGIS-based approach to map fishermen's local knowledge was used and the most important fishing grounds and the geo-referenced important fishing areas on the geo-referenced no-fishing zones defined by the multiple legislative authorities were superimposed. This will help to identify conflicts between overlapping uses in the multiple-use estuary that continues to undergo intense economic development, and to indicate other issues that should be considered prior to MSP process, thus reducing the challenges involved in its implementation and increasing the chances of success.

2. Materials and methods

2.1. Case study

This study was carried out in Guanabara Bay (GB), Rio de Janeiro State, southeastern Brazil (Fig. 1). Located within one of the largest Brazilian metropolitan areas, GB is among the largest Brazilian estuaries (348.9 km²) and is the most heavily impacted estuary in the country. The surrounding area is densely urbanized, with a population of over 12 million people [32]. GB has enormous and increasing economic importance, with 17,867 factories presently operating in the metropolitan zone [32] and many more facilities to be constructed, mainly for processing oil and natural gas, necessitating more drastic interventions such as dredging, which will inevitably affect the structure of fish populations [33] and the areas available for fishing. It has an important socio-economic role with over 3000 people engaged in fishing in the bay

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