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A new approach to assess marine opportunity costs and monetary values-in-use for spatial planning and conservation; the case study of Gulf of Naples, Mediterranean Sea, Italy

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ABSTRACT

Conservation actions (as Marine Protected Areas) are key tools to maintain coastal ecosystems. However, many reserves are characterized by several problems related to inadequate zonings that preclude important areas from economic activities, determining a strong hostility by local populations. Thus, estimations of marine economic values-in-use are needed for protection of marine ecosystem in order to find the best compromise between conservation priorities and local population needs. Algorithms to estimate monetary values of the main human activities in marine territories (large scale and small scale fishings, aquaculture, beach resorts, yachting, diving and commercial shipping) are here implemented using Gulf of Naples (centre Tyrrhenian sea, Italy) as study area example. These algorithms are based on different sources data (questionnaires, monitoring activities, official local authority reports, web and scientific literature). They can also be compared with each other being their outputs all expressed in the same measure unit. During the models development process a new flexible approach, called "Systematic Costs Assessment" (SCA), to assess opportunity costs in systematic conservation planning process was developed and applied. Results show that the total turnover in the Gulf of Naples is 3,950,753,487 € per year and 747,647,887 € per year excluding small scale fishing estimation, and one hectare of marine territory is worth 40,672 € and 7696 € per year excluding small scale fishing activity. In particular, excluding small scale fishing activity, beach resort and yachting show the highest values referred to one hectare of marine territories. In conclusion, SCA is a flexible approach where no long and costly sampling campaigns are always needed, provided that two assumptions have to be taken into account, in order to estimate credible values-in-use costs: i) do not use economic activities data and ecosystem services data in the same assessment layer, since it could lead to costs overestimation and ii) SCA method are efficient when used by operators with strong knowledge of the study area, since they are able to recognize parameters affecting economic activities of local population.

1. Introduction

The coastline is the border line separating and connecting landscape and seascape. Coastal zones are characterized by environmental gradients with high biodiversity due to a large number of species and varieties of habitats, higher along the coast than in other zones of marine territories. This is especially the case in the Mediterranean, where fishing and touristic practices are mostly confined to a narrow strip of continental shelf (Papaconstantinou and Farrugio, 2000).

Human populations and their demands for land, energy, and natural resources are exponentially growing, creating pressures on ecosystems that are not expected by conventional approaches to natural resource management (Leisinger et al., 2002). Ecosystem-Based Management (EBM) approach (Katsanevakis et al., 2011) is developed to tackle this problem from a holistic point of view, involving management of species, habitats and human activities. Ecosystem management is best thought as "the process of ecosystem-based management of human activities" (Grumbine, 1991; Kay and Schneider, 1994) using appropriate management and protection tools, such as Marine Protected Areas (MPAs) (Browman and Stergiou, 2004; Halpern et al., 2010; Rassweiler et al., 2012). Protection tools guarantee the conservation of marine biodiversity, increase commercial fish sizes and biomass (e.g. Fenberg et al., 2012; Guidetti et al., 2008), produce economic benefits and enhance visitors flows through sustainable practice of marine

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activities, such as diving and yachting (Badalamenti et al., 2000; Lopes et al., 2015; McCook et al., 2010).

Nevertheless, many MPAs are inefficient to pursue their own conservation and sustainable objectives. Indeed, relevant sites characterized by high number of species (Appolloni et al., 2017; Di Donato et al., 2006; Russo et al., 2005) or by important species for ecosystem functions (Donnarumma et al., 2018; Fraschetti et al., 2005) are located in areas of partial protection. At the same time, management efforts are often vain since local populations often consider protection policy tools simply linked to biodiversity conservation (Badalamenti et al., 2000).

In order to overcome these criticisms, the Systematic Conservation Planning approach was developed in recent years (Margules and Pressey, 2000). This is based on the explicit definition and quantification of conservation objectives to be achieved, and, at the same time, on minimization of opportunity costs linked to the protection (Smith et al., 2006). Those opportunity costs can be viewed either as ecosystems services lost by local population in environmental degraded areas (Franzese et al., 2017, 2015; Picone et al., 2017; Vassallo et al., 2017) or in the Millennium Ecosystem Assessment (MA) framework, analysing socio-ecological systems with wide influence in the policy and scientific communities (Carpenter et al., 2009 and references therein) or, at least, from the stakeholders points of view. In the latter case "opportunity costs" are defined as costs of foregone opportunities, a measure of what could have been gained via the best use of a resource if it had not been included in a reserve. In terrestrial and marine protected areas, where extractive and exploitation activities are forbidden, opportunity costs are measured as the highest economic value of those activities if no form of protection is applied (Naidoo et al., 2006). However, to assess the opportunity costs of parcels of sea territory could be very hard since marine systems are typically common-pool resources where the same parcel is used for many activities (Beck et al., 2004; Ostrom et al., 1999). Those activities producing values-in-use of marine territories are classified into two macro-categories: direct and indirect values of bio/environmental resources (McNeely, 1994, 1988). The first ones refer to consumptive (those values placed on nature products that are consumed directly, without passing through a market) and productive values (those products which are commercially harvest, often being the only biological resources having a clear monetary cost). The latter ones, representing the greatest part of marine territories, are the indirect values, concerning environmental resources that do not normally appear in national accounting systems even if their exploitation has direct consequences on the value of biological resources. All values-in-use have to be minimized during MPA planning in order to meet most stakeholders needs, that, eventually, improve MPA efficiency. Conservationists, resource managers and social scientists frequently disagree on whether it is possible to achieve a balance between social-economic and ecological benefits in environmental management (Christie, 2011), however, in a multiple objective process it is hard to maximize more than one value-in-use at a time (Stanley, 1995). In order to meet the local needs many researchers have used only fishing activity as representative of all marine economies (Klein et al., 2009; Wood and Dragicevic, 2007); however they, soon, understood that it was not enough since areas having no value for fishing, could have values for other activities, such as tourism (McClanahan, 1999; Russ and Alcala, 2004). Thus, in recent years some authors proposed that countries aiming at protecting marine biodiversity in their territorial waters should move from a single objective approach to a broader socioeconomic context incorporating multiple activities (Douvere and Ehler, 2009; Ehler and Douvere, 2009; Mazor et al., 2014a).

There are few documented examples where different kinds of activities are combined (Giakoumi et al., 2011; Green et al., 2009; Leathwick et al., 2008) since socioeconomic data are often measured in different units and/or can involve difficult decisions on weighing different costs.

Therefore, in the present investigation, models based on local data describing marine values-in-use, being preferable for decision makers and planners (Carwardine et al., 2008; Naidoo et al., 2006), are developed since they allow to sum activities on marine territory using the same economic unit (euro) and spatial extension (one hectare). Thus, it does not assess the effect of activities on ecosystems and their services to local population, but rather it might represent a way to integrate a wider set of stakeholders needs in the planning processes of protected areas.

2. Materials and methods

2.1. Study area

The Gulf of Naples is located on centre south Tyrrhenian Sea and comprises 385 km of coastline where face 25 municipalities, many of which are characterized by high population density.

The privileged geographical position makes the port of Naples one important commercial hub in Mediterranean Sea. The structure of the Naples harbour offers an articulated and complex port services system in which operate more than 370 companies employing with more than 5200 people.

Geomorphological configuration, natural beauties, excellent climate, culture and tourist facilities also make the Gulf area a very important tourist destination centre. Locations as: the Gulf Islands (Capri, Ischia and Procida), Sorrento peninsula, Vesuvius National Park, Phlegraean Fields and archaeological sites of Pompeii, Herculaneum and Pozzuoli, act as a powerful driving force of all economic sectors. In addition, in order to preserve marine habitats biodiversity, chronically subjected to multiple anthropogenic stressors, four Marine Protected Areas were established along the coastline: the Underwater Parks of Baia and Gaiola MPAs, the Regno di Nettuno MPA and the Punta Campanella MPA. Although these MPAs are established rather close to very urbanized and commercially active areas leading to marine stakeholders hostilities (principally fishermen and touristic managers) (Badalamenti et al., 2000) they became more and more important attractive poles for many touristic activities (swimming, yachting, diving, etc.) in the last years, enriching, *de facto*, a good part of the Gulf of Naples citizens.

The study area is also characterized by peculiar orographic aspects influencing wind and sea dynamics (Uttieri et al., 2011). The Vesuvius volcano (elevation: 1281 m) and Naples hills (elevation: about 450 m) can shelter north-easterly winds blowing over the basin mostly in winter, creating jet currents responsible for rapid coast offshore water exchanges (Cianelli et al., 2012). These frequent water exchanges, helped by two deep canyons, provide a continuous supply of clean and deep water, rich in nutrients, that support high biodiversity, although the area is characterized by a strong urbanization. This in economic terms translates into intense large scale and small scale fishing activities that significantly contribute to the population richness.

2.2. Data collection and computation of monetary values-in-use

Some of the main activities performed in the present investigation are georeferenced and mapped at 1:50,000 scale using ArcGIS for Desktop 10.1 © ESRI. For each activity, algorithms developed to assess their significance on local economies are described. Then a net of 10,454 hexagons of 10 ha each, hereafter called Costs Units (CUs), are considered and activities are summed in each CU.

2.2.1. Large Scale Fishing (LSF) (bathymetric range: deeper that 50 m depth)

From July 2007 to April 2008 censuses of fish catches were carried out. The fishing gear used was trawl net, the most widely used gear for large scale fishing activity in the Gulf (Regione Campania, 2014).

Fish prices showed by ISMEA (Institute of services for the agricultural market food, supervised by the Italian Ministry of Agriculture) were used in order to estimate monetary values of species recorded.