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Studying the historical evolution of ecosystem services to inform management policies for developed shorelines

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ABSTRACT

Coastal areas of developed countries have been altered by human activities, especially since the mid-20th century. This has notably affected the flow of ecosystem services that these environments provide. In this context, this paper's research has focused on the historical evolution of socio-ecological dynamics and ecosystem services in a Mediterranean coastal landscape, characterized by the intense development of recent decades and the high biodiversity value. Qualitative and quantitative data were gathered and analyzed through different methods (document and spatial analysis, statistical treatment). Results show the long history of many ecosystem services (increase/decrease in food provisioning, stabilization/decline of regulating services and no use/intense use of cultural services) and their decline in recent decades due to industrial and residential development (which expanded from 1.7 to 47.5%). To overcome this situation, this paper discusses the current state of ecosystem services and conservation tasks carried out and how the results of the research can be included in the different elements of the governance of shoreline areas.

1. Introduction

Coastal areas of many countries have been notably transformed by human action in recent decades (Bajocco et al., 2012; Defeo et al., 2009; Nordstrom, 1994). Human activities and settlements have caused damage to important ecosystem services in different coastal ecosystem types (Jackson and Nordstrom, 2011; Martínez et al., 2007). Consequently, wetlands, beaches, dunes, coastal forests and marine ecosystems have been affected worldwide (Cabrera-Vega et al., 2013; Defeo et al., 2009; Levin et al., 2009; Martínez et al., 2007; Pintó et al., 2014). Coastal areas have suffered a continuous process of urban development that has adopted different forms (urban sprawl, compact model or polycentric model) in response to specific regional tendencies (Catalán et al., 2008). In the Mediterranean region, changes in land cover have been studied, reflecting the remarkable reduction in agricultural land and the increase in impervious land (Martí, 2005). The main consequence of this trend has been the gradual degradation of the coastal landscape. This process has created dysfunctions in the coastal system, which are particularly intense in the first kilometer of the coast. Dune systems have been completely erased or considerably reduced in many beach-dune systems (Jackson and Nordstrom, 2011), as well as many coastal wetlands (Wolanski et al., 2009).

From the point of view of the management and governance of coastal areas, most studies are very recent. They have analyzed impacts, vulnerability, risks (Lozoya et al., 2011), management practices and perception of users/stakeholders (Ariza et al., 2008). However, with few exceptions, they have not described in detail the different steps by which these ecosystems (dune-beach systems, coastal forests and wetlands) of developed shores have been transformed from natural or semi-natural lands into urban areas or periurban parks, or described the different historical relationships between society/stakeholders and the natural systems. Neither has the long term evolution of the ecosystem services that these particular areas provide been consistently analyzed.

To do so, it may be appropriate to link ecosystem services with landscape history and to adopt a historical-ecological approach.

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Both approaches are able to establish a good base on which to investigate the evolution of ecosystem services by studying the relationship between a society and its environment, and derived landscape changes (Bürgi et al., 2015).

In terms of established regulations, the coastal fringe of the first 500 m–1 km is presently specifically regulated in most countries by coastal planning laws that were enacted in the 1980s. They were intended, among other objectives, to protect natural systems and guarantee public accessibility to the coast. However, in terms of preventing urban development of the first dune line (right next to the beach) they have not effectively worked (Naredo and Montiel, 2011; Ruppert, 2008) due, in part, to the intense urban development processes occurring in coastal areas prior to when the laws were passed, and the lack of strict definition and enforcement of a setback afterwards. Of note in this regard is the specific demand for a 100 m setback established in Art. 8 of the "Protocol on Integrated Coastal Zone Management in the Mediterranean" in 2008, on the countries that ratified this legal framework (UNEP/MAP/PAP, 2008). In the case of Spain, the Ley de Costas (22/1988) included this prevision, but in many occasions it was not fulfilled due to the fact that in urban and able-to-be-developed zones this limitation was reduced into only 20 m.

Studies that have focused on long term bio-physical and social trends in these areas may be useful for coping with the present worldwide failure of coastal management (Shipman and Stojanovic, 2007; Suárez de Vivero and Rodríguez Mateos, 2005). The fact that in many countries a large amount of coastal development took place before the current legal and administrative management framework was put in place makes historical landscape studies of the coastal socio-ecological system particularly valuable for guiding its future management (Bürgi et al., 2015). It may provide a new perspective by helping to define and separate the newest and oldest elements of the system and establishing governance structures and tools with the best of them. This approach may be synergistically combined with the study of past and present ecosystem services in the area. These studies have

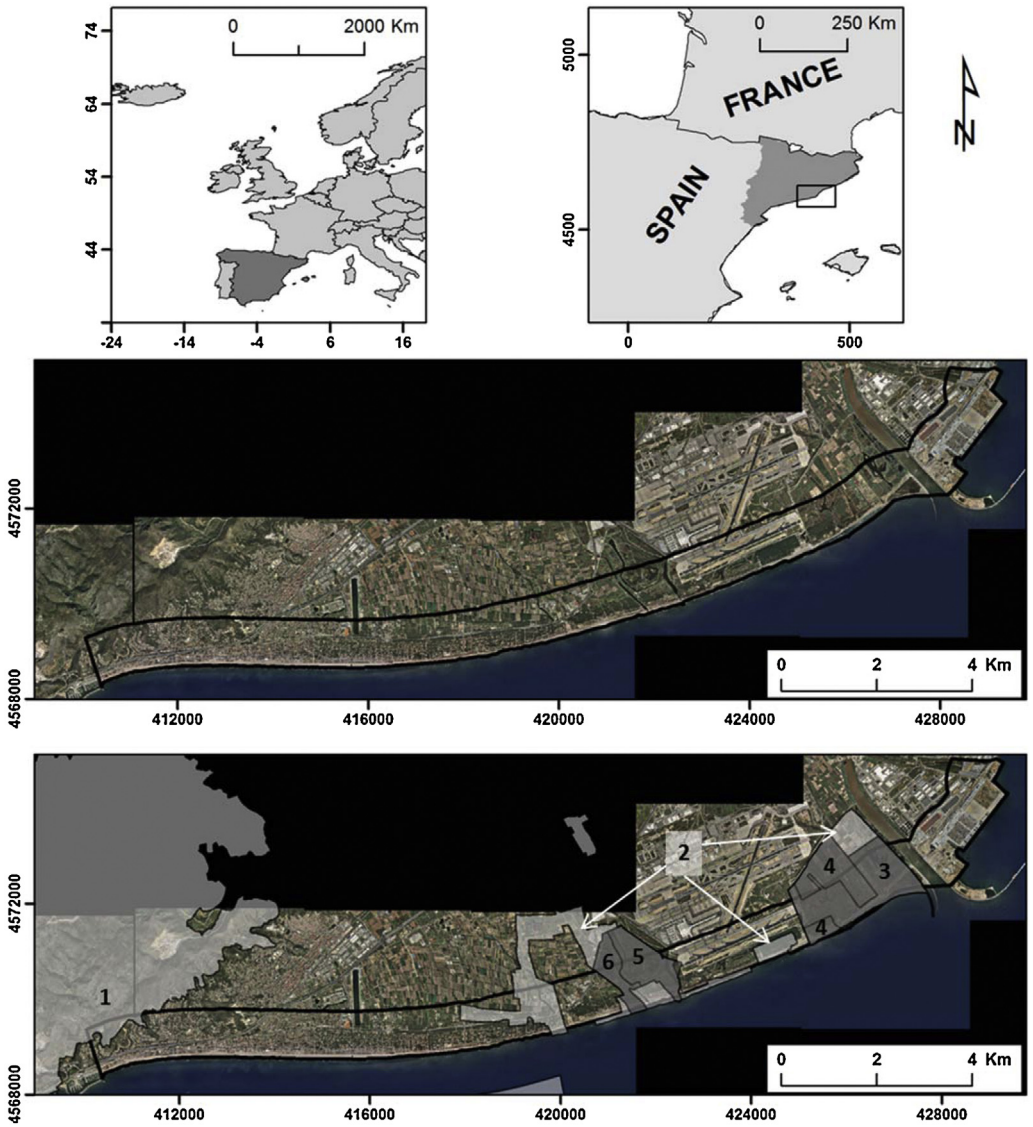

Fig. 1. Study area. Map of below shows the protected natural areas from Natura 2000 network (EU) and regional government (Generalitat de Catalunya). Natura 2000 network: (1) montains of the central coast (EU code: ES5110013); and (2) Llobregat delta (ES0000146). Generalitat de Catalunya: (3) La Ricarda – Ca l'Arana Natural Reserve; (4) Peripheral protection area of La Ricarda – Ca l'Arana Natural Reserve; (5) El Remolar – Filipines Natural Reserve; (6) Peripheral protection area of El Remolar – Filipines Natural Reserve.