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Research article

The recovery of estuarine quality and the perceived increase of cultural ecosystem services by beach users: A case study from northern Spain

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ABSTRACT

In Europe, the quality of coastal bathing waters improved considerably in the last decades, mainly due to the more demanding legislation and the adoption of water sanitation plans. In the Nerbioi estuary (North Spain), the Wastewater Treatment Plan implemented between 1990 and 2001 resulted on an abrupt decrease in microbial concentration; thus, complying with bathing waters legislation and allowing recreational activities again in the three beaches of the estuary. However, little is known about how improvements in bathing waters influences the provision of cultural ecosystem services and human well-being. A questionnaire was used to study beach users' behaviour and perceptions and compared with environmental time-series data (microbial concentration and water transparency). Most respondents perceived an improvement in bathing waters quality and linked it to the estuarine sanitation. Nerbioi beaches are important recreational areas, mainly for local visitors, and water quality improvement was found to be a critical factor for deciding to visit these beaches. Furthermore, most visitors answered that they would not return if water conditions deteriorate. Significant differences existed between beaches, with the most inner beach presenting worse environmental conditions than the other two beaches; and matching user's perceptions. Our findings highlight that water sanitation actions are important for the recovery of degraded coastal environments and for the maintenance of ecosystem services. Also, that multidisciplinary research is necessary to better comprehend the links between environmental recovery and the provision of ecosystem services.

1. Introduction

Estuarine and coastal areas attract diverse anthropogenic activities (Barbier et al., 2011) and concentrate a high proportion of human population worldwide. Indeed, 40% of the global population lives within 100 km from the coast, with 71% of them living no further than 50 km from an estuary (Agardy and Alder, 2005), concentrating a large and diverse number of human activities. These activities (e.g. urban, industrial and touristic activities) entail numerous pressures and impacts to these environments, causing rapid degradation of their ecological status (Davenport and Davenport, 2006; Jackson, 2001; Lotze et al., 2006) and jeopardizing their capacity to deliver ecosystem services (Barbier, 2017; Millennium Ecosystem Assessment, 2005). Among the multiple ecosystem services that estuarine and coastal environments provide, cultural ecosystem services are defined as those that provide recreational, aesthetic spiritual and educational benefits to society (Hernández-Morcillo et al., 2013).

Recreational activities and tourism are some of the most important human activities developed in coastal environments, in terms of economic resources mobilization and the high number of people that attract (Gormsen, 1997; Hall, 2001). Some of the most intense coastal recreational sites are beaches (Schlacher et al., 2014), composed by the sandy shore and the adjacent water body (i.e. bathing waters) and are also some of the most impacted and degraded coastal areas due to the intense anthropogenic pressures they support (Defeo et al., 2009). One of the most negative human impacts affecting beach recreation is the microbial water pollution arriving from diffuse and point sources, that degrades beaches' bathing waters (Quilliam et al., 2015) and entails a health risk for users (Abdelzaher et al., 2011; Prüss, 1998).

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The negative consequences that bathing waters degradation could cause in local economies and human well-being (Given et al., 2006; Ofiara and Seneca, 2006) have raised both scientific and policy interest. So far, the most common responses to revert beach degradation are ecological restoration and the establishment of more restrictive water quality legislation (e.g., (European Commission, 2006; Health Canada, 2012; US Government, 2000)). Many countries have legislation and guidelines to manage the health risks associated to recreational waters such as USA (US Government, 2000), Australia (Australian Government, National Health and Medical Research Council, 2008), and Canada (Health Canada, 2012). Particularly, in the European Union, a robust legislation has been established to promote a sustainable development of human maritime activities, to halt degradation of coastal environments and to protect them (e.g. (European Commission, 2008, 2006)). Beach bathing waters have been regulated since 1975 (European Commission, 2006, 1976). These Directives established the microbiological concentration limits for protecting human health, which are mandatory for monitoring all bathing waters within Europe. The approval of gradually more demanding legislation on water quality standards is having a positive effect in the recovery of beach quality (European Environmental Agency, 2017).

Indeed, beach users' perception towards beaches is known to be affected, among other parameters, by bathing water quality (Ofiara and Seneca, 2006; Tudor and Williams, 2003). Some studies found that clean water is one of the most important parameters when choosing a beach (Roca and Villares, 2008). Although water quality in beaches is assessed by microbial concentration limits, beach users' value different variables to judge water cleanliness, such as clarity (Peng and Oleson, 2017). Users perceptions on beach quality are important to understand the service flow between natural systems and cultural ecosystem services. For this reason, determining to which extent the improvement of a beach element (i.e. bathing waters) influences the overall satisfaction of beach visitors, and ultimately their well-being, is an important issue in environmental management. Indeed, the flow between natural systems and goods and benefits is not straightforward (Mace et al., 2012; Reyers et al., 2013); it partially depends on how humans value nature. However, people value nature in a multidimensional way (Chan et al., 2012; Cundill et al., 2017), which in turn affects the perception of the benefits they obtain from nature. Being the production of cultural services strongly linked to social factors (Reyers et al., 2013), the perceptions of people benefiting from those services should be taken into account when defining indicators for cultural services (Hernández-Morcillo et al., 2013; Kumar and Kumar, 2008).

In this investigation, we focus on the case of three beaches, located inside an estuary in northern Spain, which were severely degraded by industrial and urban wastewaters during the 19th and 20th centuries but have progressively recovered over the last 25 years. The objective of this study is to establish if the environmental recovery of the natural system and the estuarine water sanitation meant an improvement in the delivery of cultural ecosystem services and human well-being, stated as the perceptions and behaviour of beach users, with a special focus on bathing waters. The study has three operational goals: (i) assess the evolution of bathing waters status, through environmental data; (ii) analyse if beach user's perceptions and behaviour has changed over time in

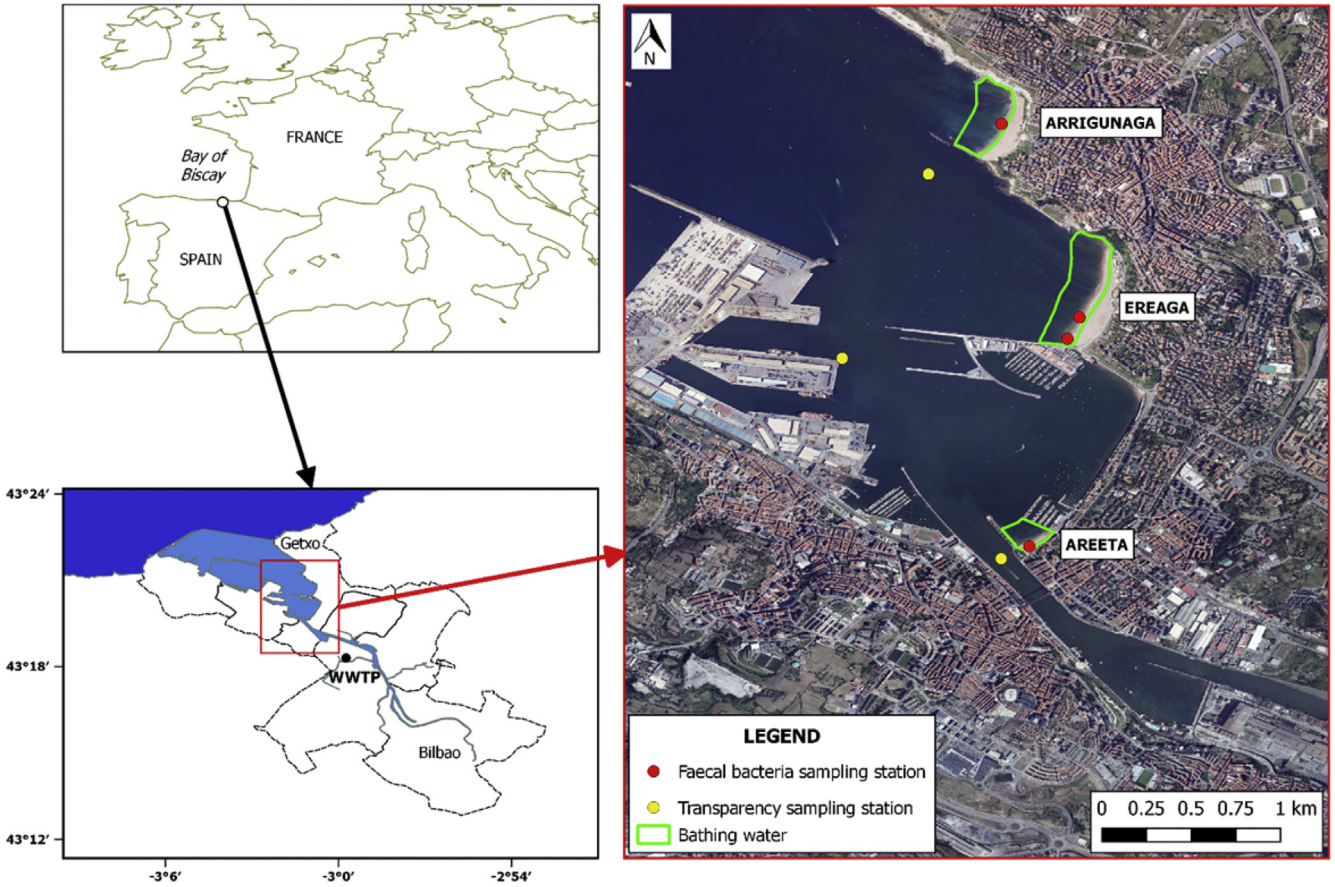

Fig. 1. Location of Nerbioi estuary within the Bay of Biscay, showing the position of the Waste Water Treatment Plant (WWTP), the three beaches investigated and the sampling stations for environmental variables.