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Valuing climate change mitigation: A choice experiment on a coastal and marine ecosystem

Kyriaki Remoundou [a,*], Pedro Diaz-Simal [b], Phoebe Koundouri [c,d,e,1], Bénédicte Rulleau [f]

[a] School of Management and Business, Aberystwyth University, Wales, UK
[b] Environmental Hydraulics Institute IHCantabria, University of Cantabria, Spain
[c] School of Economic Sciences, Athens University of Economics and Business, Greece
[d] Grantham Institute, London School of Economics and Political Science, UK
[e] ICRE8: International Center for Research on the Environment and the Economy, www.icre8.eu
[f] Cultures, Environments, Arctic, Representations, Climate (CEARC), University of Versailles Saint Quentin en Yvelines, France

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ABSTRACT

This paper adds to a limited literature eliciting willingness to pay (WTP) for mitigation measures against natural hazards caused by climate change, on coastal and marine environments. Our case study is Santander, a coastal region in Northern Spain. The case-study specific natural hazards concern (a) sea-level rise, high tides and extreme wave events that lead to floods and beach erosion, (b) rise in sea temperature that leads to invasive jellyfish blooms and changes in native biodiversity. In particular, we employ a choice experiment (CE) to elicit the value locals place on improvements, through the implementation of appropriate mitigation measures, in biodiversity, recreational opportunities and on decreases in health risks associated with jellyfish blooms. Results suggest that people value positively benefits in terms of increased biodiversity and recreation opportunities, as well as health risk reductions, and point to interesting policy implications.

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1. Introduction

Global climate change (CC) affects the physical, biological and biogeochemical characteristics of the oceans and coasts, modifying their ecological structure and functions, and consequently the amount of goods and services they provide (IPCC, 2007). Specifically, CC influences the marine and coastal ecosystems through changes in temperatures and sea level, ocean circulation, storminess and wave regimes. Changes occur on the level of nutrient availability, biological productivity, the timing of biological events and predator–prey relationships across the food web. In addition, CC effects such as ocean acidification and introduction of non-indigenous species result in more fragile marine ecosystems. The increasing frequency of extreme weather events and sea level rise can also affect coastal ecosystems and result in significant erosion of beaches which in turn impacts on recreational values and tourism.

In this paper we focus on the economic valuation of CC induced effects, which negatively affect biodiversity, the size of local beaches and therefore recreational opportunities, as well as invasive jellyfish blooms which can imply hazards for human health. Although there is some economic literature on the valuation of CC effects, like sea-level rise and flooding (e.g. Dawson et al., 2011; Nicholls et al., 2008; Ng and Mendelsohn, 2006; Brouwer and van Ek, 2004; Wardekker et al., 2010) there are only few studies assessing the willingness-to-pay (WTP) for CC mitigation options in coastal areas (e.g. Berk and Fovell, 1999; Longo et al., 2012; Polomé et al., 2005; Rulleau and Rey-Valette, 2013). This paper aims to contribute to this limited literature by eliciting WTP to avoid CC related environmental and health risks in the Bay of Santander, located in Cantabria, Northern Spain, using a choice experiment.

The remainder of this paper is structured as follows. In Section 2, we provide information on our case study, the Santander Bay in Spain. In Section 3 we present our choice experiment study and data collection method. Section 4 reports the descriptive statistics and the model estimation results. In the last section, we conclude by discussing the policy implications of our findings and limitations of the study.

2. The case study: Santander, Spain

Santander is the capital city of the Region of Cantabria, Northern Spain (Fig. 1). Its Bay is the largest estuary on the North coast

* Corresponding author.
E-mail address: kyr2@aber.ac.uk (K. Remoundou).
[1] www.icre8.eu.

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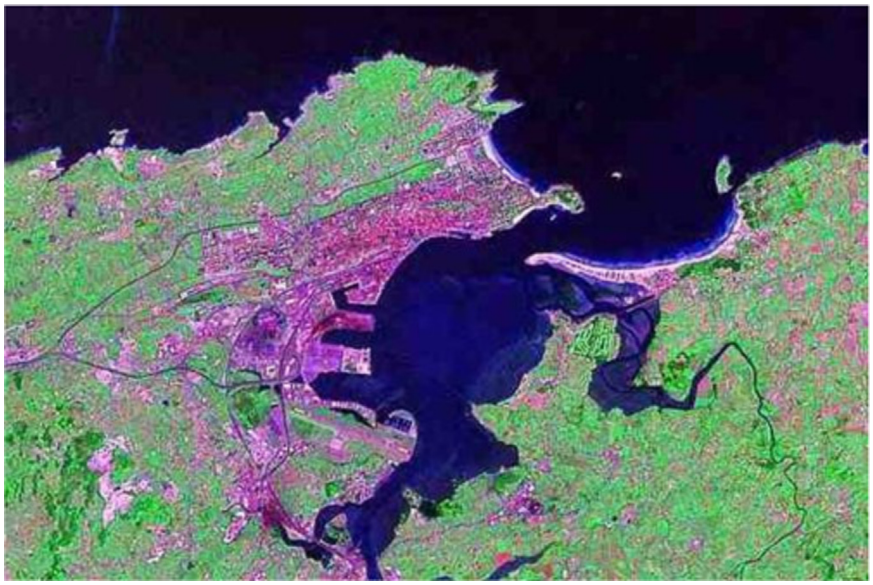

Fig. 1. Bay of Santander in 1997 (source: NASA).

of Spain with an extension of 22.42 km², 9 km long and 5 km wide. It is characterized by pocket beaches and small inlets isolated between rocky headlands. These beaches have an important role as focal locations for social and touristic activities. The Santander Bay is a member of "The Most Beautiful Bays in the World" Club and the city attracts 45% of the Cantabrian visitors. Summer activities are closely tied to the availability of beaches. Hence, Santander beaches are one of the most valuable natural assets in Cantabria.

Santander city itself has a population of around 190,000 people while more than 260,000 are living in the Bay. Due to this anthropic pressure, the morphology of the Bay has suffered important changes in the last centuries. It is estimated that more than 50% of its original extension has been filled up, drying up a large amount of marsh area, to be used as grasslands, to expand the Port of Santander, and to create new industrial and residential areas together with the local airport, located in the South of the Bay.

At the same time, the Bay of Santander will, as many coastal regions, face a number of significant challenges due to CC in the near future (Villatoro et al., 2014) and issues such as high tides and extreme wave events have traditionally attracted stakeholders' attention in the area (Touili et al., 2014). Marcos et al. (2005) have shown that sea level has been rising at a rate of 2.55 mm/year in Santander during the second half of the 20th century, which corresponds to the average trend estimated in the Western Atlantic Ocean, and a further 0.5 increase for the end of the century seems reasonable (ECCE Project, 2005). In Santander, the middle and eastern parts of the Somo sand spit, for instance, are fully exposed to the North-Western Cantabrian swell waves (Medellín et al., 2008) whose annual average significant height is about 1 m (Medina et al., 2007) and are already severely affected by periodic flooding events resulting in important erosion processes (Losada et al., 1991). Furthermore, the swelling energy reaching the Cantabrian Coast is expected to increase due to CC (ECCE Project, 2005). The Santander Bay has already suffered significant damages caused by severe weather conditions such as Storm Becky in November 2011 that came with wave heights observed near-shore of about 8 m and with a storm surge of 0.6 m. The municipality estimated costs of material damage and the subsequent clean-up to exceed €400,000 in Santander alone for this sole event. Across Galicia, the adjacent region, costs are likely to have exceeded €4 million. Fortunately, human casualties were limited.

CC is also predicted to have impacts on tourism (Hein et al., 2009). In particular, sea level rise, storm surges and erosion will affect the size of the beaches in Santander (Villatoro et al., 2014). Currently, the beaches to the east of the Bay are 4500 m-long extending from the Spit to Loredo Beach. These beaches are not only highly important for future coastal defense (Hanley et al., 2014), but they also are one of the main motivations for tourist visits in Spain, a crucial sector for the national economy (Hein et al., 2009). Actually, Cantabria receives on average above 1.5 million tourists per year (50% in summer) and 4.25 million overnights (56% in summer). The city of Santander itself registered in 2013 352,969 tourist visits (among which one quarter are people living outside Spain) and 698,248 tourist nights. Commercial and hospitality services contribute to about 20% of GDP and of wages in the region. Beaches are also focal locations for social and touristic activities in Spain (Instituto Cántabro de Estadística, 2014).

Moreover, CC is already (Peñuelas et al., 2002; Walther et al., 2002) and will in the near future, threaten native biodiversity. The Bay of Santander is characterized by large intertidal mudflats and sandflats (65% of the total area) that are an important habitat for migrating birds and invertebrates. It includes a Natura 2000 area of 675.04 ha hosting 9 "Broad" fauna species, 2 "Priority" and 19 "Broad" habitats. Shell fishing of bivalves (mainly *Ruditapes phillippinarum*, *Ruditapes decussatus* and *Solen marginatus*) is performed by professional fishermen using traditional techniques (de Vries et al., 2010; Hoggart and Thompson, 2012). It is expected that CC, by altering the morphology of the Bay and increasing sea temperature, will impact on its ability to sustain biodiversity. In Santander, sea temperature at 10 m depth has increased by 0.60 °C and sea salinity by 0.04 practical salinity unit between 1992 and 2002 (ECCE Project, 2005). Furthermore, meteorological records from the last few decades show clear signs of temperature increase, reduced water availability, and increased climatic variability all having direct and indirect consequences for plants. In coastal areas, and especially in Cantabria, it is expected that sea level rise will reduce the surfaces occupied by coastal ecosystems and that changes in geomorphologic processes maintaining dune systems, marshlands and coastal pool will occur (ECCE Project, 2005). Butterfly Parnassius apollo (*Lepidoptera Papilionidae*) for instance, a species protected by the Habitats Directive whose part of main population nuclei are on the Cantabrian coast, seems to be

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