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Eliciting beach users' willingness to pay for protecting European beaches from beachrock processes

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ABSTRACT

Although beachrocks may have undesirable consequences on coastal tourism, they have received relatively little attention in literature. Beachrocks are hard coastal sedimentary formations consisting of various beach sediments, lithified through the precipitation of carbonate cements. Beachrock as a phenomenon of increasing and remarkably obvious coastal erosion succeeds in making perceivable the meaning of "coastal erosion" by tourists, a phenomenon which otherwise would pass unnoticed by occasional visitors. This research aims at exploring beach users' perceptions regarding the impacts of beachrocks on their recreational activities and their willingness to pay in order to preserve beaches from further deterioration due to this phenomenon. Towards this aim, a contingent valuation study was implemented among European tourists in two resort beaches on the island of Lesvos (Greece). The results indicate that although the majority of tourists were not previously aware of beachrock phenomenon, half of them paid notice to the hard coastal sedimentary formations. Survey respondents believe that the authorities should undertake precautionary measures and that European Union should increase research funding in order to avoid further beachrock expansion. Actually, almost half of the respondents would be willing to pay an annual tax in the range of 13.2–16.4 € per household in order to contribute to this effort.

1. Introduction

Coastal areas deliver a number of goods and services, which are ecologically and economically vital for human welfare (Brown, 1982; Komar, 1998; Skourtos et al., 2005; Beaumont et al., 2007; Martínez et al., 2007; Jimenez et al., 2007; Kontogianni et al., 2013). One of the most important economic activities supported by coastal areas is coastal tourism. Coastlines worldwide receive millions of visits every year for recreational activities such as swimming, surfing, camping, etc. Sustainable coastal tourism is considered as a prerequisite for the transition into the Blue Economy. According to rough estimations, in 2011 the maritime and coastal tourism sector has led to the creation of €183 bil value added and of 3.18 mil jobs in the EU27. Although the contribution of coastal tourism industry differs among EU countries, it is evident that coastal tourism supports the development of local economies. This is especially true for the Mediterranean basin as here tourism industry represents 48% of the overall EU maritime and coastal tourism sector (ECORYS, 2013).

According to the EU's Blue Growth strategy, the coastal and maritime tourism sector will continue to grow by 2–3% until 2020. In this context, it is estimated that by 2025 the coasts of the Mediterranean countries will receive 235–350 million tourists, possibly double the current figures (Benoit and Comeau, 2005).

As it is the case in many countries, coastal tourism is a primary contributor to Gross Domestic Product (GDP) and employment for Greece. According to the World Travel and Tourism Council (WTTC, 2012) the direct contribution of tourism to Greek GDP in 2011

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amounted to 12.4 billion Euros (6.4% of total GDP) and the total contribution to 32.2 billion Euros (16.5% of GDP), respectively. Furthermore, tourism industry created 349,500 direct jobs (8.5% of total employment) in the same year. Including indirect and induced employment, the share of tourism industry in total employment, in Greece reached 18.4% (758,500 jobs). These figures prove beyond any doubt that tourism activity, especially in coastal areas, is of vital importance to a recovering Greek economy.

However, the Greek coastline is threatened by man-made and natural pressures. Many beaches are already eroding due to upstream structures, storm surges, and tides (Poulos and Collins, 2002; Poulos et al., 2002; Karageorgis et al., 2006). These phenomena are expected to accelerate due to predicted climatic changes (Trenberth et al., 2007; Kontogianni et al., 2013). Additionally, coastal areas may undergo geological changes – such as the natural cementation of beach sediments – which can transform significant sections of the beach face of sandy and pebbly beaches into rock outcrops known as beachrocks (Vousdoukas et al., 2007a). Beachrocks are coastal formations created by the lithification of beach sediments (clastic and biogenic sands and gravels etc) with various cements (iron, silica, calcitic or aragonitic cements, etc). Beachrocks can contain various other items such as shells, coral fragments, artifacts, wood etc. (Fig. 1).

Various studies have been conducted in order to examine beachrock formation and identify its association with various parameters such as the ages, the cementing agents and the diagenetic environments. The characteristics of beachrocks vary significantly with respect to width, length and thickness. Formation of beachrocks occurs in the intertidal zone, usually on the surface or beneath a thin sedimentary cover in high and low water tables. Beachrocks are usually located along the coastline, exhibiting several layers representing different phases of beachrock formations. For example, the older layers are created in the outer part of the formation while the younger ones in the parts towards the beach. In case that the lithification process continues, the new beachrock would be formed in a new position within the intertidal zone (Vousdoukas et al., 2005).

The lithification process, which can be of the order of few years, is associated with physico-chemical changes that promote the precipitation of carbonates and/or particular biogeochemical processes (e.g. Tucker, 1991; Neumeier, 1999). In the literature, the formation of beachrocks has been attributed to various processes such as: the direct precipitation of $CaCO_3$ from seawater due to increased water temperatures, the mixing of seawater and fresh water in the coastal aquifers affecting the solubility of $CaCO_3$, the evaporation of groundwater in arid regions with significant daily temperature variability, the degassing of CO_2 from water tables with high concentrations of dissolved $CaCO_3$ and various biological activities (Vousdoukas et al., 2005).

The rate of beachrock formation is expected to increase in the future due to climate change as the increased temperature of the interstitial water of the beach sediments and the deterioration of the environmental conditions of the coastal areas will affect the carbonate cement precipitation.

Beachrocks control beach morphodynamics and may promote erosion of beach sediments, affecting the size of a beach and diminishing its carrying capacity (Manning and Lawson, 2002). Moreover, beachrocks can make access to the sea difficult, or even dangerous to swimmers, and degrade the aesthetics and amenity value of the beach due to colonization by assemblages of epilithic and borrowing organisms (Brattström, 1992). Given that the demand for coastal tourism and recreation activities is influenced by site characteristics (e.g. Paudel et al., 2011), it is evident that beachrock occurrence may be relevant for beach recreation in different ways. Especially for Mediterranean countries receiving millions of coastal tourists annually, this is a matter requiring

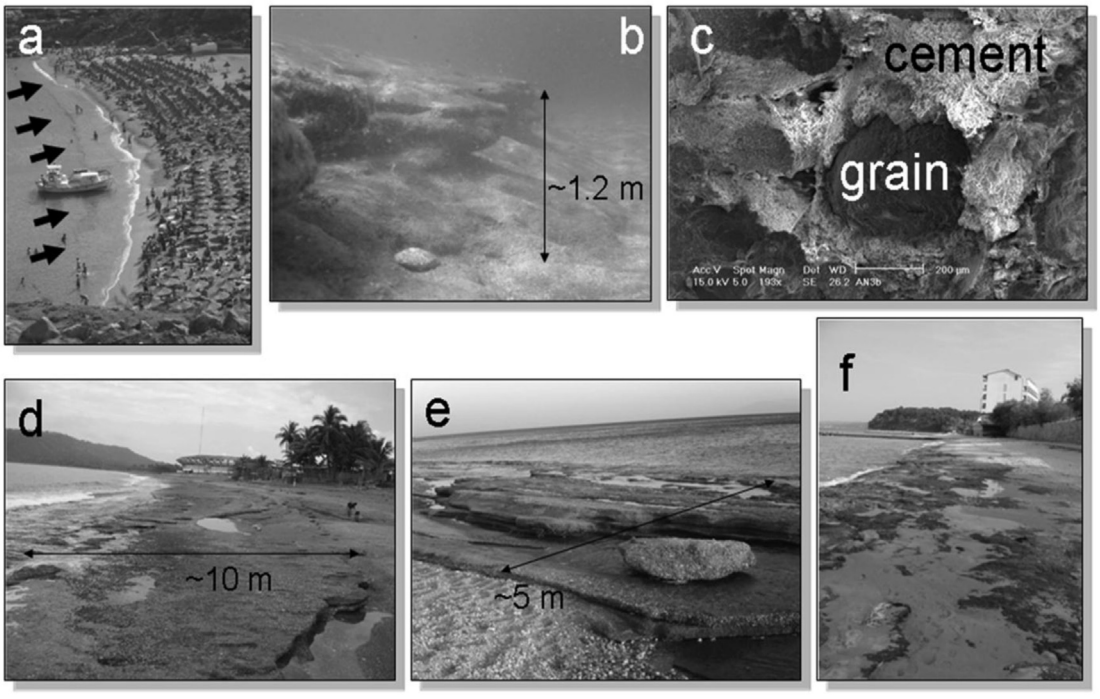

Fig. 1. (a) Beachrocks (black arrows), occupying the whole length of the beachface of the Super Paradise beach (Mykonos, Greece). (b) Underwater image from Vatera beach (Lesvos, Greece), showing a scour step at the offshore margin of the beachrock outcrop. (c) Scanning Electron Microscope (SEM) image of a beachrock (courtesy I. Issaris), showing the cementing carbonate material surrounding the original beach sediment grains. (d) Long-exposed beachrock (Baracoa, Cuba), exhibiting features of chemical weathering and mechanical erosion, such as dissolution basins and potholes. (e) Exposed beachrock bands at Plomari beach (Lesvos, Greece), showing evidence of intensive mechanical strain (broken slabs). (f) Weathered/eroded beachrock outcrops of a Chalkidiki beach (Greece).