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Valuing beaches to develop payment for ecosystem services schemes in Colombia's Seaflower marine protected area

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ABSTRACT

The Colombian Seaflower marine protected area (SMPA) is the largest MPA in the Caribbean. The economy of the main island, San Andres (SAI) relies on tourism. This study conducted 1793 surveys to capture information about tourists' experience and the value they placed on SAI's beaches. Tourists considered beaches as the main reason for choosing SAI as a destination and expressed that they would be willing to pay additional money, US$ 997,468 annually, on top of what they had already paid for their vacation to protect SAI's beaches. The study also showed how beach erosion could negatively impact economically the tourism sector of SAI, reducing revenue by 66.6% (estimated at US$ 73 million annually). This research contributed to the first stage in the development of a payment for ecosystem services (PES) scheme to protect SAI's beaches. The importance of beaches for SAI and the potential loss of revenue due to beach erosion create an opportunity to incentivize the private sector to invest in natural infrastructure that maintains and protects beaches. This study also informs the potential application of valuation studies for the development of innovative financing instruments, such as PES, to achieve financial sustainability for the MPA network in Colombia.

1. Introduction

Coastal and marine ecosystems provide a range of goods and services that supply direct and indirect contributions to human well-being. Food and raw materials are goods traded in formal markets. However, ecosystem services are commonly not marketed, including nutrient cycling, climate regulation, and coastal protection (Schuhmann, 2012).

According to the Millennium Ecosystem Assessment (2005), coastal zones represent 4% of the world's total land area, and 11% of the total ocean area. These zones host more than 30% of the world's human population with a population density three times higher than in inland areas, and provide the majority of the world's marine fish catch. The growing human population has generated an increasing demand for land development and marine food products. The conservation or restoration of coastal ecosystems provide numerous services such as sustainable food supply, recreation, and flood or wave attenuation. Researchers have demonstrated that around one third of mangroves, coral reefs, and sea-grasses have been either lost or degraded globally, placing them as the most threatened natural systems worldwide (Barbier et al., 2008, 2011). Although human populations depend on coastal ecosystems, decision makers often ignore their non-marketed benefits in part because people and governments primarily respond to monetary price signals that may differ from comprehensive economic values (Schuhmann, 2012). Therefore, benefits provided by ecosystem services and functions must be measured or valued to understand the costs and benefits to society from marine ecosystems. Valuing ecosystem services and functions will better inform management choices and/or influence policy-making and human behavior (United Nations Environment Programme—World Conservation Monitoring Centre (UNEP—WCMC), 2011), as it could assess the relative virtues of diverse management policy options in a more logical way where options are clearly linked to changes in ecosystem conditions that affect human well-being (Garnek et al., 2010).

1.1. Beaches in the Caribbean

Historically, human communities have used sandy beaches for recreational purposes such as sunbathing, walking, swimming,

Abbreviations: SMPA, Seaflower marine protected area; SAI, San Andres Island; CORALINA, Corporation for the Sustainable Development of the Archipelago of San Andres, Old Providence, and Santa Catalina; PES, payments for ecosystem services; CV, contingent valuation; WTP, willingness-to-pay

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and fishing. Beaches are dynamic systems characterized by accumulations of unconsolidated material (i.e., fine sand and cobbles). Spatially and temporally variable factors, including wave climate, sediment type, sources and sinks, littoral cells and changes in sea-level, control beach morphology (National Research Council, 2007). Those factors determine the rate of change of sedimentation (addition vs. subtraction), reflecting the amount of erosion and accretion that affects the morphology of the coast (Masselink and Hughes, 2003). Sediment transport processes that help shape the coastline depend on the interconnectedness of near-shore systems, including coral reefs, sea-grasses, and man-made structures such as groins and spurs (National Research Council, 2007).

Particularly, white sand beaches in the Caribbean originated from the abrasion of surrounding coral reefs. Studies in Caribbean Islands presented by Harborne et al. (2006) demonstrate that every year more than half of the carbonate production on a reef is reduced to sediment by bioerosion (disintegration of hard ocean substrates by living organisms), and another portion by physical damage as a function of wave energy. The natural and constant erosion of carbon substrate generated by wave crush in the reef crest, bioerosion by herbivores, and accumulated calcareous algae, generates sand accumulation on beaches and islands (Kennedy et al., 2013; Harborne et al., 2006; Granier, 2012). Reef crests play an essential role not only in wave dissipation, but also in sand production and maintenance. In fact, the quantitative meta-analysis by Ferrario et al. (2014) revealed that 97% of the wave energy is dissipated by coral reefs before reaching the shoreline. The reef demarks a limit for sediment transport, as it moves from the reef crest to the reef flat, or by gravity from the crest down slope to other ocean areas. The protective role from reef barriers is associated to the three dimensional coral structure that serves as breakwater, and thus, dissipates and shapes wave energy, preventing it from reaching the shoreline (Perry et al., 2013).

Therefore, beaches could be seen as a sentinel ecosystem as its composition and morphology depends on multiple functions and processes provided by other coastal ecosystems and structures. By understanding the interconnectedness of these ecosystems, scientists and decision-makers would be able to design articulated strategies to preserve beaches and mitigate their erosion.

According to the World Travel and Tourism Council (2014) and the International Monetary Fund (2012), most of the Caribbean islands are highly dependent on tourism. The United Nations Economic Commission for Latin America and the Caribbean—ECLAC (2011) reported that tourism revenue in the Caribbean region represented 16.6% of GDP, and on some Caribbean islands this portion reached 30%. Annual visitor spending in the region exceeded US$ 27 billion (Griffith, 2009). Most of the Caribbean populations are located in coastal areas where a significant portion of the infrastructure, including tourism facilities, are exposed to climate events and natural hazards such as beach erosion, strong winds, deeper incursions from increasing wave force, and heavier rains (Bueno et al., 2008).

Scientists suggest that climate change will impact coastlines due to anticipated changes in intensity, frequency, duration, and path of tropical storms, which are key drivers of sea-level rise and waves (IPCC, 2012). Sea-level in the 20th century rose an average rate of 1.7 mm yr^{-1}, with a significantly higher rate (3.1 mm yr^{-1}) from 1993 to 2003, posing risks for many tourism areas in small island states (IPCC, 2012). As a matter of fact, in the last century the Caribbean has experienced a rise in sea level of 20 cm, and regional projections suggest an additional 10–50 cm by 2025 (IPCC, 2001, 2007). An increase in 0.5 m in sea-level could generate a 38% ($\pm$24% SD) loss of the total beach area in the Caribbean, where lower and thinner beaches would be the most susceptible to beach erosion (IPCC, 2007).

1.2. Beach valuation

The magnitude of benefits provided by beaches depends on qualitative and quantitative factors such as: beach width, morphology, sand type, presence or absence of engineering structures, number of visitors attracted to the site, the amount they pay, and the duration of their stay (Landry et al., 2003). Economic valuation of these benefits would provide policy makers with important information to evaluate the efficiency of beach erosion control and conservation programs.

Numerous studies have calculated the value of beaches in different areas worldwide. A greater part of them have estimated the recreation demand for a site using the travel cost method to assess consumer surplus (Pendleton et al., 2011). Others have indicated that beach width has a large influence on property values (Gopalakrishnan, 2011). As tourism is the main economic driver in many places, the majority of the studies analyzed relationships between tourism and natural resources. For instance, Dharmatratne and Braithwaite (1998) revealed that the beaches along the coastline of Barbados were worth more than US$ 13 million to the local economy. And Uyarra et al. (2005) demonstrated that tourists in Barbados were unwilling to return to the island and pay the same price if beaches were negatively affected by climate change events.

1.3. The Seaflower marine protected area

The Seaflower marine protected area (SMPA), located in the Colombian Archipelago of San Andres, Providence, and Santa Catalina[2], is the seventh largest MPA in the world and the largest in the Caribbean. This area was declared the Seaflower Biosphere Reserve in 2000 by UNESCO, and in 2005 was the first official MPA to be acknowledged in Colombia by the Ministry of Environment, Housing, and Territorial Development (now Ministry of Environment and Sustainable Development); it is managed by the Corporation for the Sustainable Development of the Archipelago of San Andres, Old Providence, and Santa Catalina (CORALINA) (Baine et al., 2007). The vast area of the SMPA and the limited budget allocated by the national government generate a specific need to develop innovative financing mechanisms to protect coastal and marine ecosystems for this biosphere reserve.

San Andres is the largest island in the archipelago with 27 km^2 of land, 67,000 inhabitants, and 400,000 entering tourists every year, where 81% are domestic and 19% international according to the Departmental Secretary of Tourism (Government of the Archipelago of San Andres, Providencia and Santa Catalina, 2014). For this reason, San Andres is considered the most densely populated oceanic island in the Americas, and probably in the world (Baine et al., 2007). As with most Caribbean islands, the economy relies on tourism, which contributes to 39.3% of the GDP (above the Caribbean regional average), equivalent to US $184 million annually (Departamento Administrativo Nacional de Estadística (DANE) y Banco de La República de Colombia (2012)). A CORALINA (2001) survey found that Colombians and foreigners were motivated by factors related to environmental quality when choosing San Andres Island (SAI) as a destination, and beaches were rated as the most important factor for Colombian and international visitors.

[2] In a judgment issued on November 19, 2012, the International Court of Justice (ICJ) unanimously ruled that Colombia, not Nicaragua, has sovereignty over a number of contested islands and maritime features forming part of the San Andres Archipelago in the western Caribbean. The Court also unanimously fixed the course of the single maritime boundary between the two countries largely based on a simplified weighted line favoring Nicaragua (International Court of Justice (ICJ), 2012).