Marine economics and policy related to ecosystem services: Lessons from the world's regional seas

1. Introduction

Marine resources are critical for the health of the world's economies and the health of the planet. Yet the world's oceans face a variety of human-caused threats including acidification, climate change, the destructive modification of coastal wetlands, and overharvesting of species. Evidence suggests that many ocean fisheries have reached a critical point in terms of their ability to support current levels of human exploitation (Worm et al., 2006). According to a recent report by the World Wildlife Fund, marine species declined by 39 percent between 1970 and 2010. The largest declines were in the tropics and Southern Ocean (WWF, 2014). It is clear that new policy approaches are needed to protect the world's marine ecosystems. Traditional economic tools based on correcting market failures can be useful, but economists and policy makers also need more proactive approaches to protect marine resources. The papers in this Special Issue offer a variety of perspectives on marine ecosystem values and their measurement. Value estimates include traditional economic measures such as travel cost and choice experiments, but also include estimates of the cultural and esthetic values of coastal ecosystems.

Study areas considered in these papers include large basins like the Mediterranean, the Black Sea, and the Caribbean, as well as some of the world's most biologically diverse coastal areas. The Mediterranean coastline encompasses some of the world's most valuable real estate, and supports billions of euros of economic activity. The Black Sea's main economic activities are shortsea shipping, offshore oil and gas exploration and coastal tourism. The Caribbean Sea includes twenty-eight coastal states and territories, most of them Small Island Developing States (SIDS). It includes the Gulf of Mexico as well as waters of the Atlantic Ocean adjacent to these States and Territories. To the coastal populations of these seas, the role of marine biodiversity, and ocean health, in supporting local livelihoods is critical. Other coastal areas included in these studies are those of Zanzibar, Okinawa, Japan and the Great Barrier Reef in Australia.

The papers in this special issue emphasize policy and the interface between science and policy. The past few decades have seen an unprecedented increase in the sophistication and reach of the natural sciences. We know more today about the atmospheric, biological and geological features of planet earth than would have been dreamed possible only a few years ago. Yet using this information to inform policy lags far behind. The loss of biological diversity and the increasing destabilization of the world's climate continues unabated. These papers are a modest contribution toward that effort.

2. Summary of the papers

The Special Issue contains fifteen papers. The first paper focuses on tourism in Zanzibar and examines incentives for sustainable management of the coastal environment (Lange, 2015). The author uses data for the last two decades in Zanzibar to examine the economic and environmental impacts of tourism activity. Although tourism is now one of the most important sectors of the economy, contributing roughly 25% to Gross Domestic Product (GDP), the impact of tourism on poverty reduction and the environment has been decidedly mixed. The rapid expansion of tourist infrastructure on the coast, combined with a population growth rate of over 3%, has put great pressure on coastal areas. Of particular concern is the fact that local populations have seen their access to the beach and sea greatly restricted with resulting loss of livelihoods, while receiving little of the economic benefit from tourism. This paper explores the reasons for this, focusing on the role played by the distribution of benefits from tourism and the (dis)incentives this creates for sustainable management, especially among local communities that steward the marine ecosystem. The resulting policy recommendations are relevant not only for Zanzibar, but for all developing countries that rely on international tourism, in particular the Small Islands Developing States (SIDS).

Baker et al. (2015) analyze the interactions between processes affecting biodiversity loss in seagrass meadows and effects on food security in the Turks and Caicos Islands (TCI) in the Caribbean. Seagrass meadows provide ecosystem supporting services critical for human wellbeing. These systems are linked to traditional ways of life with multiple intangible values representing an important cultural resource for coastal communities. Using the example of food security, the authors combine social and ecological research to examine the governance of ecosystem services and the food system in TCI. Research draws on mixed qualitative methods and data gathered via the SeagrassWatch protocol. Fish surveys as well as a meta-analysis of fish assemblages, reveal anthropogenic stressors exposing TCI to economic and environmental shocks. The authors find growing concern across all socio-economic groups regarding the islands' high dependence on food imports, coupled with declining availability of local fish and seafood. Weak governance structures put TCI's marine resources under threat, with adverse consequences for food security. The authors support the application of the precautionary principle, suggesting conservation actions through societal participation and stakeholder engagement.

Castaño-Isaza et al. (2015) focus on the Colombian Seaflower Marine Protected Area, the largest MPA in the Caribbean and an

area essential to the economy of the main island, San Andres (SAI) that relies heavily on tourism. The recommendations of the paper are based on a socio-economic survey of 1793 visitors which captured information about tourists' experience and the value they placed on SAI's beaches. According to survey's results, tourists consider beaches as the main reason for choosing SAI as a destination and express that they would be willing to pay an additional total amount of US$ 997,468 annually, over and above what they had already paid for their vacation, to protect SAI's beaches. In addition, the study shows how beach erosion may negatively impact the tourism sector of SAI, by reducing revenue by 66.7% (estimated at US$ 73 million annually). These results show the importance of beaches for SAI and the potential loss of revenue due to beach erosion. According to the authors, the economic estimation results of this study can inform the development of innovative financing instruments, such as payment for ecosystem services, to achieve financial sustainability for the MPA network in Colombia.

Recent research has focused on the services of coastal ecosystems in protecting communities from storms that cause property damage, deaths and injury. Most of these studies have relied on the second-best replacement cost method, estimating the protective value of coastal ecosystems with the cost of building human-made storm barriers. On the contrary, Barbier (2015) uses an expected damage function (EDF) method which models the production of protection services and estimates their value in terms of reducing the expected damages or deaths avoided by coastal communities. The example of mangroves in Thailand is used to compare and contrast the EDF with the replacement cost approach to estimating the protective value of coastal ecosystems. Additionally, the example of marshes in the US Gulf Coast is employed to show how the EDF approach can be combined with hydrodynamic analysis of simulated hurricane storm surges to determine the economic value of expected reduced property through the presence of marsh wetlands and their vegetation along a storm surge path.

Okubo and Onuma (2015) focus on the deterioration of coral reefs in Japan. Conventional conservation policies for terrestrial ecosystems are sometimes difficult to apply to coral reef protection because of the large number of stakeholders involved. The authors examine the merits of commercial coral transplantation in marine ecosystem conservation, and suggest some reforms that could help to mitigate the problems encountered with coral transplants. A problem with transplanted corals is that when the transplanted fragments have been taken out from the natural coral colonies, it tends to cause a host of potential problems such as decreasing fecundity of donor colonies, negative effects on the surrounding environment of the exploited corals and low species diversity of transplanted fragments. The authors also discuss how the commercial transplantation in Okinawa could be applied to the conservation of other marine ecosystems.

Waite et al. (2015) directly examine the policy influence of valuation studies. They point out that although more than 100 coastal ecosystem valuation studies have been conducted in the Caribbean, only a few of these have had an observable influence on policy or ecosystem management decisions. Through a literature review and series of interviews, the authors identify 16 valuation studies that have directly influenced decision making. These success stories highlight the potential for economic valuation to improve decision making. The authors identify some key enabling conditions that likely led to success in informing decision making including having a clear policy question, local demand for

valuation, strategic choice of study areas, strong stakeholder engagement, effective communications, access to decision makers, and transparency in reporting results. This study suggests that by following a few simple rules, valuation practitioners can do more to ensure that valuation studies inform decision making.

Schuhmann and Mahon (2015) in a review of over 200 ecosystem value estimates for the Caribbean find that marine economic valuations for the basin have focused on a limited number of benefits derived from marine ecosystems, primarily those that are relatively easy to measure and convey such as associated with easily measured market indicators. Values associated with reefs have received far more attention than those associated with pelagic or shelf ecosystems. The negative economic impacts of overfishing remain largely unexplored. Regulating and maintenance services provided by the marine ecosystems have been recognized as important, but have not been properly valued. Non-use values have largely been unexplored. The authors suggest that future valuation work be coordinated so that gaps can be prioritized and valuation studies can be directed toward a more comprehensive understanding of the full value of the goods and services provided by marine ecosystems in the Caribbean.

Failler et al. (2015) examine the values of coral reefs, sea grass and mangroves for the island of Martinique. These three ecosystems produce services estimated at 250 million € per year. About 60% of this value originates from direct uses such as recreational activities (diving, excursions, beach activities, etc.) through tourism and the fishery. Ecosystem services (indirect uses) such as coastal protection, carbon sequestration, biomass production and water purification are significant and their value reaches 94 million € annually (38% of the total economic value). Non-use value linked to the improvement of the health of coastal ecosystem is estimated to be 10 million € per year. At the ecosystem level, sea grass and mangrove contribute the most (per km^2) to wealth creation (respectively 2.16 million €/km^2, 1.87 million €/km^2 against 1.78 million €/km^2 for the reefs). The authors argue that the indirect services of these ecosystems need to be protected to the same extent as the obvious services of the reefs.

van Beukering et al. (2015) examine the threat to tourism in Bermuda from damage to coral reefs. The reef-associated value to Bermuda's tourism industry was determined using various techniques which distinguished between the added economic value of cruises from that derived from air tourism. Results show that coral reef value to tourism in Bermuda provides an average annual benefit of US$406 million. Although accounting for half the visitors in Bermuda, cruise ship tourist expenditures directly benefiting the island's economy amount to only 9% of air passenger expenditures. Despite the low added value of cruise ship tourism in Bermuda, there are strong pressures to accommodate the ever-larger ships built by the cruise industry. Several options have been proposed for the upgrading and re-aligning of existing shipping channels, which potential environmental impacts may in turn affect reef-associated tourism revenue to the island. This study recommends the integration of Bermuda's coral reef value into Cost Benefit Analyses of proposed channel upgrades compared to the "business as usual" scenario.

Remoundou et al. (2015) estimate the willingness to pay for mitigation measures against natural hazards caused by climate change, on coastal and marine environments in Northern Spain. The specific natural hazards examined are (a) sea-level rise, high tides and extreme wave events that lead to floods and beach erosion, and (b) rise in sea temperature that leads to invasive jellyfish outbreaks and changes in native biodiversity. The