Expansion of Marine Protected Areas

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Identification of problem, scope

Marine ecosystems and the services they provide such as provisioning of nutrition, coastal protection, recreational opportunities and climate regulation are becoming degraded around Africa. Threats include coastal development, runoff of sediments, sewage, plastic waste, climate change, overfishing, ocean acidification and the use of destructive fishing practices. For example, 20-30% of the mangroves in west and central Africa have been lost in the past 25 years (UNEP, 2007); and in 2017 most of the fish caught in that region were classed as threatened and near threatened species (IUCN, 2017). According to the World Bank, fisheries and aquaculture provide employment to over 12 million people in Africa and directly contribute $24 billion to its economy (The World Bank, 2019). Fish is also an important source of essential proteins and nutrients to over 400 million people.

Proposed solution

In response to increasing degradation of the marine environment and declining provision of ecosystem services, several national and international initiatives have called for the development of Marine Protected Areas (MPAs)(CBD, 2010). An MPA is a clearly defined geographical space, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN, 2008). MPAs can improve the condition of marine ecosystems through diverse ecological pathways and, although challenging to quantify (Fox et al. 2014), result in improved biological parameters such as habitat complexity, survival rates of juvenile fish, species diversity, fish biomass, density and size (Lester et al., 2009). Improved ecosystem condition may translate into improved provision of ecosystem services, particularly in terms of tourism and recreation (Badalamenti et al., 2000; Potts et al. 2014), fisheries in adjacent areas through spillover effects (Roberts et al., 2001; Gell and Roberts, 2003) and cultural values associated with the conservation of marine biodiversity and mega-fauna (Cañadas et al., 2005).

The intervention addressed in this policy brief is the expansion of MPAs to 10% and 30% of the Exclusive Economic Zones (EEZ) of each of the 38 coastal countries of Africa. All MPAs are assumed to be no-take areas within which no extractive activities are allowed. The projected location of new MPAs is mapped by targeting areas characterised by high biodiversity (Kaschner et al. 2013) and low exposure to human impacts (Halpern et al., 2008), which therefore provides protection to intact ecosystems from potential future human impact. Increasing MPA coverage to 10% of each national EEZ results in 561 MPAs covering just over 3 million km^2; and 30% coverage results in 381 MPAs covering just over 9 million km^2. Note that increasing the coverage of MPAs results in fewer but larger MPAs. The time duration to set up the MPAs is assumed to be 5 years and the full benefits are assumed to accrue over a further 30 years giving a total time horizon for the evaluation of 35 years.

Principal costs of intervention

Two broad categories of cost associated with the creation and management of MPAs are included in the analysis:

- Costs incurred by the implementing agency in establishing and operating the MPA. Establishment costs include all costs incurred up to and including the designation of the MPA and the initiation of its management, whereas all costs incurred subsequently are classified as recurrent operating costs. Studies that have examined MPA establishment costs indicate that these costs are spatially heterogeneous at a fine scale (Richardson et al., 2006). Establishment and management costs for each MPA are estimated using cost functions published in the literature (Balmford et al., 2004; McCrea-Strub et al., 2011).

- Costs incurred by industry and coastal communities in the form of compliance and opportunity costs (the value of foregone activities that are restricted by the MPA). The opportunity costs to fisheries are estimated using FAO data on the value of marine capture fisheries production and the area closed to fishing, accounting for potential spillovers from MPAs to fisheries. We are unable to quantify and value other opportunity costs resulting from MPA expansion, including to shipping; oil, gas and mineral extraction; off-shore wind power generation; and subsistence fishing. Shipping costs are not expected to be greatly affected by MPA expansion because MPAs may continue to allow shipping and route distance is only a partial determinant of total shipping costs. The short-term opportunity costs incurred by small-scale and subsistence fisher communities are likely to constitute a substantial loss in livelihood given the level dependence on small-scale fisheries for income and food. While it is apparent that the communities whose livelihoods depend on fisheries may benefit in the long-term, it is important that mechanisms are put in place to offset short-term costs.

Benefits

The economic benefits of expanding MPA coverage are the maintained or enhanced flows of ecosystem services that are provided by protected marine ecosystems (Sala et al., 2013; Potts et al., 2014; Pascal et al., 2018). The marine ecosystems included in our assessment are coral reefs, coastal wetlands and mangroves. The marine ecosystem services assessed are the provision of food and other materials for subsistence or commercial use; tourism and recreation; coastal protection; biodiversity; and carbon sequestration. The monetary values of benefits are estimated using meta-analytic value functions published in the literature to account for site level variation in the bio-physical and socio-economic characteristics of each MPA (Hussain et al., 2011; Brander et al., 2012; Brander, 2014).

The BCR of expanding MPAs is 9.2. and 1.16 for coverage of 10% and 30% of each national EEZ respectively.

The assessment of benefits is partial in the sense that it has not been possible quantify the impacts to all marine ecosystems (e.g. pelagic, seamounts and seagrass) and all ecosystem services (e.g. existence values associated with marine biodiversity) that are potentially positively impacted by MPAs. The marine ecosystems for which we are able to model the benefits of MPA coverage are predominantly coastal (i.e. coral reefs, mangroves and coastal wetlands) and it has proved harder to model the effects of MPAs on open ocean.

Discussion of the implications of scale-up of the intervention

The scale of the intervention is generally implemented at the level of individual MPAs or networks of MPAs; most often at the national level but also at multi-national scales. The scale of the analysis is at the level of individual MPAs for estimating establishment and management costs; individual ecosystems for the assessment of benefits; and at the national scale for the estimation of fisheries opportunity costs. The analysis necessarily involves large generalisations and the results are aggregated to the African regional scale to provide a general indication of the economic performance of investments in MPAs.

In this analysis, the spatial targeting of new MPAs is defined by a small set of simple rules in order to explore a broad strategy for MPA expansion to target areas with high biodiversity and low human impact. The spatial allocation of MPAs does not therefore reflect the wide range factors that would ideally be considered in the actual siting and design of MPAs. In particular, the siting of MPAs, and subsequent assessment of costs and benefits, does not account for network or connectivity effects (Pujolar et al., 2013) or for institutional factors of MPA expansion (Mora et al., 2009). The process of siting MPAs would need to consider the oceanographic, cultural and ecological connectivity in the maritime space to assess a

coastal state's and communities' interests and priorities for protection.

Further research that could be undertaken either to lower the costs of the intervention or to introduce a more efficient technology

The estimated costs of MPA management are a relatively small proportion of total costs (approximately 7%) but still represent one of the biggest challenges facing marine resources managers in many developing countries. Essentially, resource managers do not have sufficient funding to ensure compliance through monitoring, policing and enforcement; and hence many MPAs are not effective in delivering socioeconomic and ecological benefits. It may be possible to reduce monitoring costs through research into advanced technological approaches for tracking activities in MPAs (McCauley et al., 2016). The main costs of expanding MPAs, however, are the estimated fisheries opportunity cost (approximately 90% of total costs). As fisheries are important to the economy and to nutrition in many African countries, research into alternative livelihoods and sources of protein could be undertaken to reduce this cost.

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