Biodiversity-based development in Small Island Developing States

Sonja Teelucksingh, Paulo A.L.D. Nunes and Charles Perrings

Environment and Development Economics / Volume 18 / Issue 04 / August 2013, pp 381 - 391
DOI: 10.1017/S1355770X13000260, Published online: 14 May 2013

Environment and Development Economics 18: 381–391 © Cambridge University Press 2013
doi:10.1017/S1355770X13000260

Biodiversity-based development in Small Island Developing States

SONJA TEELUCKSINGH
Sir Arthur Lewis Institute of Social and Economic Studies (SALISES), University of the West Indies, Trinidad & Tobago.
Email: sonja.teelucksingh@sta.uwi.edu

PAULO A.L.D. NUNES
Marine Economics Research Programme, The Mediterranean Science Commission (CIESM), Monaco. Email: pnunes@ciesm.org

CHARLES PERRINGS
School of Life Sciences, Arizona State University, P.O. Box 874501, Tempe, AZ 85287, USA. Email: charles.perrings@asu.edu

Submitted 11 April 2013; accepted 13 April 2013; first published online 14 May 2013

ABSTRACT. Small Island Developing States (SIDS) are quite diverse in terms of various development metrics, but are uniformly vulnerable both to macroeconomic shocks and to changes in the biodiversity that supports fisheries and tourism. This special section assembles a set of papers that analyze international demand for the natural resources associated with the two sectors, and the factors that lie behind changes in their supply. Since each stresses the resource base, albeit in different ways, we argue that limits on tourist pressure will be as important as limits on allowable fish catches in the future. We identify the challenge for SIDS as the need to implement an integrated, sustainable resource management strategy that allows biological resources to be allocated to their highest valued uses, while respecting the interests of those with prior rights to those resources.

1. Characteristics of Small Island Developing States

The Small Island Developing States (SIDS) are a group of countries[1] that share a number of characteristics beyond the fact that they are islands with

[1] American Samoa, Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, British Virgin Islands, Cape Verde, Commonwealth of Northern Marianas, Comoros, Cook Islands, Cuba, Dominica, Dominican Republic, Federated States of Micronesia, Fiji, French Polynesia, Grenada, Guam, Guinea-Bissau, Guyana, Haiti, Jamaica, Kiribati, Maldives, Marshall Islands, Mauritius, Montserrat, Nauru, Netherlands Antilles, New Caledonia, Niue, Palau, Papua New Guinea, Puerto Rico, Samoa, São Tomé and Principe, Seychelles, Singapore, Solomon Islands , St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines,

a limited land mass. While quite diverse in terms of development metrics such as per capita gross domestic product or the human development index, they are uniformly vulnerable both to macroeconomic shocks and to the effects of environmental change. Economically, SIDS are extremely open. They are dependent upon a handful of productive export sectors, and have a high marginal propensity to import. Environmentally, they have been shown to be increasingly vulnerable to extreme events. Over the last four decades, for example, SIDS have been more and more severely affected by natural disasters, whether measured in terms of the number of people affected or real damage costs. Six SIDS – Samoa, Saint Lucia, Grenada, Vanuatu, Tonga and Maldives – head the list of countries ranked by the size of damage costs relative to net capital formation (UN Department of Economic and Social Affairs, 2010). A number of SIDS are especially vulnerable to the effects of climate change. Those with a significant share of their population in coastal areas less than 10 m above sea level, for example, are directly threatened by sea-level rise and storm surges. Indeed, under a number of climate change scenarios, several states (e.g., Kiribati, Maldives, Marshall Islands and Tuvalu) are likely to become uninhabitable (IPCC, 2007).

SIDS are also vulnerable to changes in the resources that support the main economic activities – tourism and fisheries (Dhoray and Teelucksingh, 2007; Ghermandi *et al*., 2011). These industries depend upon the exploitation of coastal and marine resources, both within territorial waters and in the Exclusive Economic Zones (EEZs). On average, international tourism receipts account for more than 50 per cent of the total value of exports in SIDS, and almost 75 per cent in the case of the Maldives (World Bank, 2013). Because most island tourism is based on coastal resources, it is highly vulnerable to the effects of climate change. The IPCC conjectures that coral reefs will be adversely affected by changes in surface temperature, sea levels, turbidity, nutrient loading and the effects of higher carbon dioxide concentrations on ocean chemistry. At the same time, sea-level rise and increased sea water temperatures are expected to accelerate beach erosion (IPCC, 2007). Coastal resources are also threatened by land use, marine pollution, over-exploitation and destructive fishing, and by shore-derived sediment and nutrients (Hughes *et al*., 2003). The volume and pattern of tourism itself is also a direct threat, long implicated in the deterioration of the very ecosystems upon which tourism depends (Hawkins and Roberts, 1994).

Fisheries in SIDS have similar importance for the economy, are similarly vulnerable to the effects of environmental change, and are similarly affected by the level and pattern of fishing activity. Fisheries, in particular artisanal fisheries, are important sources of employment, income and livelihoods, and export earnings in many SIDS (Dhoray and Teelucksingh, 2007). In fact, in a number of Pacific island states fisheries make a greater contribution to these things than tourism. Like tourism, fisheries

Suriname, East-Timor, Tonga, Trinidad and Tobago, Tuvalu, US Virgin Islands, Vanuatu.

are similarly impacted by changes in climatic conditions, and are similarly susceptible to the effects of excess pressure on the resource. Illegal, unreported and unregulated fishing, harmful fishing methods and overfishing are reported to be severely depleting fish stocks in many SIDS (UN Department of Economic and Social Affairs, 2010). While much of the debate about the state of global fisheries in recent years has hinged on the effectiveness of management regimes inside and outside the EEZs (Worm *et al.*, 2007; Worm *et al.*, 2009; Costello *et al.*, 2008), many SIDS have chronic difficulty in regulating fisheries of all kinds. Artisanal fisheries have a critical role in supplying animal protein in many SIDS, but they have also been shown to have negative impacts on both fishery and tourism resources. A study of six Caribbean islands in which artisanal fishing pressure on reef fisheries varied significantly, for example, showed that artisanal fishing pressure systematically reduced biomass, decreased larger bodied fish within families, compromised coral cover and complexity, and increased algal cover (Hawkins and Roberts, 2004).

It follows that SIDS economies are structurally dependent on the biodiversity that supports both tourism and fisheries. This makes them susceptible to the impact these and other industries have on biodiversity. The isolation and size of SIDS mean that an unusually high proportion of the species found in them are endemic. Indeed, four groups of islands are among the biodiversity hotspots originally identified by Myers *et al.* (2000): the Caribbean Islands; Madagascar and the Indian Ocean Islands; Polynesia and Micronesia; and the East Melanesian Islands. Island species are vulnerable to the effects of species introductions both because they lack the competitors and predators that control introduced species in their home range, and because they often have vacant ecological niches due to their distance from colonizing populations (MacArthur and Wilson, 1967).

In this special section we have assembled a set of papers that addresses the risks in the industries that dominate most SIDS economies: fisheries and tourism. The first two papers address the demand for the biodiversity that underpins island tourism (Mwebaze and Macleod, 2013; Teelucksingh and Watson, 2013). The third considers the incentives that lead to overfishing in SIDS EEZs (Sumaila *et al.*, 2013), and the last reports on three case studies of mechanisms currently in use to develop conservation incentives (Niesten *et al.*, 2013). In what follows we first set the arguments developed in these papers in context, identifying the features of each problem that are peculiar to SIDS. We then consider how the issues are related, and draw out the implications of the results reported in the papers for the integrated management of SIDS ecosystems as multi-use resources.

2. The demand for biodiversity

The demand for natural resources – biotic or abiotic – derives from the demand for the goods and services produced using those resources. Specifically, the marginal value of a natural resource in use is the value of the final good or service multiplied by the marginal impact of the resource on the production of that good or service. Where the resource in question is an ecosystem – a community of species – the marginal physical product of the system along some axes may involve a number of interacting effects. A change in nutrient loading, for example, may affect the production of a valued good or service via interactions between species that are both positive (e.g., mutualistic and symbiotic) and negative (e.g., predator–prey or competitive). If an ecosystem is exploited as a fishery, say, an increase in nutrient loading is a benefit if the net effect of such interactions is an increase in the abundance of harvested species, and a cost if it is the reverse. On the other hand, if the ecosystem service is biodiversity-based tourism, then an increase in nutrient loading is a benefit only if its net effect is to enhance species richness. Where an ecosystem is exploited for different things, then the value of a marginal change in the system along some axes depends on the net effect of the changes it induces on all services yielded by the system, and the relative value of those services. It follows that the measure of ecosystem 'outputs' used will depend upon – and be specific to – the ecosystem service of interest.

The first paper in this special section (Teelucksingh and Watson, 2013), starts from the proposition that biodiversity change affects human wellbeing through the effect it has on the flow of ecosystem services, of which tourism may be the most important in SIDS. Following recent work on the effect of biodiversity on tourism demand in Ireland (Loureiro *et al.*, 2012), and worldwide (Ghermandi and Nunes, 2013), Teelucksingh and Watson estimate a demand function for tourism that includes a number of biodiversity-related country characteristics among the more traditionally used independent variables. Specifically, it includes measures of both marine and terrestrial protected areas, along with the number of 'key biodiversity sites' in the destination country. The measure of protected areas is the proportion of territorial waters or land area protected, and the measure of biodiversity sites is a simple count. The proportion of territorial waters or land area protected is an indicator of national commitment to conserve ecosystems rather than a measure of the biodiversity in those systems, but it is reasonable to assume that it is among the indicators that potential tourists would consider in distinguishing between alternative destinations.

Teelucksingh and Watson find all biodiversity-related variables to have a positive impact on tourist arrivals, and to be both individually and jointly significant. Their interpretation of the results reflects the choice of measures. They argue that their results show that policies aimed at biodiversity conservation positively impact tourism arrivals. They find, for instance, that a 1 per cent reduction in marine protected areas, terrestrial protected areas and key biodiversity sites will result in a decline in tourist arrivals of, respectively, 5.6, 2.5 and 8.6 per cent. It is worth keeping in mind, though, that a measure such as the proportion of territorial lands and waters under protection is not a measure of the quality of the protected areas, and the fact that tourist arrivals are increasing in the proportion of territorial lands and waters under protection points to another potential issue with tourism in SIDS. After some point, the congestion of tourist sites both reduces their appeal and, potentially, negatively impacts the ecology of the site.

That is the problem addressed by the second paper in the special section (Mwebaze and Macleod, 2013). The paper focuses on an island in the Indian Ocean that is especially dependent on both tourism and fisheries: the Seychelles. Together, the two sectors directly account for 34 per cent of GDP, 37 per cent of employment and close to 100 per cent of exports. While conservation of the natural resource base has high priority – some 46 per cent of territorial land and waters are under protection – the quality of protected areas is under stress and has been declining in recent years. Using the travel cost method, Mwebaze and Macleod estimate tourist willingness to pay to access either single or multiple marine protected areas in their current condition. Since the quality of different sites was not recorded, they were unable to obtain estimates of willingness to pay for quality *per se*. However, using existing estimates of the cost of enhancing environmental quality in marine protected areas (Cesar *et al.*, 2004), Mwebaze and Macleod conclude that international willingness to pay is at least consistent with policies to enhance the quality of MPAs. They also conclude that the consumer surplus attaching to both single and multiple site visits is such that there is considerable scope for the government of the Seychelles to capture more of the value of marine protected areas to tourists. They note, for example, that the consumer surplus for multiple site visitors is more than 10 times the average park entrance fee. They also note that the price elasticity of demand for park access is extremely low.

The third paper considers the other significant industry in SIDS: fisheries (Sumaila *et al.*, 2013). It addresses one of the drivers behind the depletion of fish stocks. The overexploitation of fisheries is one of the best studied and best understood problems in the economics of natural resources. The effects of open access to common pool resources on harvest rates has been understood since the 1950s (Gordon, 1954, 1967), and the impact of subsidies on capitalization in the global fishing industry is a well-studied problem (Pauly *et al.*, 2002; Sumaila *et al.*, 2010). The specifics of the problem in SIDS have not, however, been previously addressed.

In this paper, Sumaila *et al*. use estimates of 'catch loss' from Srinivasan *et al.* (2010, 2012). This is defined as the difference between current catch and the maximum sustainable yield of a fish stock, if the maximum sustainable yield has already been reached in historic catch data. By this measure, around 60 per cent of fish stocks in SIDS are currently overfished, the proportion varying between 72 per cent in Africa and 51 per cent in Latin America and the Caribbean. The associated catch losses relative to maximum sustainable yield are 48 per cent, on average, ranging from 59 per cent in Oceania to 25 per cent in Asia. They then regress catch losses in SIDS against a set of independent variables that include three different types of subsidies: on fishery management and research; on fishery capital equipment and infrastructure; and on buyback or decommissioning programs. They find that the extent of catch loss is positively correlated with total subsidies in the fishing industry, and in particular with subsidies on capital assets or infrastructure (Sumaila *et al.*, 2013).

There are two things that differentiate the problem in SIDS from the problem elsewhere. The first is its extent. If the data are correct, SIDS have more than double the proportion of overfished stocks compared to the rest of the world, and more than double the catch loss. Given the importance of fish protein in the diet of local communities, and the importance of the fishing industry for output, employment and exports, catch losses on this order of magnitude must have significant implications for wellbeing. The second thing that makes overfishing especially problematic in SIDS is the interaction between fishing and tourism. Sumaila *et al*. do not investigate this, but they note that overfishing can adversely affect other services delivered by the same ecosystem, such as recreation and tourism. In fact, there is considerable evidence that fishing pressure in in-shore fisheries is currently having strongly negative effects on the coral reefs that also support tourism in the Caribbean (Hawkins and Roberts, 2004).

The final paper in the special section makes the connection between fisheries and tourism even more explicit. Niesten *et al.* (2013) investigate the options for developing conservation incentives in SIDS, especially where local ecosystems have been adversely affected by overfishing. Given recent attention to the potential for systems of payments for ecosystem services to encourage private provision of environmental public goods (Ferraro and Kiss, 2007; Wunder and Wertz-Kanounnikoff, 2009; Pattanayak *et al.*, 2010), this is an especially interesting topic. The paper illustrates a subset of the available policy options by reporting three cases studies: Phoenix Islands Protected Area fisheries license revenue offset (Kiribati); the Navini Island Resort lease (Fiji); and the Pohnpei Island sponge and coral farming project (Federated States of Micronesia).

The first combines the establishment of a marine protected area with the development of a financial mechanism to compensate the government of Kiribati for the fisheries license revenue foregone by excluding commercial harvesting from at least some of the Phoenix Islands EEZ. The mechanism exploits international willingness to pay for marine biodiversity conservation. It centers on the establishment of a fund operated by an independent trust, along with a conservation agreement with the government of Kiribati. The second protects the sea area exploited by a tourist resort in Fiji through the establishment of a managed marine area, the Navini Island managed marine area, as a partnership between the Navini Island Resort and the Tui Lawa chiefly clan. The arrangement protects the reefs surrounding Navini Island in exchange for payments to compensate members of the clan for the forgone benefits of fishing activities. The third case involves the establishment of sponge farms within marine protected areas around Pohnpei Island in Melanesia. While the motivation for the initiative was to establish alternative sources of revenue for fishing communities in the region, it has instead created an additional source of revenue that is regarded as complementing, rather than substituting for, fishing revenue.

Each of the three cases shows the need to compensate resource users for the opportunity cost of conservation, and specifically the need to offset future income losses resulting from a change of resource use. Niesten *et al.* note that, whereas buyouts can provide an upfront incentive to stop some activity, conservation agreements are needed beyond that to provide a flow of benefits sufficient to compensate for forgone future income. The point is well made. The diversity of species that are exploited in SIDS has historically yielded not one but many services. As the relative value of different services has changed over time, so have the activities of the people with rights of access to the resources. The current tensions between alternative uses of environmental resources in SIDS reflect changes in the relative value of resources resulting from integration of SIDS into the global economy. The papers in this special issue all address the problem in two parts. The first is the growth in international demand for biodiversity in SIDS for recreation, tourism, science and conservation. This reflects growth in the values that drive international conservation: the option and quasi-option values that motivate scientific inquiry, biological prospecting, pharmaceuticals development and so on; the spiritual and moral values that drive conservation and stewardship; and the aesthetic and recreational values that drive biodiversity-based tourism. The second is the evolving nature of access and use rights to the natural resources of SIDS. Negotiating the tradeoffs between alternative uses of SIDS resources has required the development of new access and use rights.

3. Access and use rights to biodiversity in SIDS

The generic problem to be addressed in the SIDS is the management of multiple use resources in the public domain. Open access to common pool resources has long been recognized as leading to their overexploitation, and fisheries have long been recognized as being especially vulnerable. Indeed, most of the classic examples of the overexploitation of open access common pool resources stem from wild capture freshwater and marine fisheries, and this is still recognized to be the most worrisome feature of marine fisheries beyond national jurisdiction (Worm *et al.*, 2007). Of course, there is nothing inevitable about the overexploitation of common pool resources, and much has been done to document the various ways in which access to such resources is regulated (Ostrom, 1990; Brousseau *et al.*, 2012). National regulation of fisheries has certainly provided some relief within territorial waters and EEZs (Costello *et al.*, 2008). However, the persistence of subsidies on capital assets referred to by Sumaila *et al.* (2013), has compromised the effectiveness of fishery regulation in territorial waters and EEZs. Where the same open or weakly regulated resource is exploited for multiple services, the problem is magnified. In such cases, interactive effects between changes in the abundance of multiple harvested or impacted species can transform the ecosystem – leaving it vulnerable to a range of perturbations. Coral reefs that are subject to multiple stresses are particularly affected (Hughes *et al.*, 2003, 2007).

The specific problems to be addressed in SIDS stem from the limited set of development options open to those economies, and the ill-defined nature of many use and access rights to environmental resources. It is not just that marine resources are subject to multiple stresses from fisheries and tourism in SIDS, but that there are currently few economic alternatives to these industries. In many SIDS, the two most feasible growth options – tourism and fisheries – both imply increasing stress on the resource base. The lessons from the papers in this special section are that efficiency and sustainability in the use of biological resources in SIDS require four things: (a) formal recognition of prior ownership rights, and the associated entitlement to grant access for new uses; (b) establishment of payment mechanisms to ensure that prior right holders realize the benefits of reallocating resources to more highly valued uses; (c) spatial separation of competing uses; and (d) regulation of the level of all uses within sustainable limits. Requirements (a) and (b) can be thought of as necessary conditions for the efficient (and equitable) allocation of biological resources. Requirements (c) and (d) can be thought of as necessary conditions for the sustainable use of the resource base.

Although the first of these conditions may seem the most straightforward, since the communities with prior rights should be known in any given case, it may in practice be the hardest to satisfy. One reason for this is that recent national and international law has reassigned many prior rights to the state. When the United Nations Convention on the Law of the Sea was negotiated in 1982, all the resources of sea areas beyond national jurisdiction were defined to be the common heritage of humankind. The earliest international agreement about the genetic diversity of terrestrial species, the International Undertaking on Plant Genetic Resources adopted in 1983, also treated plant genetic resources as the common heritage of humankind (Rose, 2004). By the time the Convention on Biological Diversity was negotiated in the 1990s, however, the language had changed. Nation states assumed sovereign rights over their territorial biological resources (UN, 1993). This effectively gave national governments the right to assign access and use rights to species within their jurisdiction, and revoked the common heritage principle in the International Undertaking. In so doing it also gave them rights that had previously rested with individuals and communities within their jurisdiction.[2] In terrestrial systems the effective loss of communal rights to the genetic material in land races and wild crop relatives has already impacted their conservation (Santilli, 2012). While marine systems have not yet been affected in quite the same way, the development of new access and use rights to biological resources rests with national governments.

The second condition is needed to ensure that changes in resource use that confer public benefits are fully compensated. This is an issue that has attracted a good deal of attention in the literature and the principles are reasonably well understood (Ferraro and Kiss, 2007). Whether the payment mechanism takes the form of royalties, land rents, profit shares, conditional transfers or payments for specific ecosystem services, payments should be sufficient to compensate right holders for the income forgone by converting resources from one use to another. They should also be conditional on performance. One issue with a number of existing schemes is that payments are independent of performance, and this compromises their effectiveness as conservation incentives (Pattanayak *et al.*, 2010; Kinzig *et al.*, 2011).

The third and fourth requirements reflect the logic behind specialization in complementary uses, and the importance of mechanisms that constrain activity levels with sustainable limits. While all ecosystems are the source of multiple ecosystem services, there are often tradeoffs between services. Higher timber yields, for example, generally mean lower water yields. The

[2] Article 15 of the Convention on Biological Diversity asserts that the authority to determine access to genetic resources rests with national governments, and is subject to national legislation.

spatial separation between activities that trade off against one another is reflected in zoning regulations in terrestrial systems. In marine systems the same result is typically achieved through the establishment of marine protected areas. All of the case studies reported by Niesten *et al.* (2013), for example, address the spatial separation of competing activities in marine systems, along with the institutional conditions and payment mechanisms needed to enforce that separation. A second, critical, element in this is the establishment of limits on activity levels that are sensitive to the current state of the system. While the importance of this in fisheries is recognized in the widespread use of total allowable catches (and a variety of other activity caps) (Pauly *et al.*, 2002), less attention has been paid to the problem of congestion in tourism. Mechanisms such as the transferable development rights devised in the 1980s (Chomitz, 1999) have considerable potential, but have yet to be deployed in SIDS. In the meantime, the separation of function built into many existing marine protected or management areas achieves something of the same result.

The evidence for the increasing value of resources committed to tourism or conservation relative to wild capture fisheries suggests that tourism will continue to grow at the expense of capture fisheries in the foreseeable future. At the same time, however, since tourist willingness to pay to access biodiversity-rich ecosystems is increasing in the quality of those ecosystems and decreasing in their congestion, it is likely that limits on tourist pressure will be as important as limits on allowable fish catches in the future. The challenge for SIDS is accordingly to implement an integrated, sustainable resource management strategy that allows biological resources to be allocated to their highest valued uses, while respecting the interests of those with prior rights to those resources. The papers in this special section highlight the consequences of the development of tourism for the quality of marine ecosystems in SIDS, and discuss some critical aspects of this challenge.

References

Brousseau, E., T. Dedeurwaerdere, P.-A. Jouvet, and M. Willinger (eds) (2012), *Global Environmental Commons: Analytical and Political Challenges in Building Governance Mechanisms*, Oxford: Oxford University Press.

Cesar, H., P.V. Van Beukering, V. Payet, and E. Grandcourt (2004), *Evaluation of the Socio-Economic Impacts of Marine Ecosystem Degradation in the Seychelles: Final Report to the Government of Seychelles*, Victoria, Seychelles: SEYMEMP.

Chomitz, K.E. (1999), 'Transferable development rights and forest protection: an exploratory analysis', in *Workshop on Market-Based Instruments for Environmental Protection*, Cambridge, MA: John F. Kennedy School of Government, Harvard University.

Costello, C., S.D. Gaines, and J. Lynham (2008), 'Can catch shares prevent fisheries collapse?', *Science* **321**: 1678–1681.

Dhoray, S. and S.S. Teelucksingh (2007), 'The implications of ecosystem dynamics for fisheries management: a case study of selected fisheries in the Gulf of Paria, Trinidad', *Journal of Environmental Management* **85**: 415–428.

Ferraro, P. and A. Kiss (2007), 'Direct payments to conserve biodiversity', *Science* **298**: 1718–1719.

Ghermandi, A. and P.A.L.D. Nunes (2013), 'A global map of coastal recreation values: results from a spatially explicit meta-analysis', *Ecological Economics* **86**: 1–15.

Ghermandi, A., P.A.L.D. Nunes, R. Portela, N. Rao, and S.S. Teelucksingh (2011), 'Recreational, cultural, and aesthetic services from estuarine and coastal ecosystems', in M. Van Den Belt and R. Costanza (eds), *Ecological Economics of Estuaries and Coasts*, Burlington, MA: Academic Press, pp. 217–238.

Gordon, H.S. (1954), 'The economic theory of common-property resources', *Journal of Political Economy* **62**: 124–142.

Gordon, R.L. (1967), 'A reinterpretation of the pure theory of exhaustion', *Journal of Political Economy* **75**: 274–286.

Hawkins, J.P. and C.M. Roberts (1994), 'The growth of coastal tourism in the Red Sea: present and future effects on coral reefs', *Ambio* **23**: 503–508.

Hawkins, J.P. and C.M. Roberts (2004), 'Effects of artisanal fishing on Caribbean coral reefs', *Conservation Biology* **18**: 215–226.

Hughes, T.P., A.H. Baird, D.R. Bellwood, *et al.* (2003), 'Climate change, human impacts, and the resilience of coral reefs', *Science* **301**: 929–933.

Hughes, T.P., L.H. Gunderson, C. Folke, *et al.* (2007), 'Adaptive management of the great barrier reef and the Grand Canyon world heritage areas', *Ambio* **36**: 586–592.

IPCC (2007), *Climate Change 2007: Synthesis Report*, Geneva: Intergovernmental Panel on Climate Change.

Kinzig, A.P., C. Perrings, F.S. Chapin, S. Polasky, V.K. Smith, D. Tilman, and B.L. Turner (2011), 'Paying for ecosystem services: promise and peril', *Science* **334**: 603–604.

Loureiro, M., G. Macagno, P. Nunes, and R. Tol (2012), 'Assessing the impact of biodiversity on tourism flows: an econometric model for tourist behaviour with implications for conservation policy', *Journal of Environmental Economics and Policy* **1**: 174–194.

MacArthur, R.H. and E.O. Wilson (1967), *The Theory of Island Biogeography*, Princeton, NJ: Princeton University Press.

Mwebaze, P. and A. Macleod (2013), 'Valuing marine parks in a small island developing state: a travel cost analysis in Seychelles', *Environment and Development Economics* **17**, DOI: http://dx.doi.org/10.1017/S1355770X12000538

Myers, N., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, and J. Kent (2000), 'Biodiversity hotspots for conservation priorities', *Nature* **403**: 853–858.

Niesten, E., H. Gjertsen, and P.S. Fong (2013), 'Incentives for marine conservation: options for small island developing states', *Environment and Development Economics* **17**, DOI: http://dx.doi.org/10.1017/S1355770X12000484

Ostrom, E. (1990), *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge: Cambridge University Press.

Pattanayak, S.K., S. Wunder, and P.J. Ferraro (2010), 'Show me the money: do payments supply environmental services in developing countries?', *Review of Environmental Economics and Policy* **4**: 254–274.

Pauly, D., V. Christensen, S. Guenette, *et al.* (2002), 'Towards sustainability in world fisheries', *Nature* **418**: 689–695.

Rose, G.L. (2004), The international undertaking on plant genetic resources for food and agriculture: will the paper be worth the trees?', in N. Stoianoff (ed.), *Accessing Biological Resources: Complying with the Convention on Biological Diversity*, Dordrecht: Kluwer, pp. 55–90.

Santilli, J. (2012), *Agrobiodiversity and the Law*, London: Earthscan.

Srinivasan, U.T., W.W.L. Cheung, R. Watson, and U.R. Sumaila (2010), 'Food security implications of global marine catch losses due to overfishing', *Journal of Bioeconomics* **12**: 183–200.

Srinivasan, U.T., R. Watson, and U.R. Sumaila (2012), 'Global fisheries losses at the exclusive economic zone level, 1950 to present', *Marine Policy* **26**: 544–549.

Sumaila, U.R., A.J. Khan, A. Dyck, R. Watson, G. Munro, P. Tydemers, and D. Pauly (2010), 'A bottom-up re-estimation of global fisheries subsidies', *Journal of Bioeconomics* **12**: 201–225.

Sumaila, U.R., A. Dyck, and W.W.L. Cheung (2013), 'Fisheries subsidies and potential catch loss in SIDS Exclusive Economic Zones: food security implications', *Environment and Development Economics* **17**, DOI: http://dx.doi.org/10.1017/S1355770X13000156

Teelucksingh, S.S. and P.K. Watson (2013), 'Linking tourism flows and biological biodiversity in Small Island Developing States (SIDS): evidence from panel data', *Environment and Development Economics* **17**, DOI: http://dx.doi.org/10.1017/S1355770X13000120

UN (1993), *Convention on Biological Diversity*. United Nations Treaty Series, New York: United Nations.

UN Department of Economic and Social Affairs (2010), *Trends in Sustainable Development: Small Island Developing States*, New York: United Nations.

World Bank (2013), 'International tourism, receipts (% of total exports)', [Available at] http://data.worldbank.org/indicator/ST.INT.RCPT.XP.ZS/countries?display=default.

Worm, B., E.B. Barbier, N. Beaumont, J.E. Duffy, *et al*. (2007), 'Biodiversity loss in the ocean: how bad is it? Response', *Science* **316**: 1282–1284.

Worm, B., R. Hilborn, J.K. Baum, T.A. Branch, *et al.* (2009), 'Rebuilding global fisheries', *Science* **325**: 578–585.

Wunder, S. and S. Wertz-Kanounnikoff (2009), 'Payments for ecosystem services: a new way of conserving biodiversity in forests', *Journal for Sustainable Forestry* **28**: 576–596.