Secretary-General report:
Protection of coral reefs for sustainable livelihoods and development

The following content was provided by the World Resources Institute, adapted primarily from the *Reefs at Risk Revisited* publication. Please cite as: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

Please note: We are happy to provide maps or graphics for the report. Please see www.wri.org/reefs for the full report and full list of maps available.

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Background Info (from Burke et al., 2011)

- Coral reefs are among the most biologically rich and productive ecosystems on earth. They also provide valuable ecosystem benefits to millions of coastal people. They are important sources of food and income, serve as nurseries for commercial fish species, attract divers and snorkelers from around the world, generate the sand on tourist beaches, and protect shorelines from the ravages of storms.

- However, coral reefs face a wide and intensifying array of threats—including impacts from overfishing, coastal development, agricultural runoff, and shipping. In addition, the global threat of climate change has begun to compound these more local threats to coral reefs in multiple ways. Warming seas have already caused widespread damage to reefs, with high temperatures driving a stress response called coral bleaching, where corals lose their colorful symbiotic algae, exposing their white skeletons. This is projected to intensify in coming decades. In addition, increasing carbon dioxide (CO_2) emissions are slowly causing the world's oceans to become more acidic. Ocean acidification reduces coral growth rates and, if unchecked, could reduce their ability to maintain their physical structure. With this combination of local threats plus global threats from warming and acidification, reefs are increasingly susceptible to disturbance or damage from storms, infestations, and diseases. Such degradation is typified by reduced areas of living coral, increased algal cover, reduced species diversity, and lower fish abundance.

- Despite widespread recognition that coral reefs around the world are seriously threatened, information regarding which threats affect particular reefs is limited, hampering conservation efforts. Researchers have studied only a small percentage of the world's reefs; an even smaller percentage have been monitored over time using consistent and rigorous methods. The World Resources Institute's *Reefs at Risk* series was initiated in 1998 to help fill this knowledge gap by developing an understanding of the location and spread of threats to coral reefs worldwide, as well as illustrating the

links between human activities, human livelihoods, and coral reef ecosystems. With this knowledge, it becomes much easier to set an effective agenda for reef conservation.

Info on threats/adverse impacts (from Burke et al., 2011)

The majority of the world's coral reefs are threatened by human activities.

a) **Local pressures on reefs** - More than 60 percent of the world's reefs are under immediate and direct threat from one or more local sources —such as overfishing and destructive fishing, coastal development, watershed-based pollution, or marine-based pollution and damage.
b) Of local pressures on coral reefs, overfishing—including destructive fishing—is the most pervasive immediate threat, affecting more than 55 percent of the world's reefs. Coastal development and watershed-based pollution each threaten about 25 percent of reefs. Marine-based pollution and damage from ships is widely dispersed, rated as threatening about 10 percent of reefs.
c) **Present local and global pressures combined -** Approximately 75 percent of the world's coral reefs are rated as threatened when local threats are combined with thermal stress, which reflects the recent impacts of rising ocean temperatures, linked to the widespread weakening and mortality of corals due to mass coral bleaching.
d) **Threats have increased considerably over the past ten years.**
    - In comparing results from the 1998 *Reefs at Risk* analysis[1] with the current (2011) *Reefs at Risk Revisited,* we estimate that the percent of reefs rated as threatened has increased by 30 percent in the 10 years since the first *Reefs at Risk* analysis (comparing data from 1997 and 2007), with increases in all local threat categories and in all regions.
    - **By local threat:** The greatest driver of increased pressure on reefs since 1998 has been an increase in the threat from overfishing and destructive fishing, most significantly in the Pacific and Indian Ocean regions. This change is largely due to the growth in coastal populations living near reefs and increased demand for seafood. Pressure on reefs from coastal development, watershed-based pollution, and marine-based pollution and damage has also increased dramatically above 1998 levels.
    - **By region:** In the Pacific and Indian oceans, many reefs formerly classified as low threat are now threatened, largely reflecting increased overfishing pressure. In the Middle East, Southeast Asia, and the Atlantic over the past ten years, extensive areas of reefs have been pushed from medium threat into higher threat categories through a combination of local threats.

Current local pressure on reefs (by region) (from Burke et al., 2011)

Local threats to coral reefs are the most severe in Southeast Asia and least severe in Australia.

- Of the six coral reef regions examined, local pressure on coral reefs is highest in **Southeast Asia**, where nearly 95 percent of reefs are threatened, and about 50 percent are in the high or very high threat category.[2] Overfishing and destructive fishing pressure drive much of the threat in this region, followed by watershed-based pollution and coastal development.
- In the **Atlantic region**, more than 75 percent of reefs are threatened, with more than 30 percent in the high or very high threat category.[3] In more than 20 countries or

territories in the region—including Florida (United States), Haiti, the Dominican Republic, and Jamaica—all reefs are rated as threatened.[4] The Bahamas have the largest area of reef rated as low threat in this region. Overfishing is the most pervasive threat, but marine-based pollution and damage, coastal development, and watershed-based pollution also pose significant threats.

- In the **Indian Ocean**, more than 65 percent of reefs are threatened by local activities, with nearly 35 percent under high or very high threat.[5] Overfishing is the most widespread threat, but land-based pollution and coastal development also significant threats.
- In the seas of the **Middle East**, 65 percent of reefs are at risk from local threats, with more than 20 percent rated in the high or very high threat category.[6] In Yemen, Qatar, Bahrain, Iran, Djibouti, and Kuwait, more than 95 percent of reefs are threatened.[7] In this region, all four threats add significant pressure.
- Although the wider **Pacific** region has long enjoyed relatively low pressure on coastal resources, almost 50 percent of reefs are currently considered threatened, with about 20 percent rated as high or very high.[8] French Polynesia, the Federated States of Micronesia, Hawaii (United States), and the Marshall Islands have some of the lowest overall threat ratings (under 30 percent threatened.)[9] Overfishing and runoff from land-based sources are the predominant threats, though coastal development is also a major pressure in some areas.
- Australia's reefs are the world's least threatened, with an estimated 14 percent threatened by local activities.[10] Our analysis identifies both marine-based pollution and watershed-based pollution as the dominant threats, but vast areas of reef are remote from such impacts.

GLOBAL THREATS: Changes in climate and in ocean chemistry represent significant and growing threats.

- **Impact of CO_2**: Rising concentrations of CO_2 and other greenhouse gases in the atmosphere have led to warming of the atmosphere and, as a result, an increase in sea surface temperatures. Mass coral bleaching, a stress response to warming waters, has occurred in every region and is becoming more frequent as higher temperatures recur.[11] Extreme bleaching events kill corals outright, while less extreme events can weaken corals, affecting their reproductive potential, reducing growth and calcification, and leaving them vulnerable to disease. These effects also compound the local threats described above. Managing this threat is particularly challenging because it does not arise from local human actions, but from global changes to the atmosphere as a result of human activities.
- **Thermal stress:** The *Reefs at Risk Revisited* analysis projects that during the 2030s roughly half of reefs globally will experience thermal stress sufficient to induce severe bleaching in most years.[12] During the 2050s, this percentage is expected to grow to more than 95 percent.[13] These projections assume that greenhouse gas emissions continue on current trajectories and local threats are not addressed. Although coral reefs can recover from infrequent and mild bleaching, this degree of high, regular stress presents a significant risk of irreversible damage.
- **Rising acidity**: Rising levels of CO_2 in the oceans are altering ocean chemistry and increasing the acidity of ocean water, reducing the saturation level of aragonite, a compound corals need to build their skeletons. By 2030, fewer than half the world's

reefs are projected to be in areas where aragonite levels are ideal for coral growth, suggesting that coral growth rates could be dramatically reduced.[14] By 2050, only about 15 percent of reefs will be in areas where aragonite levels are adequate for coral growth.[15]

- **Combined impacts**: The combined impacts of ocean warming and acidification will increase the threat levels on more than half of all reefs by 2030, pushing the percentage of threatened reefs from 75 percent today to more than 90 percent by 2030.[16] By 2050, nearly all reefs will be affected by warming and acidification and almost all reefs will be classified as threatened, assuming there is no change in local pressure on reefs.[17]

III. Coral reefs and sustainable development

A. International agreements

B. Resolutions

C. Conventions

D. Declarations

E. Initiatives (global/regional level)

Recommendations for international collaboration to protect coral reefs (from Burke, et al. 2011)

Scaling up: International collaboration

We already have much of the knowledge, information, and tools needed to take actions that will effectively reduce local pressures on coral reefs and promote reef resilience in the face of a changing climate. However, at both local and national scales, we also need the political will and economic commitment to implement these actions. If we are to achieve meaningful results globally, it is critical to scale up these local and national approaches, and work internationally: to share knowledge, experience and ideas; to seek solutions to global-scale threats; and to make use of existing international frameworks to foster change. Examples of such international tools and agreements include:

- **International agreements.** When signed, ratified, and enforced, international agreements are important tools for setting and achieving collective goals. Agreements in several key areas may help to reduce threats to reefs. The UN Convention on the Law of the Sea establishes ocean governance which, when used effectively and enforced, can significantly reduce fishing pressure in domestic waters. CITES is an effective international agreement designed to control the trade of listed endangered species, including most hard coral species. MARPOL provides a framework for minimizing marine pollution from ships, but more widespread adoption and enforcement is needed in coral reef nations. The UN Framework Convention on Climate Change (UNFCCC) provides an important framework and urgently needs to establish new strict and binding protocols to drive reductions in greenhouse gas emissions. Climate adaptation funds, such as those established under the UN Framework Convention on Climate Change (UNFCCC), should support efforts to protect

coral reefs and reduce vulnerability of reef-dependent people (e.g., through livelihood enhancement and diversification), as key priorities for adaptation planning.

- **Transboundary collaboration and regional agreements.** Neither marine species nor pollution respect political boundaries. Efforts to effectively manage coral reefs and reduce pressures will often be transboundary in nature—including managing reef fisheries and trade, establishing international MPAs, and managing river basins that cross political borders. Regional agreements such as the Cartagena Convention (to address land-based sources of pollution, oil spills, protected areas, and wildlife) may have a pivotal role to play in achieving political commitments. Elsewhere, smaller bilateral or multilateral agreements may suffice, building trust and enabling the sharing of experience, resources, and results to build effective management up to larger scales.
- **International regulations on the trade in reef products.** Better regulation is needed on all trade in reef products. In particular, trade in live reef organisms should require certification to show that they have been sustainably caught, using nondestructive methods, and that they have been held and transported in a way that minimizes mortalities. In order to achieve this goal, testing and monitoring must be improved at the national level, to reliably identify sustainably fished or aquacultured species from those that have been harvested unsustainably or illegally. Cyanide detection facilities should be established at major live fish collection and transshipment points, for both the live reef food fish trade and the aquarium trade. Monitoring should include assessments of shipping practices and holding facilities along the supply chain.
- **Climate change efforts.** Coral reefs are extremely sensitive to climate change, which has led many reef scientists to recommend not only a stabilization of CO_2 and other greenhouse gas concentrations, but also a longer-term reduction to 350 ppm.[18] This target will be extremely challenging to attain, requiring immense global efforts to reduce emissions and, possibly, to actively remove CO_2 from the atmosphere. These actions will only be driven by demand, by reason, and by example. Thus there is a role to be played by all—individuals and civil society, NGOs, scientists, engineers, economists, businesses, national governments, and the international community—to address this enormous and unprecedented global threat.

IV. Economic, social, environmental and developmental benefits of protecting coral reefs, in the context of the themes and objectives of the United Nations Conference on Sustainable Development in 2012:

A. Objectives:

- secure renewed political commitment for sustainable development
- assess the progress to date and the remaining gaps in the implementation of the outcomes of the major summits on sustainable development
- address new and emerging challenges

Links to sustainable livelihoods / reef dependence (from Burke et al., 2011)

Dependence on coral reefs is high in many countries, especially small-island nations.

- Worldwide, approximately 850 million people live within 100 km of reefs, many of whom are likely to derive some benefits from the ecosystem services they provide.[19] More than 275 million people reside in the direct vicinity of coral reefs (within 30 km of reefs and less than 10 km from the coast), where livelihoods are most likely to depend on reefs and related resources.[20]
- Of 108 countries and territories with coral reefs examined in the *Reefs at Risk Revisited* analysis, the most reef-dependent were almost all small-island states, many located in the Pacific and the Caribbean.[21]
- Populous Asian nations, such as Indonesia and the Philippines, account for the greatest absolute numbers of reef fishers. Relative to population size, many of the countries with high participation in reef fisheries are in the Pacific.
- At least 94 countries and territories benefit from reef tourism; in 23 of these, reef tourism accounts for more than 15 percent of gross domestic product (GDP).[22]
- More than 150,000 km of shoreline in 100 countries and territories receive some protection from reefs, which reduce wave energy and associated erosion and storm damage.[23]

Degradation and loss of reefs will result in significant social and economic impacts.

Within the *Reefs at Risk Revisited* analysis, vulnerability to reef loss was assessed for 108 inhabited reef countries and territories, based on current level of threat to reefs, dependence on ecosystem services (food, livelihoods, exports, tourism, and shoreline protection), and adaptive capacity (ability to cope with the effects of degradation).

- The 27 countries and territories identified as highly vulnerable to reef loss are spread across the world's reef regions. Nineteen are small-island states.
- Nine countries—Haiti, Grenada, the Philippines, Comoros, Vanuatu, Tanzania, Kiribati, Fiji, and Indonesia—are most vulnerable to the effects of coral reef degradation.[24] They have high ratings for exposure to reef threat and reef dependence, combined with low ratings for adaptive capacity. These countries merit the highest priority for concerted development efforts to reduce reliance on reefs and to build adaptive capacity, alongside reducing immediate threats to reefs.

If you would like addition detail on social and economic vulnerability of nations to degradation and loss of coral reefs, please see Chapter 6 of *Reefs at Risk Revisited.*

Failures of marine management (from Burke et al., 2011)

It is important to make the point that current efforts to protect coral reefs and reduce local pressures are insufficient. It is, however, critical that we reduce local pressures to help coral reefs survive the additional pressures from warming and acidifying seas.

The *Reefs at Risk Revisited* analysis found that many reefs are found within protected areas (especially in Australia); most marine protected areas are ineffective or only offer partial protection.

- Approximately 27 percent of the world's reefs are located inside marine protected areas (MPAs).[25] This coverage includes strictly controlled marine reserves, locally managed marine areas, and sites where management controls only one or two types of threat. Of the reef area inside MPAs, more than half is in Australia. Outside Australia, only 16 percent of coral reefs are within MPAs.[26]
- The *Reefs at Risk Revisited* analysis identified 2,679 MPAs in coral reef areas and were able to rate nearly half, including most of the larger sites, for their effectiveness in reducing the threat of overfishing. Of those rated, 15 percent of sites were rated as effective, 38 percent as partially effective, and 47 percent as ineffective.[27]
- Based on these ratings, only 6 percent of the world's coral reefs are located in effectively managed MPAs and 73 percent are located outside MPAs. Increasing the MPA coverage and efficacy thus remains a priority for most areas.[28]
- The coverage of MPAs is strongly biased away from areas of greatest threat, limiting their potential for reducing threats in areas of heavy human pressure.

B. Themes:

- A green economy in the context of sustainable development and poverty eradication;
- The institutional framework for sustainable development

V. Rio+20: Coral reefs within the so called "blue economy" approach

VI. The role of national legislation in protecting coral reefs (including importance of inclusion of indigenous/local communities)

National legislation is a key part of what we need to do to reduce local pressures on coral reefs. I have, however, included these recommendations in the next section: "The way forward".

VII. The way forward: Potential actions (consistent with international law) needed to protect coral reefs and related ecosystems, including proposals for coordinated and coherent action across the United Nations system

The way forward / what we need to do (from Burke et al., 2011)

The world's coral reefs are severely threatened, and pressures continue to increase. Local human activities already threaten the majority of reefs in most regions, and the accelerating impacts of global climate change are compounding these problems. The extent and severity of threats to reefs, in combination with the critically important ecosystem services they provide, point to an urgent need for action. There is, however, reason for hope: reefs around the world

have shown a capacity to rebound from even extreme damage,[29] while active management is protecting reefs and aiding recovery in some areas.[30]

The global community needs to move quickly, collectively and comprehensively, on existing efforts to protect reefs and the services they provide humanity. The array of measures to deal with the many threats to reefs must be comprehensive. Local threats must be tackled head-on with direct management interventions, while efforts to quickly and significantly reduce greenhouse gas emissions are of paramount concern not only for reefs, but for nature and humanity as a whole. At the same time, we may be able to "buy time" for coral reefs in the face of climate change, through local-scale measures to increase reef resilience to climate-related threats.

Toward these aims, we recommend the following specific actions involving a broad range of stakeholders at the local, national, regional, and international scales:

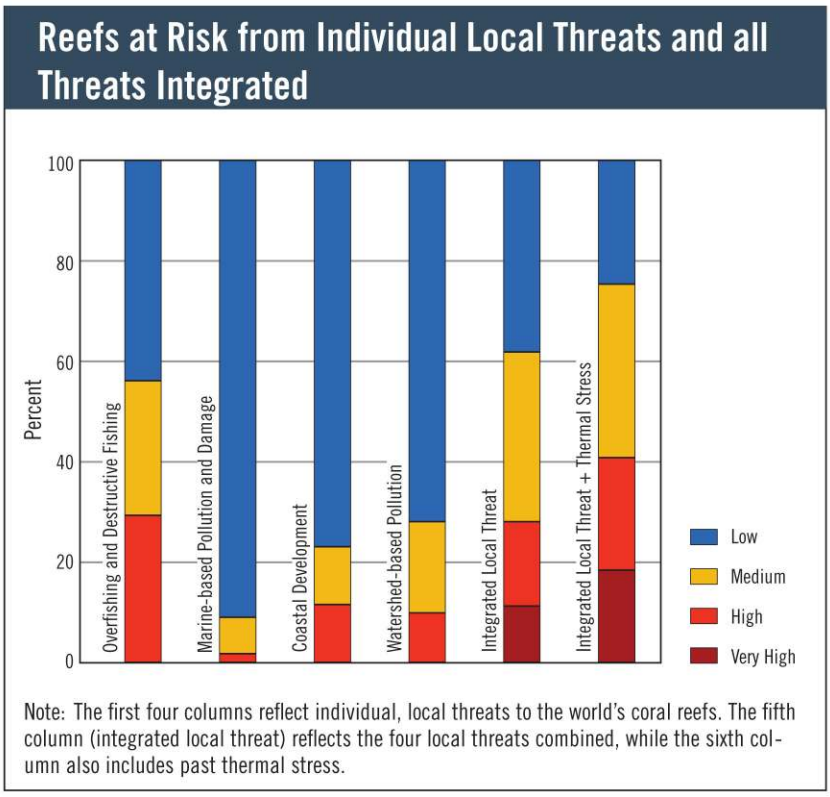
- **Mitigate threats from local human activities.**
    - ***Reduce unsustainable fishing*** by addressing the underlying social and economic drivers of overfishing; establishing sustainable fisheries management policies and practices; reducing excess fishing capacity and removing perverse subsidies; enforcing fishing regulations; halting destructive fishing; improving and expanding MPAs to maximize benefits; and involving stakeholders in resource management.
    - ***Manage coastal development*** through coastal zone planning and enforcement to prevent unsound land development; protecting coastal vegetation; implementing erosion-control measures during construction; improving sewage treatment; linking marine and terrestrial protected areas; and developing tourism in sustainable ways.
    - ***Reduce watershed-based pollution*** by reducing sediment and nutrient delivery to coastal waters through improved agriculture, livestock, and mining practices; minimizing industrial and urban runoff; and protecting and restoring riparian vegetation.
    - ***Reduce marine-based pollution and damage*** by reducing at-sea disposal of waste from vessels; increasing regulation of ballast discharge from ships; designating safe shipping lanes and boating areas; managing offshore oil and gas activities; and using MPAs to protect reefs and adjacent waters.
- **Manage for climate change locally.** A growing body of evidence has shown that by reducing local threats (including overfishing, nutrients, and sediment pollution), reefs may be able to recover more quickly from coral bleaching. Strategic planning to enhance local-scale reef resilience should target critical areas, building networks of protected areas that include (and replicate) different parts of the reef system, as well as include areas critical for future reef replenishment. Such efforts may represent an opportunity to "buy time" for reefs, until global greenhouse gas emissions can be curbed.
- **Develop integrated management efforts at ecosystem scales.** Plans that are agreed to by all sectors and stakeholders and that consider ecological relationships are most likely to avoid waste, repetition, and potential conflicts with other interventions and maximize

potential benefits. For reefs, relevant approaches include ecosystem-based management, integrated coastal management, ocean zoning, and watershed management.

- **Scale up efforts through international collaboration**. At all scales, we need political will and economic commitment to reduce local pressures on reefs and promote reef resilience in the face of a changing climate. It is also critical to replicate successful local and national approaches, and work internationally, using tools such as transboundary collaboration and regional agreements, improved international regulations to govern trade in reef products, and international agreements such as the UN Convention on the Law of the Sea, which helps regulate fishing, and MARPOL, which controls pollution from ships.
- **Support climate change efforts**. Reef scientists recommend not only a stabilization of CO_2 and other greenhouse gas concentrations, but also a slight reduction from our current level of 388 ppm (2010) to 350 ppm, if large-scale degradation of reefs is to be avoided. Attaining this challenging target will take time, and require immense global efforts. There is a role to be played by all—individuals and civil society, NGOs, scientists, engineers, economists, businesses, national governments, and the international community—to address this enormous and unprecedented global threat.
- **Build consensus and capacity.** Closing the gap between knowledge and results depends on action within the following key areas:
    - ***Scientific research*** to build understanding of how particular reefs are affected by local activities and climate change and how different stressors may act in combination to affect reef species; to explore factors that confer resilience to reef systems and species; to assess the extent of human dependence on specific reef ecosystem services; and to determine the potential for coastal communities to adapt to expected change.
    - ***Education and Communication*** to inform communities, government agencies, donors, and the general public about how current activities threaten reefs and why action is needed to save them, and to highlight examples of replicable conservation success.
    - ***Policy support*** to aid decision makers and planners in making long-term decisions that will affect the survival of coral reefs, as well as enhancing the ability of coastal communities to adapt to environmental changes and reef degradation.
    - ***Economic valuation*** to highlight the value of reefs and the losses associated with reef degradation, and to aid in assessing the longer-term costs and benefits of particular management and development plans.
    - ***Training and capacity building*** of reef stakeholders, to manage and protect reefs, understand and argue for their value, spread awareness, and reduce vulnerability in reef-dependent regions.
- **Involvement of local stakeholders** in the decision-making and management of reef resources is critical to the development of successful plans and policies.

- **Individual action.** Regardless of whether you live near or far from a coral reef, you can take action to help coral reefs:
    - Follow local laws and regulations designed to protect reefs and reef species.
    - If you fish, do it sustainably, avoiding rare species, juveniles, breeding animals, and spawning aggregations.
    - Avoid causing physical damage to reefs with boat anchors, or by trampling or touching reefs.
    - Minimize your indirect impacts on reefs by choosing sustainably caught seafood and reducing household waste and pollution that reaches the marine environment.
    - Help improve reef protection by working with others in your area to establish stronger conservation measures, participating in consultation processes for planned coastal or watershed development projects, and supporting local organizations that take care of reefs.
    - Tell your political representatives why protecting coral reefs is important.
    - Tourists can help by choosing sustainably managed, eco-conscious tourism providers and by not buying souvenirs made from corals and other marine species.
    - Educate through example, showing your family, friends, and peers why reefs are important to you.
    - Reduce your carbon footprint.

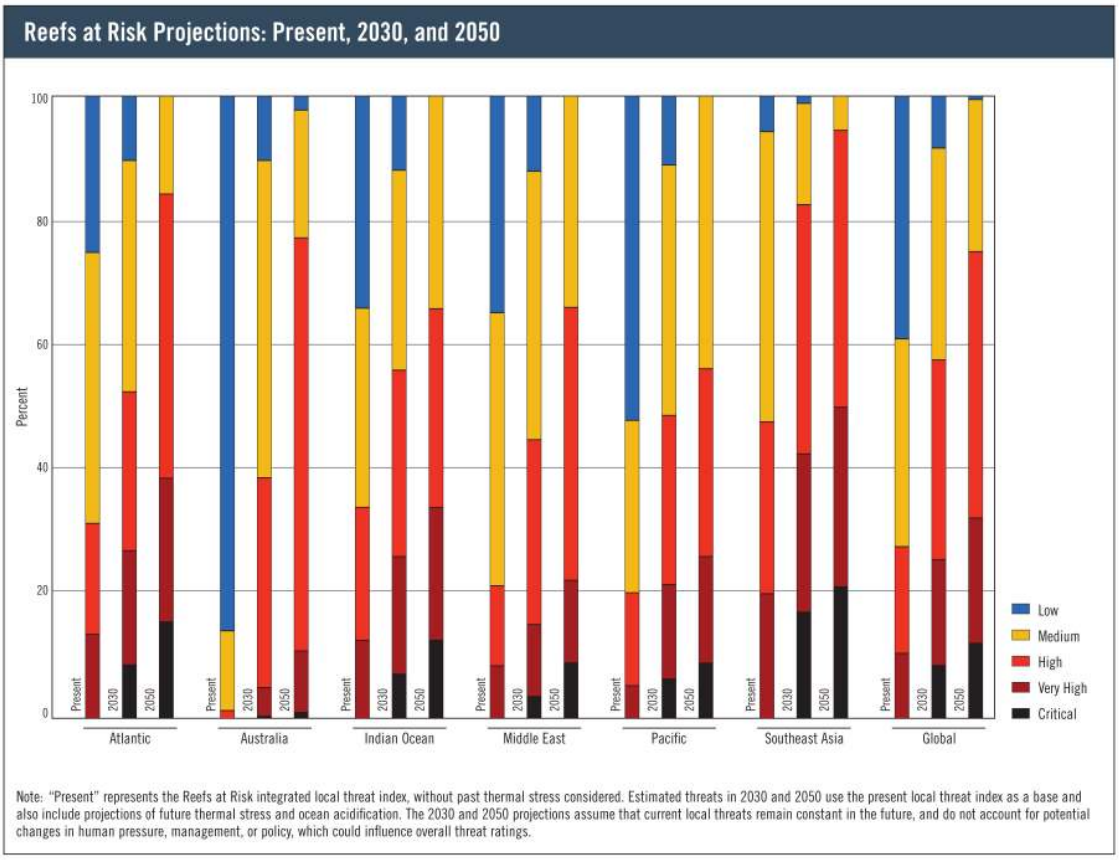
Reefs at Risk Worldwide by Category of Threat



Notes: Individual local threats are categorized as low, medium, and high. These threats are integrated to reflect cumulative stress on reefs. Reefs with multiple high individual threat scores can reach the very high threat category, which only exists for integrated threats. The fifth column, integrated local threats, reflects the four local threats combined. The right-most column also includes thermal stress during the past ten years. This figure summarizes current threats; future warming and acidification are not included.

Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

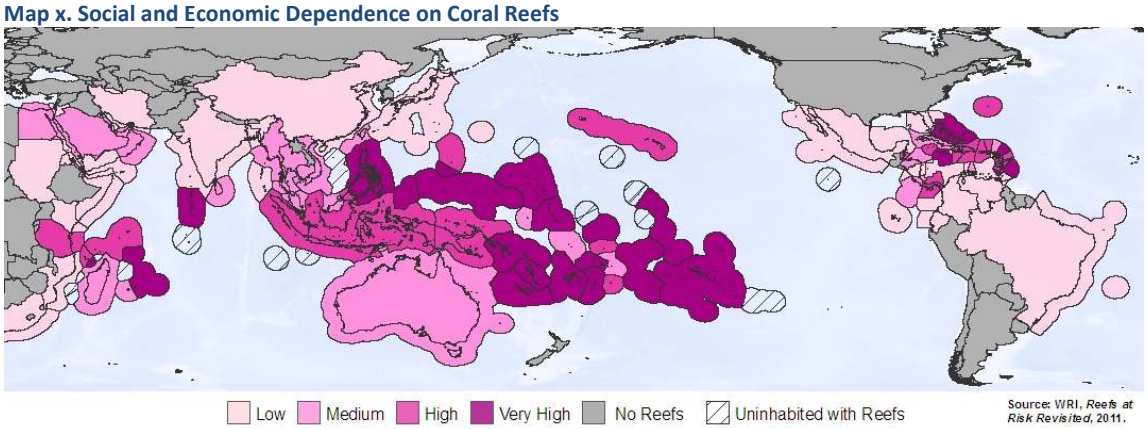
Reefs at Risk: Today, 2030, and 2050



Note: "Present" represents the *Reefs at Risk* integrated local threat index, without past thermal stress considered. Estimated threats in 2030 and 2050 use the present local threat index as the base and also include projections of future thermal stress and ocean acidification. The 2030 and 2050 projections assume no increase in local pressure on reefs, and no reduction in local threats due to improved policies and management.

Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

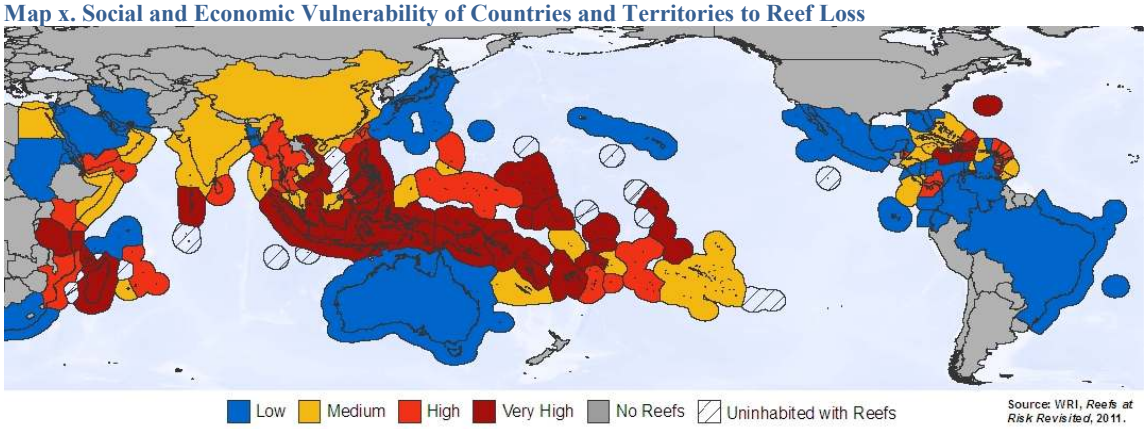
Map x. Social and Economic Dependence on Coral Reefs



Note: Reef dependence is based on reef-associated population, reef fisheries employment, nutritional dependence on fish and seafood, reef-associated export value, reef tourism, and shoreline protection from reefs. Countries and territories are categorized according to quartiles.

Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

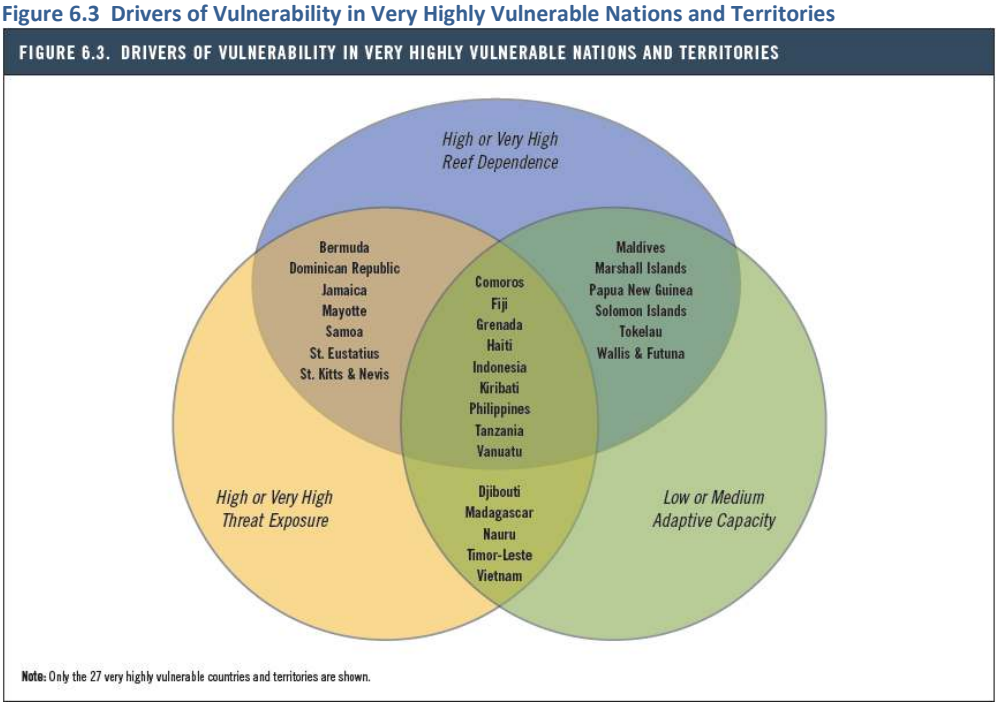
Map x. Social and Economic Vulnerability of Countries and Territories to Reef Loss



Notes: Vulnerability is based on exposure to reef threats, reef-dependence, and adaptive capacity. Eighty-one countries, 21 island territories, and six subnational regions (Florida, Hawaii, Hong Kong SAR, Peninsular Malaysia, Sabah, and Sarawak) were assessed, and are categorized according to quartiles.

Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

Figure 6.3 Drivers of Vulnerability in Very Highly Vulnerable Nations and Territories



Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

TABLE 6.3. SAMPLE VALUES: ANNUAL NET BENEFITS FROM CORAL REEF-RELATED GOODS AND SERVICES (US$, 2010)

Extent of Study	Tourism	Coral-reef Fisheries	Shoreline Protection
Global [a]	$11.5 billion	$6.8 billion	$10.7 billion
Caribbean (Regional)[b]	$2.7 billion	$395 million	$944 million to $2.8 billion
Philippines & Indonesia[c]	$258 million	$2.2 billion	$782 million
Belize (National)[d]	$143.1 million to $186.5 million**	$13.8 million to $14.8 million**	$127.2 to $190.8 million
Guam (National)[e]	$100.3 million**	$4.2 million**	$8.9 million
Hawaii (Subnational)[f]	$371.3 million	$3.0 million	Not evaluated

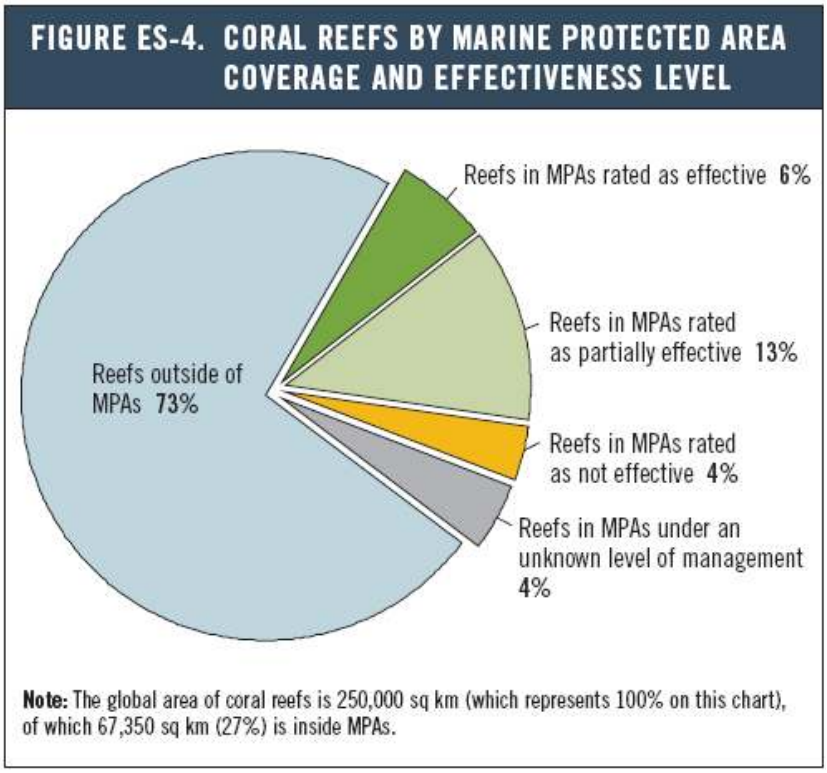
* All estimates have been converted to US$ 2010.
** Estimates of the value of coral reef-associated fisheries and tourism for Belize and Guam are gross values, while all other numbers in the table are net benefits, which take costs into account.
a. Cesar, H., L. Burke, and L. Pet-Soede.2003. *The Economics of Worldwide Coral Reef Degradation*. Zeist, Netherlands: Cesar Environmental Economics Consulting (CEEC).
b. Burke, L., and J. Maidens. 2004. *Reefs at Risk in the Caribbean*. Washington, DC: World Resource Institute.
c. Burke, L., E. Selig, and M. Spalding.2002. *Reefs at Risk in Southeast Asia*. Washington, DC: World Resources Institute.
d. Cooper, E., L. Burke, and N. Bood. 2008. *Coastal Capital: Belize The Economic contribution of Belize's coral reefs and mangroves*. Washington, DC: World Resource Institute.
e. Haider, W. et al. 2007. *The economic value of Guam's coral reefs*. Mangilao, Guam: University of Guam Marine Laboratory.
f. Cesar, H. 2002. The biodiversity benefits of coral reef ecosystems: Values and markets. Paris: OECD.

Valuation of losses due to degradation

Although many economic valuation studies have focused on estimating the benefits of coral reef ecosystem services, some studies have also focused on changes in value—that is, what an economy stands to lose if a reef is degraded. For example, the 2004 *Reefs at Risk in the Caribbean* study estimated that, by 2015, the projected degradation of Caribbean reefs from human activities such as overfishing and pollution could result in annual losses of US$95 million to US$140 million in net revenues from coral reef-associated fisheries, and US$100 million to US$300 million in reduced tourism revenue. In addition, degradation of reefs could lead to annual losses of US$140 million to US$420 million from reduced coastal protection within the

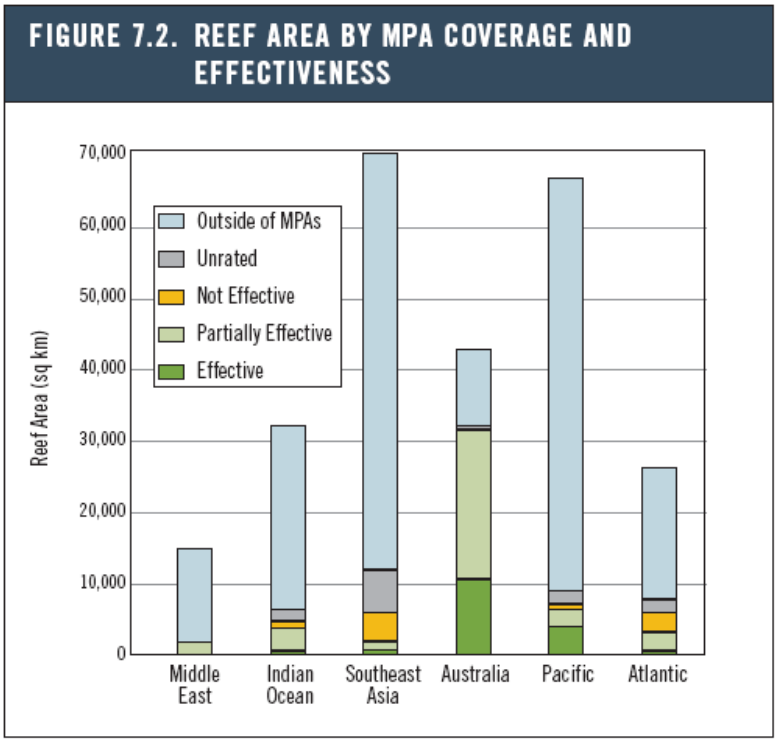
next 50 years.[31] Other studies estimate that Australia's economy could lose US$2.2 billion to US$5.3 billion over the next 19 years due to global climate change degrading the Great Barrier Reef,[32] while Indonesia could lose US$1.9 billion over 20 years due to overfishing.[33]

Figure ES-1. Coral Reefs by Marine Protected Area Coverage and Effectiveness Level



Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

MPA Coverage and Effectiveness (by area of coral reef) per Region



Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. Reefs at Risk Revisited. (Washington, DC, USA: World Resources Institute, 2011).

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