Global Changes and Capacity Building in Coral Reef Management in the Pacific

Engaging Scientists and Policy Makers in Fiji, Tonga, Samoa and Tuvalu

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Introduction

Healthy coral reefs are vital to the sustainability of peoples' livelihoods in the Pacific Islands. However, global changes including sea-level rise, increased sea

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surface temperature, ocean acidification, and numerous natural phenomena like cyclones, coupled with the effects of larger populations and worsening poverty, have increasing and often damaging impacts on Pacific coral reefs, leading to increased vulnerability of coastal communities. Integrating knowledge of these global changes across various national government sectors, then translating this knowledge into policies that lead to sustainable coastal ecosystems management is the challenge that the Global Change and Capacity Management in the Pacific Project is ultimately aimed at addressing. The project brought senior Pacific leaders in Fiji, Tonga, Samoa and Tuvalu together with scientists and experts on the sustainable management of coral reefs, so that they could be apprised of the impacts of global changes and of those factors affecting the health of their coral reefs. This engagement process was conducted through face-to-face dialogue between reef experts familiar with the science of climate change, and government, non-governmental organizations (NGOs) and civil society personnel responsible for developing appropriate policies focusing on the sustainable management of coral reefs in the four target countries.

Methodology

Between June and August 2010, some 130 senior officials attended four national workshops that were organized for this project. Detailed country dossiers prepared by the project team in consultation with these countries were used as references for the discussions. The workshops comprised presentations on the current status of coral reef and climate change issues and policies and some existing initiatives given by the project team leaders, government officials, NGOs and civil society representatives. Following open discussions, breakout groups reviewed and analyzed national needs and gaps (as per country dossier) and recommended modifications, additions and comments. The resulting conclusions were then discussed in plenary, where the four national coral reef action plans were formulated using the suggestions from the breakout groups.

Coral Reef Management: Issues and Gaps

Pacific Islanders heavily depend on coral reefs and their resources for their livelihoods. This dependence has had adverse effects on the continuance of a balanced ecosystem. Some of the major threats affecting reef ecosystems are global climate change, overfishing, pollution, coastal development and

biological threats. Rapid population growth and worsening poverty in the region exacerbate all of these threats, which are evident to greater or lesser extents in the target countries. However, monitoring results in the South West Pacific indicate that reefs in this region are more resilient in the face of continuing acute threats from increased sea surface temperatures, cyclones, tsunamis and crown of thorns. Nevertheless, there are suggestions that reefs are experiencing an increase in exposure to chronic stresses such as human-induced impacts which are difficult to measure.[1,2] As suggested by Veitayaki et al., the challenge for the Pacific Islands is to design and institute a disaster management plan at the regional, national, district and local levels.[3]

Global Climate Change

Climate change issues are widespread in the Pacific region but are regarded differently by each country because of differing sets of priorities, strategies and responses to these issues. The Pacific Islands are vulnerable to the effects of climate change but the atolls and coastal and low lying areas are most at risk.[4]

Coral bleaching seems to be increasing in frequency, scale and severity. During late February through to early March 2000, mass bleaching occurred in Fiji after a prolonged period of temperatures in excess of 30°C. This coincided with similar coral bleaching reported across the South Pacific from Papua New Guinea to Easter Island. Prior to and during this period, satellite surveillance of sea surface temperature (SST) revealed a band of progressively elevating temperatures. Degree heating weeks (DHWs) indicate the accumulation of thermal stress that coral reefs have experienced. One DHW is equivalent to one week of SST 1°C greater than the expected summertime maximum. Two DHWs are equivalent to two weeks at one degree above the expected summertime maximum or one week at two degrees above the expected summertime maximum (and so on). For the duration of the event, Tonga and the Cook Islands and areas of southern Fiji showed 10–15 DHWs and bleaching occurred after 5–6 DHWs. No coral bleaching in Kiribati, Tuvalu or the Samoas was experienced. A major bleaching occurred subsequently in Fiji in 2002 and mainly affected the north side of the two main islands, Viti Levu and Vanua

1 C. Whippy-Morris, ed., *South-West Pacific Status of Coral Reefs Report 2007* (Noumea: Coral Reef Initiatives for the Pacific, 2009).

2 L. Burke, K. Reytar, M. Spalding and A. Perry, *Reefs at Risk Re-visited* (Washington, DC: World Resources Institute, 2011).

3 J. Veitayaki, P. Manoa and A. Resture, "Addressing Climate Change and Sea Level Rise in the Pacific Islands," *Kagoshima University Research* 48 (2007): 1–17.

4 Id.

Levu, which had escaped the 2000 bleaching. Kiribati suffered severe bleaching in 2003 in the Phoenix Islands and in the Gilberts in 2005.[5]

Land loss is a major concern throughout the Pacific, considering that in many countries, a large proportion of their population live in urban areas along the coast. Even for the higher and larger islands, the land loss associated with sea-level rise will be devastating to coastal areas. In the atolls, where the average height of landmass is less than five meters, the loss of land or whole islands will mean catastrophic changes. At the moment, the effects of higher sea level are evident in cultural sites such as burial grounds in Tuvalu.[6]

In addition to sea temperature and sea-level rise, ocean acidification is also predicted with increased carbon dioxide (CO_2) levels in the atmosphere, which will have adverse effects on marine ecosystems. Oceans, along with terrestrial plants, absorb CO_2 from the atmosphere. In the past 200 years, the increased CO_2 in the atmosphere has led to increased amounts of dissolved CO_2 in the ocean, which in turn increased carbonic acid concentration in the ocean.[7] "A decrease in ocean pH would affect marine life by lowering the amount of calcium carbonate (the substance created when CO_2 is initially dissolved) in the water which would put the productivity and even the survival of thousands of marine species at risk."[8]

Increased frequencies of natural disasters (hurricanes, earthquakes, and tsunamis etc.) threaten reefs around the Pacific. For example, Lovell et al. mention that cyclones Ofa and Valarie, in 1990 and 1991 respectively, devastated Samoan reefs, stripping the seaward reef slopes of coral.[9] In 2004, cyclone Heta damaged 13 percent of coral reefs in Samoa.[10] A preliminary post-tsunami

5 E. Lovell, "Coral Bleaching in Fiji and the South Pacific," *PIMRIS Newsletter* 17, no. 4 (2005).

6 Veitayaki et al., n. 3 above.

7 S. Solomon, D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt, "Technical Summary," in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller, eds. (Cambridge: Cambridge University Press, 2007).

8 Veitayaki et al., n. 3 above.

9 E. Lovell, H. Sykes, M. Deiye, L. Wantiez, C. Garrigue, S. Virly, J. Samuelu, A. Solofa, T. Poulasi, K. Pakoa, A. Sabetian, D. Afzal, A. Hughes and R. Sulu, "Status of Coral Reefs in the South West Pacific: Fiji, Nauru, New Caledonia, Samoa, Solomon Islands, Tuvalu and Vanuatu," in *Status of Coral Reefs of the World: 2004*, Volume 2, C. Wilkinson, ed. (Townsville: Australian Institute of Marine Science, 2004), 337–362.

10 J.I. Samuelu and M. Sapatu, "Status of Coral Reefs in Samoa," in Whippy-Morris, n. 1 above.

assessment on coral reefs in Samoa found that damage due to wave transport of shingle, boulders and especially displaced coral colonies affecting attached coral through impact and burial was greater on the barrier back reefs and the more inshore portion of fringing reefs. The assessment concluded that the tsunami's impact on coral resulted from the degree of exposure to waves and the influence of the islands' shore morphology in reducing or augmenting wave forces.[11] A report from American Samoa states that researchers found several sites that lost 20–30 percent of their existing coral, although a marine ecologist stated that reefs in the main urban center were already in a poor condition before the disaster.[12]

According to Salvat and Wilkinson, cyclone frequencies are unlikely to alter significantly in the future.[13] However, the strength of these cyclones will be strongly influenced by increasing global climate change and rising SST. They suggest that as a result, there will probably be more category 4 and 5 storms, which in turn will result in even more localized damage to coral reefs and associated islands. While these cyclones will not be devastating for reefs at regional and global ocean scales, the synergy between their localized damage and more widespread effects of increasing SST, ocean acidification and rising sea levels, pose major threats for the long-term existence of coral reefs as they occur today. Coral reef resource managers have no mechanisms to combat cyclones other than by joining global campaigns against climate change and greenhouse gas emissions. However, they can assist in making reefs more resistant and resilient to cyclone damage by taking serious action to reduce direct and localized anthropogenic damage.

Overfishing

Overfishing is defined as fishing at a rate faster than the reproductive rate of the targeted population. The overexploitation of reef resources is one of the principal threats to ecosystem stability.[14] An exponential increase in human population has led to a directly proportional increase in demand for fisheries resources for food. The case is demonstrated in Fiji where the fish

11 E. Lovell, J. Samuelu Ah Leong, L. Bell, P. Ifopo, B. McAdoo, P. Skelton and J. Ward, *Inspection of Selected Coral Reefs on Upolu Samoa following the 30 September 2009 Tsunami*. Unpublished report commissioned by the Government of Samoa, 2009.

12 Associated Press, "Samoa tsunamis obliterate some coral reefs," *NBC News* (November 17, 2009).

13 B. Salvat and C. Wilkinson, "Cyclones and Climate Change in the South Pacific," *Revue Ecologique* (*Terre Vie*) 16 (2011): 105–115.

14 K. Newton, I.M. Cote, G.M. Pilling, S. Jennings and N.K. Dulvy, "Current and Future Sustainability of Island Coral Reef Fisheries," *Current Biology* 17 (April 3, 2007): 655–658.

consumption rate for Fijians was estimated at ca. 55 kg/capita/year,[15] and throughout the Pacific Islands region where the importance of fisheries was reflected in the annual per capita consumption of fish estimated at between 44 and 62 kg/capita/year. Long-term unsustainable fishing may result in a reduction in species diversity and/or the endangerment or extinction of target species, which also affects other non-targeted species in the process.[16] Commercial exploitation has led to many marine species such as the Maori wrasse, turtles, whales, sharks, bumphead parrotfish, sea cucumber, pearl oyster, Trochus snail, green snail, giant clam and triton becoming endangered.[17]

Studies in Fiji by the Institute of Applied Science at the University of the South Pacific have shown that nationally, most food fish catches are of a length less than that of the length at maturity, indicating that the fisheries around the nation are not healthy.[18] As noted by Roberts, such a situation could ultimately lead to the loss of entire functional groups of species.[19]

The live reef food fish trade (LRFFT) often targets spawning aggregations of selected high-value species, leaving a population with relatively reduced spawning stock, thus resulting in recruitment limitation.[20] A 2005 study conducted by Sadovy and Domeier concluded that, although the need for aggregation protection is now obvious to most biologists and fishers, the vulnerability of spawning sites, spawning aggregations, and aggregating fish species is still not widely recognized by fisheries managers, particularly in the Indo-Pacific and Caribbean.[21] In addition, few exploited aggregating species are regularly monitored, and few aggregations globally are currently managed or incorporated into marine protected areas (MPAs) and other means of protection such as seasonal closures. Furthermore, marine ornamental and curio

15 Fiji Fisheries Division, *Annual Report*, 1996.

16 C.M. Roberts, "Effects of Fishing on the Ecosystem Structure of Coral Reefs," *Conservation Biology* 9, no. 5 (1995): 988–995.

17 S. Foale, "Conserving Melanesia's Coral Reef Heritage in the Face of Climate Change," *Historic Environment* 21, no. 1 (2008): 30–36; H. Pippard, "The Pacific Islands, An Analysis of the Status of Species as Listed on the 2008 IUCN Red List of Threatened Species," (Gland: International Union for the Conservation of Nature, 2009); Whippy-Morris, n. 1 above.

18 James Comley, Institute of Applied Sciences, University of the South Pacific, Suva, Fiji, pers. comm., June 2010.

19 Roberts, n. 16 above.

20 R.S. Pomeroy, J.E. Parks and C.M. Balboa, "Farming the Reef: Is Aquaculture a Solution for Reducing Pressure on Coral Reefs," *Marine Policy* 30, no. 2 (March 2006): 111–130.

21 Y. Sadovy and M. Domeier, "Are Aggregation-fisheries Sustainable? Reef Fish Fisheries as a Case Study," *Coral Reefs* 24 (2005): 254–262.

trades may also have negative effects on reef ecosystems if not done sustainably.[22]

Pollution

According to the US National Oceanic and Atmospheric Administration, primary sources of coral reef pollution are predominantly land-based: "Runoff often carries large quantities of sediment from land-clearing, high levels of nutrients from agricultural areas and sewage outflows, and other pollutants such as petroleum products and pesticides."[23] All Pacific Islands have fringing reefs adjacent to the shoreline that are particularly susceptible to land-based pollution. The major sources of nutrients to coastal waters in Fiji and other Pacific Islands are typically from poorly treated human waste and chemicals (detergents and fertilizers). Poorly maintained sewage, septic tanks, primary treatment plants and pit latrines are all in use. With the exception of limited studies in major harbors, there are few water quality studies available. Anecdotal evidence suggests that many reefs in Fiji are undergoing a phase-shift to become macro-algal dominated.[24] Waste management in atolls is worsening as nutrient-rich waste (human and livestock) quickly enters the groundwater due to the porous nature of the soil and high water table. In addition, sewage sludge from septic tanks is pumped out to sea periodically, while suitable treatment and disposal arrangements are not available.[25]

Coastal Development

Coasts are dynamic areas that constantly undergo natural changes over time. In addition to these natural changes, coasts are subjected to human-induced alterations, including beach mining, reclamation of shorefront land and building coastal structures. According to Veitayaki et al., mining of coral aggregates in the Pacific provides in some cases the only source of construction materials in several countries including Fiji, Tonga, Tuvalu and Samoa.[26] However, this

22 H. Scales, A. Balmford and A. Manica, "Impacts of the Live Reef Fish Trade on Populations of Coral Reef Fish off Northern Borneo," in *Proceedings of the Royal Society Biological Sciences*, suppl. ser., 274, no. 1612 (April 2007): 989–994.

23 United States, National Oceanic and Atmospheric Administration (NOAA), "How pollution affects coral reefs," (July 19, 2012), available online: <http://celebrating200years.noaa.gov/visions/coral/side.html>.

24 L. Mosley and B. Aalbersberg, *Nutrient Levels and Macro-algal Out-breaks in Fiji's Coastal Waters*, IAS Technical Report No. 2005/01 (Suva: Institute of Applied Sciences, University of the South Pacific, 2005).

25 Veitayaki et al., n. 3 above.

26 Id.

activity disturbs the sand budget of the coastal areas and coastline stability. As Gillie explains, small islands (atolls, reefs and raised islands) have a limited volume of beach material and a relatively low rate of natural replenishment in comparison to rates of beach mining for use as construction aggregates.[27] For example, in Tongatapu, many beaches that are subject to mining have natural replenishment rates of 20–50 percent of the extraction rate, which is unsustainable. The understanding of natural sources of beach material and carbonate sediment budgets in many Pacific Island nations is fundamental to coastal resource management.

Land-use practices related to logging, mining, farming and grazing have led to extensive sedimentation problems in the Pacific that affect coral reefs. For example, results of a study carried out in Tefisi village, Vava'u in Tonga, found that removing forests for developing agriculture land, roads and settlements resulted in high sedimentation of the stream and coastal waters due to soil erosion. This sedimentation led to a low coral cover, low number of benthic organisms and fish assemblages, including an absence of butterfly fish.[28] In Fiji, an extensive dredging program has been undertaken to deepen rivers and reduce flooding. The dredging has been associated with the loss of wetlands and the destruction of marine fisheries that villagers rely on.[29]

Biological Threats

Coral disease outbreaks (bacterial, viral, and fungal) also deteriorate reef health. "Coral diseases and syndromes generally occur in response to biotic stresses such as bacteria, fungi and viruses, and/or abiotic stresses such as increased sea water temperatures, ultraviolet radiation, sedimentation and pollutants."[30] The frequency of natural disasters and disease outbreaks may

27 R. Gillie, "Distinctive Physical Features of Pacific Island Coastal Zones," in *Coastal Protection in the Pacific Islands: Current Trends and Future Prospects*, Proceedings of the First and Second Regional Coastal Protection Meetings on 21–23 February 1994 in Apia, Western Samoa and on 16–20 May 1994 in Suva, Fiji (Secretariat of the Pacific Regional Environment Programme and South Pacific Geoscience Commission, 1994).

28 A. Palaki, T. Samani and M. Masi, *Soil Sedimentation Effect on the Coastal Marine Environment, Tefisi Village, Vava'u*. Unpublished report (Department of Environment, Tonga, 2005).

29 Veitayaki et al., n. 3 above.

30 United States, NOAA, "Major Reef-building Coral Diseases," quoting D.L. Santavy and E.C. Peters, "Microbial Pests: Coral Disease Research in the Western Atlantic," Proceedings of the 8th International Coral Reef Symposium 1: 607–612, available online: <http://www.coris.noaa.gov/about/diseases/>.

increase due to global climate change and pollution. According to Lovell et al., coral disease was more widely reported in Fiji as a post-bleaching phenomenon.[31] Various researchers had reported white band disease and the coralline lethal orange disease that was discovered in 1995.[32] White band disease has also been reported in Samoa following localized bleaching.[33]

Crown of thorns starfish infestation has been reported in certain areas of the Pacific. Fiji experienced an infestation from 2006 to 2007, which resulted in a decreased coral cover.[34] Researchers found infestations of crown of thorns starfish in different stages of development in many island areas, usually in close proximity to villages or urban areas. There was no "common denominator" to clarify the cause of the population blooms. Instead, the picture that emerged was that blooms are likely to occur where the reefs are stressed, and the reefs of the Pacific are stressed by many different causes.[35]

The Way Forward

Although there are great differences among the four target countries in terms of size, environment, culture and population, the workshops agreed on a number of common and recurrent themes. All of the countries are signatories to the United Nations conventions and agreements relevant to global changes and the environment, although for some countries, reporting presents challenges. All countries have in place and are currently reviewing or updating the necessary policies regarding the conservation and sustainable use of their coral reefs and marine resources. All of these countries recognize the important role of climate change in the long-term sustainability of their marine resources and food security, but climate change issues have not yet been incorporated as a cross-cutting theme among the relevant government departments. In Tonga, for example, the Ministry of Environment and Climate Change seeks to put things in perspective under one umbrella, but it was evident that there are difficulties between them and the Ministry of Fisheries regarding allocation of funding and responsibilities.

31 Lovell et al., n. 9 above.

32 Seaweb web site, available online: <http://www.seaweb.org>.

33 E. Lovell, *Baseline Biological Survey of Tu'atuga Reef (5 mile reef), Samoa*. Unpublished report, requested by the Government of Samoa, 2004.

34 Whippy-Morris, n. 1 above.

35 Tellus Consultants, available online: <http://www.tellusconsultants.com/Thread/ACANTH.HTM>.

In general, the governments recognize the need for integrated planning, but there is a need to improve communications among those line departments responsible for the management of coral reefs; for some this will require a significant change in mind-set and *modus operandi*. There was a universal lack of knowledge of the 2002 Pacific Islands Regional Oceans Policy (PIROP),[36] developed and approved by the Forum Leaders and presented at the World Summit on Sustainable Development held in Johannesburg. In discussions, two countries, Tonga and Tuvalu, resolved to examine the possibility of using PIROP as a template for the development of national oceans policies.

The need to raise public awareness about global changes and coral reef issues was recognized by all, as was the need to find ways to incorporate marine issues into the school curriculum. This would require the necessary teacher education and much of the curriculum is currently based on developed-country principles. Common threats to coral reefs throughout the region include unsustainable fishing causing stock depletion, pollution from land-based sources, habitat destruction and global climate changes. All of these threats are evident to greater or lesser extents in the targeted countries.

Wilkinson and Salvat note that globally, natural resources continue to decline despite major advances in our scientific understanding of how ecosystems and human populations interact and considerable conservation and management efforts at scales from local user communities to oceans.[37] Greater effort will be required to avert increasing damage from over-exploitation, pollution and global climate change; all deriving from increasing exploitation driven by poverty and progress. They argue that the "tragedy of the commons" identified by Hardin is essentially real and will continue to threaten the lives of millions of people unless there are some major moral and policy shifts to reverse increasing damage to coastal habitats and resources. They agree with Hardin's conclusion that the solution to the tragedy will not be through the application of natural sciences, but via implementing exceedingly difficult and controversial moral decisions.[38]

All four countries recognize overfishing and the depletion of reef fish stocks as major problems and these, coupled with ever-increasing population growth rates, indicate that there will be serious fish shortages within the next 20 years

36 Secretariat of the Pacific Community (SPC), *Pacific Islands Regional Oceans Policy and Framework for Integrated Strategic Action* (Noumea: SPC, 2005).

37 C. Wilkinson and B. Salvat, "Coastal Resource Degradation in the Tropics: Does the Tragedy of the Commons Apply for Coral Reefs, Mangrove Forests and Seagrass Beds?," *Marine Pollution Bulletin* 64(6) (2012): 1096–1105.

38 C. Hardin, "The Tragedy of the Commons," *Science*, 162 (1968): 1243–1248.

unless some strong conservation and management measures are put in place. The importance of monitoring in support of management and policy is considered a high priority in all countries, although the lack of monitoring capacity is a limiting factor. The enforcement of fishery regulations is a serious problem throughout the Pacific Islands largely because of a lack of capacity and the logistical challenges posed by the scattered nature of islands. Alternative livelihoods will need to be developed for disenfranchised fishers. The expansion of aquaculture is seen as a possible replacement source for reduced protein supplies; however, the scope for this is limited in Samoa and Tuvalu. With the exception of Fiji, national biodiversity inventories are seriously inadequate and much of the marine biodiversity, with the exception of commercially important species, is unrecorded. All countries recognized the need for much more work on the development of their national marine biodiversity inventories. The scarcity of national or regional experts in taxonomy is a hindrance and training in this area is urgently needed.

The establishment and management of marine protected areas (or similarly designated areas) is of high priority in all the countries, as well as the recognition of the important role they play in conservation. Only in Fiji and Samoa has this reached a high level of community engagement through the Fiji Locally Managed Marine Areas Programme, and the Village Fish Reserves, accompanied by village by-laws, in Samoa. Community engagement was seen as crucial to the long-term effectiveness of protected areas. Tonga has a variety of reserves and parks, with policies and community engagement still evolving; in Tuvalu there is only one significant MPA involving strong community participation, while the Falekaupule (traditional assembly) in the outer islands is exercising control in the use of their fisheries resources.

The workshops identified the following actions for follow-up:

- Upgrade national marine biodiversity inventories and conduct surveys in Tonga, Samoa and Tuvalu.
- Introduce the Seagrass Watch Programme in Tonga and Samoa.
- Develop a regional climate change clearinghouse, preferably at the University of the South Pacific (USP).[39]
- Increase capacity-building in all countries.
- Address the disconnection between communities, government and other players.

39 A great deal of information and coordination on climate change information and related topics is already available under the project PIRCA (Pacific Islands Regional Climate Assessment), available online: <http://www.eastwestcenter.org/PIRCA>.

- Harmonize projects so as to have better coordination among agencies.
- Assist the marine science program at the National University of Samoa.
- Raise public awareness of coral reef issues and find ways of introducing relevant curriculum in schools.
- Support the *Two Samoas* initiative.
- Facilitate attachments of USP students in their home governments.
- Introduce coral identification training in Tonga, Samoa and Tuvalu.
- Encourage closer cooperation with the Secretariat of the Pacific Regional Environment Programme on coral reef and coral reef management issues.
- Enhance good governance at the community level.
- Continuously monitor in support of government policies and create relevant statistics on fish stocks and fishing in order to understand trends.
- Establish more marine protected areas.