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Chapter 15

Coastal lagoon management in three Pacific island situations: Is scientific knowledge used effectively?

Introduction

The small islands of the South Pacific region, like many other parts of the world, are experiencing population growth and, more particularly, the movement of people into major urban centres. Most Pacific cities, especially the capitals of regional countries, are located in naturally protected coastal waterways. This is a historical situation, arising from the need to provide protected deep-water harbours for ships, the main form of international travel and trade. These waters are protected by offshore barrier reefs, by islands or by riverine deltas. However, these protective mechanisms also have the effect of limiting mixing of near-shore and open-ocean waters (Viles and Spencer, 1995). This provides an opportunity for problem materials, derived from human activities, to accumulate in the near-shore waters and the marine zone with which most people interact.

Urbanised coastal lagoons represent one of the most threatened global environments. These water bodies, as a result of their adjacent populations, are subjected to human impacts from habitat modifications, poor waste management, industrial discharges, storm-water runoff and shipping activities. In some cases, the lagoons are approaching ecological collapse. The ecological behaviour of these water bodies is difficult to determine as they are constantly undergoing change due to the effects of tides and river inputs. The management of coastal lagoons is often complicated by the multi-jurisdictional nature of the legislation that frequently applies to them.

It is a common saying that 'you cannot manage what you cannot measure'. There has therefore been a significant global effort to gather scientific information about coastal areas with the stated goal of ensuring that decision-making is based on a firm knowledge base. The knowledge base should focus on ecological conditions and processes in coastal water bodies and the potential impacts of humans on them. It is also important to emphasise that planning and management should be integrated and multi-dimensional in nature, and should accommodate the technical, social and economic components of such a complex undertaking. Despite this aspiration, a number of researchers have found that an integration of science, policy and management is lacking (e.g. Hoare, 2002; Kay and Alder, 2005; van Kerkhoff, 2005; Thompson, 2006). In this context, the Pacific islands have not received much attention.

The global effort to provide management regimes for coastal lagoons tends to involve three main phases, notwithstanding local variations, as follows:

Phase 1: Evaluation of ecological processes and community expectations to create a scientific understanding of the main factors controlling lagoons and the expectations and goals of the people using them.

Phase 2: Development of a cooperative management plan using information gathered in Phase 1. This needs to be flexible and adaptable as new information becomes available.

Phase 3: Implementation and monitoring to determine whether the plan is achieving its goals.

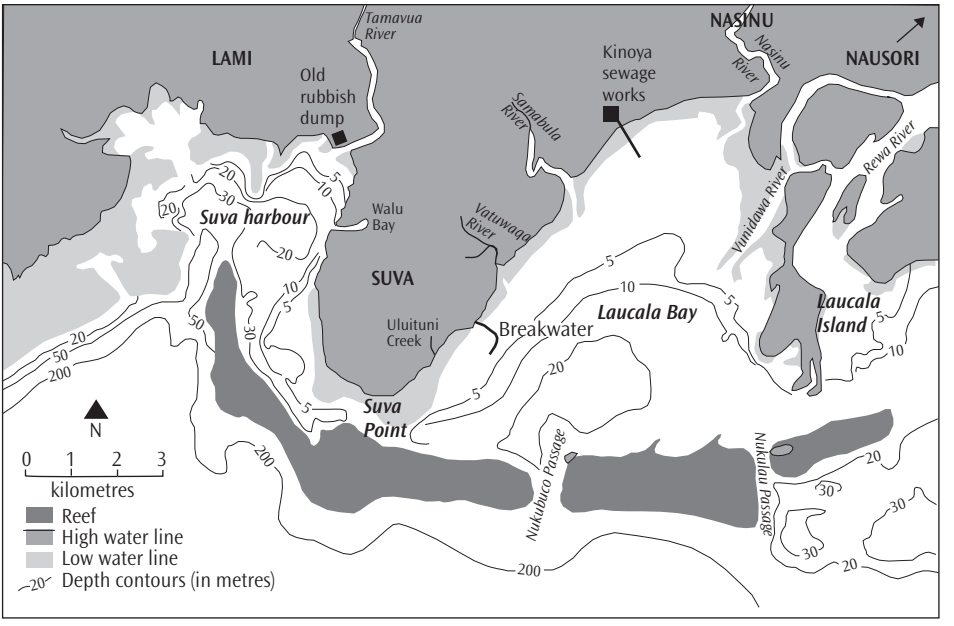
This chapter reviews the situation in three Pacific localities, Suva Lagoon in Fiji, Fanga'uta Lagoon in Tonga and Funafuti Lagoon in Tuvalu, by examining what is being done about the management of these areas, what scientific knowledge is available and how it is being utilised therein.

Suva Lagoon

Suva Lagoon, located in south-east Viti Levu, the largest island of the Fiji group, consists primarily of Laucala Bay and Suva Harbour (Figure 15.1).

The lagoon is one of the most commercially important water bodies in the South Pacific region. Since Suva (at 178°43'E and 18°15'S) was established as the capital of Fiji in 1882, this lagoon has been an intensive shipping centre, acting as both a national and regional hub for transport and trade. The development of Suva as a major commercial centre in the Pacific islands has also led to a rapid expansion of the local population (see

Figure 15.1. The Suva Lagoon System, Viti Levu, Fiji



Source: Tuvalu Map Server: http://map.tuvalu.tv

Table 15.1. Population census data for the Suva area

Date	Greater Suva*		Suva City	
1966	80,269	(17%)#	54,157	(11%)
1976	117, 827	(20%)	63,628	(11%)
1986	157,980	(22%)	69,665	(10%)
1996	214,628	(28%)	77,366	(10%)
2007	247,141	(30%)	75,225	(9%)

* Greater Suva = the Suva, Lami, Nasinu and Nausori local government areas (LGAs)

#The figures in parentheses are the % of the total population of Fiji

Source: Fiji Bureau of Statistics. http://www.statsfiji.gov.fj/

Table 15.1), with subsequent increases in construction, industry and related infrastructure. The local populace have also made extensive use of the resources within and around Suva Lagoon for food, shelter and recreation. All of these activities have had a dramatic impact on the local environment with some components (e.g. the old Lami rubbish dump) having significant immediate influence, while others (e.g. declining water quality) have had less obvious consequences (Morrison and Aalbersberg, 2006).

Given the importance of Suva Lagoon to Fiji and the region, and the rapidly expanding urban population (now over 200,000 in the surrounding catchment), it is surprising that the local authorities have not given higher priority to the systematic acquisition of environmental information on this water body, particularly on the pollution situation, which is regarded by one observer as being 'out of control' (reported in Morrison, 2006). While information has been collected since the 1970s, no systematic programme is in place to determine the sources, types and quantities of pollutants entering the Suva Lagoon system. An assessment of the potential contaminant sources (Morrison et al., 2006) indicates a range of problem materials – nutrients, metals, hydrocarbons, organo-chlorines, micro-organisms and other materials such as plastics, tyres, clothing and general rubbish.

A recent review of the ecological and other information on the Lagoon (Morrison, 2006) indicates that some 'true' knowledge gaps exist (e.g. bird life, invertebrate ecology, reef-seagrass-mangrove interactions, health impacts of poor Lagoon condition) while other information has been collected but not published (e.g. reef changes, physical oceanography, regional geology, algae, seagrasses and fish). It was also observed that there is no systematic information on current community and non-community resource use/impacts. The degree of community awareness of the ecological processes, status of biodiversity and how this affects the community is uncertain, and systematic collection of such information is not being undertaken. Gathering such information would facilitate identification of community stakeholders (who are the more inclusive community, e.g. resource owners, subsistence and commercial users, researchers).

There is no integrated planning in Fiji for large coastal water bodies like Suva Lagoon. Examination of the current planning system in Fiji indicates that most plans are land-based or address a specific topic/sector. There is minimal integrated planning at the catchment/receiving water body level. Early attempts at total catchment planning (e.g. FAO in

1980s) were never fully developed. Almost all foreshore planning is reactive rather than strategic, and therefore is generally ineffective thus emphasising the need for stronger linkages between the roles of, for example, the Department of Lands and the Port Authorities. While changes to administrative systems have been occurring in recent years, these do not fully address the requirements for managing important ecosystems.

The planning system needs to be revisited to move towards a modern environmental planning system (involving the integration of planning activities of rural authorities, local government agencies, Departments of Town and Country Planning, Environment and Lands). There is a lack of mangrove and foreshore planning, and therefore no ability to fill key gaps, e.g. health impacts of poor living environments. The Suva City structural plan (zoning) only covers land (with some uncertainty about the situation in mangroves and reclamation areas); the situation in the Lami, Nasinu and Nausori LGAs is also unclear as they have different priorities.

Community engagement is the basis of successful management – more effort/support is required in this area, and there should be a priority concern for the needs of traditional owners/users. There is an urgent need to determine community perceptions on issues relating to Suva Lagoon. The information needs of various communities should be determined, collected and appropriately disseminated, and there is a need to involve communities in research and intellectual property issues.

Based on the experience in other countries, the successful management of Suva Lagoon will require the establishment of a coordinating body to develop and *implement* a **Suva Lagoon Management Plan**. To be effective, this body must be a high-level national group and have jurisdiction covering the lagoon and relevant components of the adjacent catchments. Linked to the establishment of an oversight body, there is an urgent need for a review of current planning agencies in Fiji to facilitate restructuring of the system to incorporate the recent international developments in integrated and ecosystem-based planning (this might be a role for the National Environment Council, and/or the Law Reform Commission).

The successful management of Suva Lagoon will be a multi-sectoral activity, involving teams/groups from many traditional disciplines. This involves accurate identification of key stakeholders, clear declaration of their roles and responsibilities, with precise objectives in the management plan, and well-defined processes to achieve the desired goals. Mechanisms for enforcement of regulations must be established, including who will carry out the enforcement, how this will be done and what funding (e.g. national government, local government, private sector, and an environmental levy on shipping) and other resources will be available. As noted earlier, community engagement is the basis of successful management – more effort/support is required in this area, and the needs of traditional owners/users should be a priority concern.

One approach to developing and implementing a Suva Lagoon Management Plan could be to adopt Locally Managed Marine Areas (LMMA)-type alliances and strategies (Veitayaki et al., 2003) in concert with the Suva Lagoon Community. Further, there should be maximum involvement of visiting scientists (both local and overseas) with local

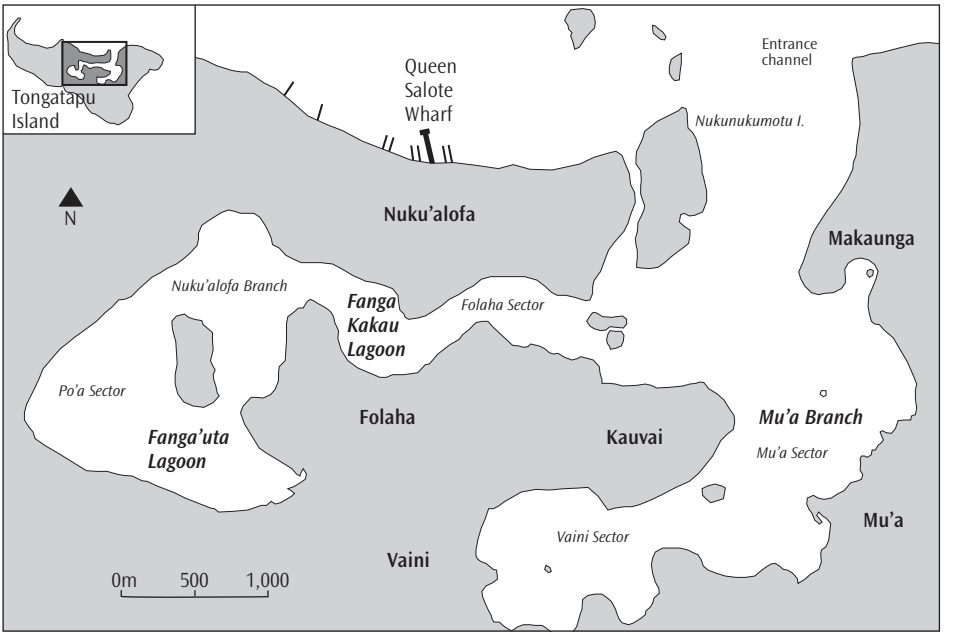
community members, schools and other community groups. Community-based programmes should be developed for the protection and replanting of native coastal trees, and a primary school programme (one-week module) should be introduced in all local primary schools to educate children on the importance of coastal ecosystems. In addition, a series of community-based workshops with appropriate presentations by relevant people should be established.

Improved links between poor-quality environmental conditions on human health could be determined through socio-economic and health surveys linked to resource use and degradation, including the collection of better health statistics for environmental planning. While this will require resources, effective linkages between the Department of Health and the local tertiary institutions (University of the South Pacific, Fiji School of Medicine, Fiji Institute of Technology) could achieve much, utilising student projects focused in this area. Topics that could be investigated include the effects of recreational use of contaminated shoreline waters, shellfish quality at time of consumption, and preparation of a comprehensive database on health statistics for residents of the foreshore areas around Suva Lagoon.

Fanga'uta Lagoon

The Fanga'uta Lagoon system is one of the most important water bodies in Tonga and is one of the dominant natural features of Tongatapu, the Kingdom's main island (Figure 15.2). The Lagoon system, located at 175°12'W, 21°18'S, comprises two major arms, one in the west including the Fanga'uta and Fanga Kakau sections, and one in the east including the Fangalongonoa and Vaini sections. In this chapter, the term Fanga'uta will normally refer to the whole system.

Figure 15.2. The Fanga'uta Lagoon System, Tongatapu, Tonga



Source: Tuvalu Map Server: http://map.tuvalu.tv

As the national capital (Nuku'alofa) and several large villages (Vaini, Mua and Folaha) are located immediately adjacent to the lagoon, the catchment population is approaching 40,000, and has been growing rapidly over the last 30 years. The Lagoon system has provided fish and shellfish supplies for the surrounding population for generations, but in recent years yields have dropped and some species are no longer sustainable. In addition, lagoon resources such as mangroves have been extensively exploited, and significant areas, especially in the western section have been 'reclaimed' for urban expansion (Kaly and Lloyd, 2001). The Lagoon system has also provided many recreational opportunities for local residents and visitors (Pelesikoti, 2003).

The first detailed ecological study of Fanga'uta Lagoon was carried out in 1981 (Zann et al., 1984). This study found that water clarity was >1m throughout and that the lagoon was dominated by extremely productive soft substratum communities. Zann et al. (1984) reported that even in 1981 the system was undergoing significant changes. The large mullet fishery (yielding about 185 t/yr) of the 1960s had gone into decline resulting in closure to commercial fishing in 1975. The lagoon was reported as shallowing, mangroves were being cleared, land reclamation for building was occurring, and the mussel (mainly Anadara sp.) fishery was in decline.

Studies in 1987–88 (Naidu et al., 1991) indicated that further changes had occurred in the lagoon. Although water clarity was still good (most readings >1m), sewage-related contamination with high nutrient concentrations, sufficient to impact on coral growth, was recorded. Further declines in mullet and mussel catches were noted with mussels reported as having disappeared from some locations in the lagoon.

In the early 1990s a major change occurred (Kaly and Morrison, 2005). Aerial photographs taken in 1992 showed Fanga'uta Lagoon with relatively clear waters as it was possible to see areas of seagrasses, coral rubble and patch reefs to depths of at least 2 m. Information was emerging by this time that the lagoon was occasionally turning green, that turbidity was increasing, and that fish catches continued to decline. Then, during 1993, the lagoon 'flipped' (changed for good). It lost its clear waters, fish kills started to occur and foam was often seen forming on its narrow muddy beaches. The many species of seagrasses in the lagoon became covered in algae and more and more mangrove areas were being cut and damaged. By that time many of the beaches were converted to seawalls and sewage was a common component of storm water entering through drains.

The early 1990s saw several activities in the policy, planning and management areas, including the production of an 'Environmental Management Plan for the Kingdom of Tonga' (ESCAP and GoT, 1990) and 'The Kingdom of Tonga: Action Strategy for Managing the Environment' (Thistlethwaite et al., 1993). In addition, based on the outcomes of the 1987–88 studies, an inception report on a proposed environmental management plan (EMP) for the Fanga'uta lagoon system was prepared by the Ministry of Lands Survey and Natural Resources and the Ministry of Health. Progress on the implementation of such plans was slow, and a number of major developments around the lagoon were proposed, including the possibility of causeways across the main lagoon entrance and the Fanga Kakau sector, and reclamation of major areas in the north and

south of the Pe'a sector. These proposals could have had dramatic environmental impacts and were of concern to the government and many people in the wider community.

Concerns for the health of Fanga'uta Lagoon reflected wider apprehension about the environment in Tonga, and in 1993 AusAID, in consultation with the Government, commissioned a team to design a project for Australian assistance to the environment sector in Tonga. The project aimed at strengthening the capacity of a range of Ministries and agencies in the Government of Tonga to undertake environmental management and planning roles. As a result of the community concern about the condition of the Fanga'uta Lagoon, the project was designed to utilise the lagoon and its adjacent communities as a case study for project training activities. Funding for the Tonga Environmental Planning and Management Strengthening Project (TEMPP) was approved in 1997 to run until 2001.

The TEMPP project provided a unique opportunity to gather new information on the Fanga'uta Lagoon system and to train national staff in a range of scientific, planning and management activities. A full suite of scientific investigations was completed including monitoring of various aspects of the lagoon ecosystem (e.g. water quality, seagrasses, fish and shellfish catches) over several years. Issues like mangrove loss, waste management (an identified key problem for the lagoon), chemicals management and reclamation/seawalls were also reviewed. About fifty technical reports were produced facilitating an accurate assessment of the condition of the Lagoon in 2001 (Kaly and Lloyd, 2001). Community education activities were also conducted and community perceptions and aspirations about the lagoon were assessed.

One of the main objectives of the TEMPP project was to produce an environmental management plan (EMP) for Fanga'uta Lagoon. This was completed in 2001 (Kaly and Lloyd, 2001) and submitted to the Government of Tonga. This plan contained a review of the current condition of the lagoon, the major issues facing the water body and the surrounding catchment. The approach taken attempted to accommodate all components through a zoning strategy for different usage areas, each with its own set of resources, stresses and human needs. The zoning plan and the recommended activities for each zone are given in Table 15.2.

The Fanga'uta EMP was relatively unique in the Pacific islands region in that it was based on a strong scientific knowledge base and had significant community input as the views of government, NGOs and the general community were taken into account in its preparation. The importance of the EMP and the Lagoon was given some recognition as the Tongan Cabinet endorsed the EMP in 2003, but minimal progress has been made on implementation because of funding limitations. Given the recent (November 2006) catastrophic damage to the Nuku'alofa business district during rioting, it is unlikely that substantial funds will be made available for undertaking the required actions to protect Fanga'uta Lagoon. This is of concern as it is inevitable that in the absence of such action the condition of the Lagoon is likely to further decline.

Table 15.2. Summary of recommended activities within each of the Fanga'uta management zones

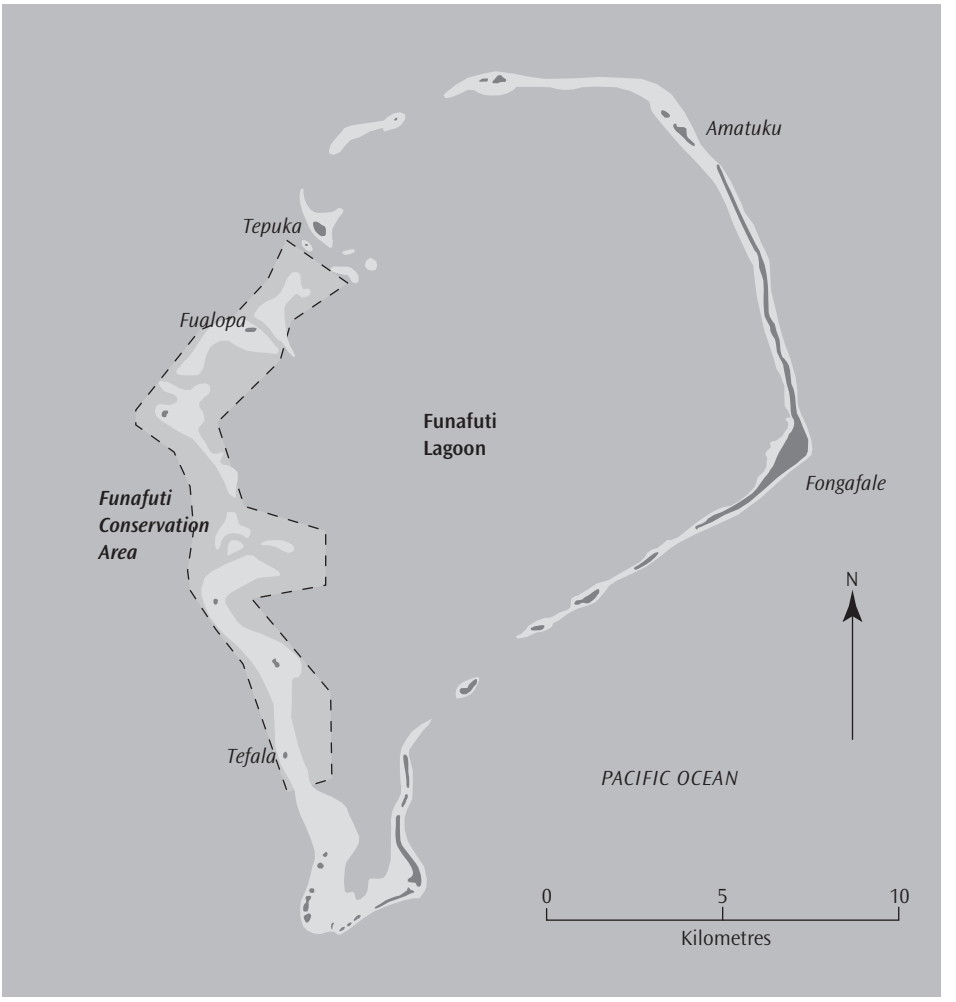
Zones	1	2	3	4	5	6	7	8
Activity	Mouth fisheries	Lagoon fisheries	Mangrove conservation	Mangrove use	Village & agriculture	Village special use	Urban	Public special use
Land allocation below present MHWM	✘	✘	✘	✘	✘	✘	✔	✘
Commercial fishing/ aquaculture	✔	✘	✘	✘	na	✘	na	✘
Subsistence fishing	✔	✔	✘	✔	na	✔	na	✘
Mangrove removal	na	na	✘	✘	na	✘	na	✘
Seagrass removal	✘	✘	na	na	na	✘	na	✘
Mangrove use (wood, crafts, medicine)	na	na	✘	✔	na	✔	na	✘
Mangrove rehabilitation	na	na	✘	✔	na	✔	na	✘
Reclamation	✘	✘	✘	✘	✘	✘	✔	✔
Seawalls	✘	✘	✘	✘	✘	✘	✔	✔
Dredging/sand & gravel extraction	✘	✘	✘	✘	✔	✘	✔	✘
Anchor/boat disturbance	✘	✘	✘	✘	na	✘	✘	✘
Buildings	✘	✘	✘	✘	✔	✘	✔	✘
Rubbish dumping	✘	✘	✘	✘	✘	✘	✘	✘
Industry	na	na	✘	✘	✘	✘	✔	✘
Tourism	✔	✔	✘	✔	✔	✔	✔	✘
Recreation	✔	✔	✘	✔	✔	✔	✔	✔
Research	✔	✔	✔	✔	✔	✔	✔	✔

MHWM = Mean high water mark; na = Not applicable; ✘ = Not permitted; ✔ = Permitted

Funafuti Lagoon

Funafuti is the capital of nine atolls and islands that form the nation of Tuvalu. The islands and atolls are all low, comprised entirely of reefs and their derivatives and stretch between Nanumea in the north-west (5°38'S, 176°07'E) and Niulakita in the south-east (10°45'S, 179°38'E) for a distance of approximately 680 km. The total land area is only 26 km^2, spread over an exclusive economic zone (EEZ) of almost 1 million km^2. Funafuti is located roughly in the centre of this geographic spread at 8°31'S, 179°12'E and comprises a large atoll lagoon (approximately 15 x 22 km) surrounded by a reef rim on which has formed 30 coral islets (Figure 15.3). The largest of these, Fogafale is about 5 km long and up to 500 metres wide and provides a land area of around 1.45 km^2 . About one-third of the nation's 16,000 population, and the seat of government, are located on Fogafale.

Figure 15.3. Map of Funafuti Atoll showing Funafuti Lagoon, the Capital District on Fogafale and the Funafuti Conservation Area (dashed line)



Source: Tuvalu Map Server: http://map.tuvalu.tv

Funafuti Lagoon represents the opposite extreme to the ecological conditions, human interactions and scientific knowledge and requirements described earlier for Suva. While Suva Lagoon is formed by fringing reef and estuarine areas bordering a high island, and Fanga'uta Lagoon is formed in the centre of the raised coral platform of Tongatapu, Funafuti Lagoon is formed as part of a true atoll in mid-oceanic conditions subject to no terrestrial influences. The country's shipping is mostly limited to about one tanker vessel per month, two inter-island transport vessels and a small fishing fleet. Funafuti is not a regional shipping hub and has no local manufacturing activity. The lagoon has several large channels connecting it with the ocean and a large sea-to-land ratio. Most of the impacts and management issues relating to the lagoon are derived either from relatively localised impacts of the small human population, natural events or global influences.

With a density of about 3,600 people per km^2, Fogafale islet is heavily populated and subjected to significant environmental stresses, including habitat modifications, damage to the groundwater lens, loss of tree cover, sewage and rubbish pollution. The surface of the island has been highly modified for housing, roads, an airport and the creation of 10 'borrow pits' during WWII to provide materials for building the airport runway. In recent times, the borrow pits have been used to dispose of the increasing quantities of solid waste being generated through the westernisation of the population's lifestyle. Open to the air and in communication with groundwater, these borrow pits threaten the freshwater supply and public health, further reduce the already limited useable land and increase the risk of island break-through by waves during storms. Added to this are the significant problems and risks presented by climate change and sea-level rise, problems with near-shore erosion on the lagoon and ocean side of the island, increasing problems with king tides inundating areas of the land and a loss of island-maintenance processes. There is evidence that demersal fishes and invertebrates of the lagoon are over-fished and reports of increasing algal growth in the near-shore areas of the lagoon and ocean side of the island.

Tuvalu has recently drafted an Environment Protection Bill which is expected to be passed at the next parliamentary session. The country is signatory to a range of international conventions and treaties (around 36 treaties recorded in the Columbia University ENTRI database – http://sedac.ciesin.columbia.edu/entri/) and there are environmental laws, policies and strategies embodied in the national development plans (Kakeega o Tuvalu), the National Environmental Management Strategy and the powers of the Island Councils. The Department of Environment was established in 1995 and is currently focusing on four main areas;

i Climate Change/Sea Level Rise and the National Adaptation Plan of Action (UN Development Programme under UN Framework Convention on Climate Change);
ii The International Waters Programme (GEF/UNDP, now concluded) which focused on lagoon and oceanic waters;
iii Ozone Depleting Substances Project concluded in 2006 to meet obligations under the Vienna Convention and the Montreal Protocol; and
iv Waste Management Programme (AusAID, now to be taken over by Department of Environment or Funafuti Island Council (Kaupule).

Scientific studies undertaken in Funafuti date back to the late nineteenth Century with the original investigations of the nature of atolls by the Royal Society of London (1896) and Edgeworth David (1896–68) who bored into Fogafale to a depth of 340 metres and gave support for Darwin's theory that coral atolls grow progressively on slowly sinking platforms. During the 1970s and 1980s, scientific attention was directed at Funafuti in response to the Cyclone Bebe disaster in 1972 which also created a large storm bank and decimated corals (Maragos et al., 1973; Baines et al., 1974) and later to identify natural resources in the form of arable land and sand and aggregates for development (McLean and Hosking, 1991, 1992). A large part of the recent work on beach profiling, wave dynamics, climate, geology, coastal erosion, disasters and sediment resources has been undertaken by SOPAC (e.g. Barstow and Haug, 1994: Smith, 1995a, b; Xue and Malologa, 1995; Xue, 1996). During the period 1987–2000, a series of studies focused on living lagoon resources was undertaken in response to development plans and/or treaty requirements. These included baseline surveys for dredging, channel blasting, ciguatera management and the establishment of the Funafuti Conservation Area on the western side of the lagoon (e.g. Kaly and Jones, 1994; Kaly 1997, 2000; Ramsay and Kaly 2003). These studies generated basic information on coral cover, demersal fish stocks, invertebrates (such as shellfish) and ciguatera-causing dinoflagellates at selected areas around the lagoon – particularly in the west within and around the Funafuti Conservation Area, along and to the north and south of Fogafale – and on selected patch reefs in the centre of the lagoon. During these studies it was noted that the reef fish and invertebrate faunas were depleted and that unexpected algal growth was occurring over reef areas close to the centre of human habitation.

The South Pacific Regional Environment Programme (SPREP) has been active in establishing the Funafuti Conservation Area in 1996 and in assisting Tuvalu to address common issues within a more regional and global framework (Berdach, 2003; Carter, 2007). SOPAC, in collaboration with a range of partners, has also assisted through the development of an Environmental Vulnerability index (EVI) and country profile which, if adopted, could assist with management of the lagoon (Kaly et al., 2005a, b). The Foundation for the Peoples of the South Pacific International (FSPI) has been working in Tuvalu in Nukufetau and Nanumea to establish community approaches to the management of living marine resources as part of its Communities and Coasts Programme. There are plans to expand the approaches to Funafuti and other parts of the country.

It is unlikely that Tuvaluans perceive any major threat to the integrity of their lagoon, though they do report changes in fish and invertebrate species (especially giant clams and beche-de-mer) abundance and/or catches and increasing algal growth. The Funafuti Conservation Area is considered an important step in lagoon management and has provided the impetus for the passage of the Conservation Area Act (1998) and Funafuti Council by-laws (1999). It is thought to have led to improved productivity of resources within and outside the conservation area. However, the project suffers from the lack of an integrated, community-based management plan to manage the area over the long term (Berdach, 2003).

In Funafuti, most of the environmental concerns are focused on threats to the coastal and

land area of Fogafale, and the integrity of the other islets around the lagoon (e.g., Tepuka vilivili which disappeared during a cyclone). The most important perceived threats to the ecosystem are through sea-level rise (which is seen as a cause of erosion), king tide flooding, loss of land and climate change, particularly in regard to increased frequency of storms. Although Tuvalu is actively seeking assistance with adaptation to these threats, there has not yet been any attempt to rationalise all the threats and develop an integrated management plan to optimise the use of resources while building island resilience and maintaining ecosystem integrity and productivity.

General discussion

The three case studies described above present different Pacific island scenarios – Suva being much more heavily developed with a broad-based economy; Fanga'uta being less well developed and having a narrower economy; and Funafuti with a very narrow and even less well-developed economy. The three locations also differ in geomorphology and ecological conditions. However, the pressures on the lagoons have many similarities, such as population changes and the desire to expand the local economies and improve living conditions (better housing, medical services and schools, as well as jobs availability).

The three locations describe different scenarios in terms of scientific information availability and its utilisation for planning. For Suva Lagoon, there is a good body of relevant information (although some key gaps have been identified), but minimal use is made of this information in the planning and management of the Lagoon. There is also little evidence of integration in the planning system and the development of knowledge priority listings. In Fanga'uta, much recent information was developed in the TEMPP project (less in total that for Suva, but still a significant quantity), and some of this was incorporated into the development of the environmental management plan. Effectively no implementation of the plan has occurred. In Funafuti, while there is significantly less scientific information available, some planning and management activities have been based on the available information and limited implementation has occurred. It is clear that there are different levels of scientific information, but in no case is the available knowledge being effectively applied for improved management of key coastal water bodies.

In all three locations, it is claimed that there are limited resources available for such management activities (information gathering/planning/implementation) despite the fact that nationally important water bodies are being impacted. Possible explanations lie in the fact that the water bodies are not as closely scrutinised as land-based issues by the wider local population, and that some problems (e.g. microbial pollution) are not clearly visible. There would also appear to be an issue with the planning systems themselves and there is no strong history of integration in the planning system, such that, for example, information needs are categorised and prioritised.

Despite advice and support from a number of sources, Pacific island communities have not made much progress in the development and implementation of integrated coastal management (ICM) or community-based management (CBM, apart from the locally managed marine areas type strategies mentioned above). This may be a result of local

decisions, but, in part, may also be a consequence of a substantial component of environmental planning and management activities being reactive (rather than pre-emptive), and driven by outside agency priorities, interests and funding. Development of locally driven integrated coastal planning should be a priority and support for this is available through regional organisations such as SPREP and SOPAC. One factor contributing to the limited success of earlier efforts in this regard is the relatively low levels of appropriate expertise and staffing changes that regularly occur in small government organisations (including losses through migration and movement to the private sector). It is hoped that it will not require national emergencies such as that arising from a cholera outbreak in Tarawa in 1977 (Johannes et al., 1979) for action to be taken to dramatically improve the management of important coastal water bodies.

Conclusion

Examination of the situation in three Pacific Island lagoons has shown that there is minimal effective utilisation of scientific information in the development and implementation of management plans for important coastal water bodies. Recognition of the importance and the fragility of coastal lagoons is a first step in moving towards better management. The extent of available information varies, but even where much has been done, some of the data has yet to be fully processed and published. In addition, the work completed has been somewhat sporadic in nature, and few systematic long-term studies that can be used to identify environmental trends are available. Key gaps in available knowledge, e.g. health data, make it difficult to develop 'cause and effect' relationships.

There is also little emphasis on integrated coastal zone planning; in some cases the planning arrangement covering the lagoons and the adjacent catchments could be said to be chaotic. The involvement of national agencies, regional and international bodies, and, in some cases, local government authorities, means that minimal coordinated planning is taking place. Until this planning issue is addressed, the management of the lagoons will continue to be ineffective and the overall quality of the local environment will deteriorate, to the detriment of both the residents and the ecosystems as a whole.

Greater community engagement is regarded as another key step in the improved management of coastal lagoons. Without the support and interest of the local communities, minimal progress will be made in making such water bodies better places for people to live near and raise their families.

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