Marine/Coastal Biodiversity in the Tropical Island Pacific Region: Population, Development and Conservation Priorities

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The Impact of Human Settlements on Marine/Coastal Biodiversity in the Tropical Pacific

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Introduction: Status and changes in human settlements in the tropical Island Pacific

Globally the population of coastal areas is equal to the entire population in the 1950s (IFPC, 1994: 13). In the Pacific, as in the rest of the world, most of the major cities and towns are located in coastal areas. Only in Papua New Guinea are there any towns of significant size located in the interior. Most Pacific countries are too small to have more than one major town, and the majority of urban Pacific islanders (around 90%) live in the coastal zone. In addition, the majority of Pacific islanders, whether urban or rural dwellers, depend on the coast for their livelihood. The impact of human settlements on mangroves, the intertidal zone and coral ecosystems can be extreme if settlements are not well managed. As is well known, there is very little resilience in such ecosystems, and loss of their diversity represents a significant loss for subsistence and semi-subsistence communities. Obviously human settlements compete with other forms of development such as industry, port construction, tourism and so on. This is why coastal management must take an integrated approach which includes recognition of the impacts of human settlements.

The term 'human settlements' has a broad range of meanings. It does not refer only to the development of cities, but includes housing, physical layout, land use and tenure, population densities and numbers, employment and health related issues, water, sanitation, environment, social relationships and other economic and political factors which may impinge. History, cultural behaviour and attitudes are obviously also intrinsic to any discussion of human settlements. Not all of the above aspects of human settlements can be covered in this paper, and that the emphasis will be on increasing urban development and the physical implications of that growth for coastal areas. In the Pacific, as elsewhere, urban growth cannot be neatly separated from issues of land tenure and social change.

The significant point about urban development in both the global and Pacific contexts, is that cities and large towns transform natural landscapes. This occurs not only within the immediate, built-up area, but for miles around as a result of population and developmental demands for fertile land, forests, water and coasts. Construction of roads, factories, buildings, as well as the dumping of wastes from both enclosures, and growing human populations have major impacts on local ecosystems (Mishra and Satterthwaite, 1994: 14). Cities also create new landforms through reclamation, alter the movement of groundwater, and influence stream patterns (Douglas, 1983), and thus it can be assumed, in the context of the small island Pacific, the health of reefs and coasts.
Population and urbanisation in the Pacific

Urban areas in the Pacific are generally growing faster than economic growth, and than overall population. The trend is not surprising given the urban emphasis of current economic development in the region. Migration is clearly a response to this development, but there is also significant natural increase in Pacific towns, as urban centres have now become homes for several generations of islanders, some of whom are the traditional landowners of the centres of economic and urban development.

**TABLE 1. Population Growth Rate, Pacific Countries**

<table>
<thead>
<tr>
<th>Country</th>
<th>Population Growth Rate (p.a.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Samoa</td>
<td>1.7</td>
</tr>
<tr>
<td>Cook Islands</td>
<td>1.6</td>
</tr>
<tr>
<td>Pacific Palau</td>
<td>1.4</td>
</tr>
<tr>
<td>Federated States of Micronesia</td>
<td>1.3</td>
</tr>
<tr>
<td>Tonga</td>
<td>1.2</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>1.1</td>
</tr>
<tr>
<td>Nauru</td>
<td>1.0</td>
</tr>
<tr>
<td>Niue</td>
<td>0.9</td>
</tr>
<tr>
<td>Western Samoa</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Source: Smith and Mabodah, 1995

1. This figure assumes low and upper limits for the high net emigration after the 1997 census. Other estimates place the FIP PCP at around 1.7% per annum (Smith, 1995).
What is clear is that many Pacific islanders are no longer solely rural people (Bryant-Tokalau, 1993; Connell, 1984), and the change is occurring very rapidly (Table 2). In the Micronesian and Melanesian countries in particular, the urban growth rate clearly outstrips population growth.

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>MAIN URBAN CENTRE</th>
<th>TOTAL POPN URBANISED (%)</th>
<th>AV. URB. GR RATE p.a. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palau</td>
<td>Ngerul Channel</td>
<td>84.4</td>
<td>5.4</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>Lautoka</td>
<td>83.5</td>
<td>5.3</td>
</tr>
<tr>
<td>Marshall</td>
<td>Majuro</td>
<td>80.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Marshall</td>
<td>Majuro</td>
<td>80.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Micrones</td>
<td>Majuro</td>
<td>80.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Micrones</td>
<td>Majuro</td>
<td>80.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Niue</td>
<td>Apia</td>
<td>77.7</td>
<td>4.6</td>
</tr>
</tbody>
</table>


In small island countries such as Kiribati, Tuvalu and the Marshall Islands, the proportion of the population urbanised is particularly significant, not only because of the limited land areas involved, but also because of the annual urban growth rate and the pressure on the physical and human environments which are of course wholly coastal.

The social impacts of such a change are complex and have been described in detail elsewhere (Bryant, 1993, 1994). The physical impacts have been less thoroughly examined, although the various coastal management studies currently being undertaken by regional and international agencies go some of the way towards addressing the issues facing human settlements, particularly in urban areas (see, for example, Kay et. al. 1993, Nunn, 1990, 1992, Nunn et. al. 1993, SPREP 1994).

The impacts of human settlements on coastal biodiversity

It is impossible to generalise about the current state of and future of the urban areas. Isolated, low lying, densely settled atolls with few natural resources, contrast with urban centres on large, high islands with many resources. Some areas are characterised by overcrowded, sub-standard and often informal housing, a concentration in diseases related to poor and insanitary living conditions such as respiratory illnesses, tuberculosis, cholera.
and other gastro-intestinal complaints, polluted water supply and the over-present difficulty of human waste disposal, particularly on low-lying atolls. Urban growth also has an impact on the availability of land for market gardening, the supply of fuelwood (where available at all) and the question of how and where to dispose of rubbish, both industrial and household.

Devas (1993) considers the environmental problems which are increasingly obvious in the developing world. Part of his list may usefully be applied to small island nations, including those in the Pacific. In any urban area, coastal biodiversity may be affected by the following:

1. The pollution of water supplies by disposal of sewage, solid waste and toxic waste into or within ground water sources; by salt-water penetration of ground-water (a common problem in limestone islands such as Rarotonga and Tongatapu).
2. Construction of housing on dangerous and ecologically fragile zones, including drainage areas.
3. The destruction of vegetation and forests with obvious consequences for soil erosion and flooding.
4. High to dangerous levels of atmospheric pollution in many cities (for example Suva is now considered to have high levels of lead from vehicle emissions).

Although Devas is not paying particular attention to the impacts of human settlements on coasts, and the biodiversity of those coasts, it is obvious that all of the above must be paid specific attention. Urban development obviously places a number of demands on food, water, energy, building materials supplies, and overuse of these lead to a number of environmental stresses (Rakodi and Devas, 1993: 289). There is little specific analysis of these physical impacts of human settlements on urban environments in particular. Possibly the most well-known researcher in this field is Ian Douglas, the urban geomorphologist who analyses the physical consequences of city development, including earth-moving and its impacts on the hydrologic cycle, and the off-site consequences of such changes, particularly with respect to sedimentation and landscape evolution (Douglas, 1986: 274; 1989). Douglas is not specifically concerned with the impacts of urban development of coastal biodiversity, but he does explore the impacts of the loss of vegetation for human and physical development in cities. The undermining of coasts, beach erosion and consequent salination have impacts on both marine life and coastal plants. Areas which remain densely vegetated have greater possibilities of maintaining shorelines and reducing sedimentation, and thus not perpetuating the cycle of sedimentation which ultimately leads to the destruction of coastal biodiversity.
Urban densities and housing

A significant fact about urban growth is the high population densities, particularly in countries with small land areas such as the atoll countries. Population densities in the small coastal areas that comprise most Pacific towns and cities, in the atoll countries, are reaching levels generally considered to be unsustainable, and which are higher than almost anywhere in the world (Table 3).

In Kiribati, for example, there are 1,600 people per square kilometre on South Tarawa, but in the area of Betio, west of the main government centre of Bairiki, densities reach over 4,000 persons per square kilometre. The pressures on both human life and coastal biodiversity in such densities, even where such populations are small by world standards, have been partially documented and include problems of communicable diseases, high infant mortality, largely as a result of biological contamination of water, food supplies and overcrowding.
<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
<th>Population Density/km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cook Islands (Rarotonga)</td>
<td>9,200</td>
<td>154</td>
</tr>
<tr>
<td>Fiji (Suva City)</td>
<td>141,273</td>
<td>3,418</td>
</tr>
<tr>
<td>Kiribati (South Tarawa)</td>
<td>30,000</td>
<td>1,416</td>
</tr>
<tr>
<td>Palau (Ngerul)</td>
<td>10,500</td>
<td>571</td>
</tr>
<tr>
<td>Papua New Guinea (Port Moresby, NCD)</td>
<td>194,295</td>
<td>817</td>
</tr>
<tr>
<td>RMI (Eibey)</td>
<td>8,324</td>
<td>22,956²</td>
</tr>
<tr>
<td>(Urban Majuro)</td>
<td>15,000</td>
<td>1,623³</td>
</tr>
<tr>
<td>Solomon Islands (Honiara)</td>
<td>35,000</td>
<td>1,394</td>
</tr>
<tr>
<td>Tonga</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Nuku’alofa)</td>
<td>30,000</td>
<td>3,308</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>3,000</td>
<td>1,071</td>
</tr>
<tr>
<td>Niue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Ararua)</td>
<td>19,311</td>
<td>762</td>
</tr>
<tr>
<td>Western Samoa (Apia)</td>
<td>40,000</td>
<td>548</td>
</tr>
</tbody>
</table>

Source: SPREP Reports to UNCED (Kiribati, Fiji, RMI), Conrad and Lee, 1993.

1. The SPREP report to UNCED claims a density figure for urban Cook of 417 persons per km².
2. The SPREP report to UNCED claims a density of 19,417 persons per km² which translates to a density of 22,956 km².
3. The PFD report claims a density of 1,071 in the DCD area. Clearly the discrepancy in density figures calls for more careful measurement of both land areas and populations.
Specific impacts of human settlement on coastal marine biodiversity

There are a number of impacts which should be examined in detail. These include the clearing of land, reef gleaning, and the disposal of human waste and water. Not all can be discussed in detail here but a thorough analysis and examination of the impacts of human settlements on coastal biodiversity should include:

- city development - the development of recreation space, container terminals, office blocks and car parks, reclamation.
- urban waste disposal and water supply
- solid and industrial waste disposal
- hazardous wastes
- drainage and flood control
- the tragedy of the commons - e.g. coastal gleaning for food supplies

City development - construction

Construction, whether small scale in the sense of the building of family homes, or large scale creation of office blocks and car parks, inevitably has a major on coastal ecosystems. Balanced development should recognize potential impacts and attempt to minimize damage in the interests of long-term sustainability. Unfortunately urban construction has often created damage out of proportion to its long-term sustainability. Much of this damage is to coastal ecosystems. In Kiribati, for example, coastal erosion has increased, partly due to the construction of causeways built to link the atolls (Sullivan and Gibson, 1990). The construction of roads, airports and harbours, must always involve the destruction of some of the coastlines through reclamation. Outbreaks of ciguatera fish poisoning have also been linked with physical changes to habitats, and the fact that there was no ciguatera on some atolls before construction, with heavy outbreaks after construction is circumstantial evidence of the impacts of construction on marine environments and human health (Carpenter and Maragos, 1989: 202). Excavation and dredging using cranes and buckets, landflling and shore protection measures, and other forms of coastal construction, have been demonstrated to have significant impacts on coastal marine resources. Carpenter and Maragos report disturbance to the habitats of bottom-dwelling organisms, and of course the use of explosives in reef blasting can kill a number of organisms. The contamination of changes created by coastal construction activities, and the related events such as sewage outfall from coastal settlements can inhibit coral regenerations (ibid., pp 77-93).

Urban waste disposal and water supply

The nature of the atoll countries with limited or no ground water reserves, and their dependency on marine and limited terrestrial resources makes them very vulnerable to the problems of waste disposal. Toxic and hazardous wastes are a particular issue in industrializing countries, but it is the disposal of solid and liquid wastes (especially domestic garbage and human excreta) which causes the greatest problem. As urbanization increases
in the Pacific, it is likely that the pollution of ground water will increase. South Tarawa in Kiribati and Peni'itani in Tuvalu are two examples of severe pollution from inadequate disposal of human waste, leading to outbreaks of cholera and other gastro-intestinal diseases. Groundwater pollution and the contamination of shellfish by micro-organisms from excrement cause a range of health problems including skin and eye disorders, as well as gastro-intestinal illnesses.

Waste disposal is an issue faced most dramatically in urban areas. Many of the larger towns have a sewerage or drainage system for disposing of waste. This is generally passed through pipes which discharge into the sea, although not as far out as is desirable. In some countries this is due to the steepness of coasts and the problem of waves (Carew-Reid, 1989: 83), but in most, where there is a fringing reef and a surrounding lagoon, the fact that the pipes rarely extend more than a few feet can only be due to ignorance or expense. In any case, there is also a great deal of other, direct contamination due to latrines sited over the sea (as in Kiribati), the discharging of septic tanks onto the shore, and underground seepage. In still environments this causes immediate problems with groundwater supply (ibid.)

In Suva, Port Vila, Tarawa, and Fagafu‘uta (Tonga) lagoons, faecal coliform levels have been found to be high everywhere and of concern to public health (World Bank, 1993: 72). In the Suva area the fact that 95 percent of mangrove oysters collected in eight sites exceed WHO limits for human consumption (ibid.) should be cause for serious alarm. In Kiribati faecal contamination of shellfish as a result of inadequate sanitation in Tarawa is the cause of outbreaks of diarrheal diseases, hepatitis and sometimes cholera. Overcrowding is contributing to the contamination, not only from sewage, but also from the disposal of animal waste (especially pigs) and household garbage. Despite the construction of sewage disposal systems in Tarawa, lagoon and groundwater contamination continue to exist (Kelly, 1994), for example shellfish from marine grass flats in coastal areas were significantly more contaminated by faecal coliforms than those in deep water (ibid.: p.13). Indeed the waters of Tarawa lagoon are considered to be 'unsafe for exposure through swimming, bathing and harvesting shellfish' (ibid.: p.16). The levels of bacterial contamination have increased since 1979, largely due to the pressure of population growth.

Interestingly, nutrient levels do not appear to be high (ibid.: p.22) despite the major problems of domestic waste disposal reported by Tulega (1992) and Gangaiya (1994) who found that 5000 tonnes of waste is generated on South Tarawa each year. If this were disposed of at a height of one metre, then an area about the size of Bairiki, an area of 0.5 km² in South Tarawa would probably be covered in 40 years time (Gangaiya, 1994). Current disposal practices of dumping all forms of waste at the end of the dilai could be expected to contaminate the lagoon, although the major problem seems to come from bacteriological pollution.

The disposal of waste is also a problem in the urban areas of Fiji. In the Suva area for example, septic tank effluents cannot percolate properly as much of the area is underlain by marl, or soaptone. The high annual rainfall of around 3000mm and low evaporation (around 1340mm) causes frequent saturation which prevents oxygen penetration. This means that the septic tanks work slowly and inefficiently. There is therefore widespread
seepage of sewage waste into Santa's water bodies (Chape and Wadding, 1991:27), as well as increasing levels of phosphorus, most probably from agricultural fertilizers.

Sewage systems are expensive and in countries where earnings are low and overall budgets are stretched as well as at least partially dependent upon foreign aid, the provision of sewage treatment plants is not a high priority. If a community cannot afford to construct a sewage plant, then it is unlikely that they can afford to operate and maintain one (Carron-Reid, 1989:83). This must surely call into question the wisdom of aid money being spent purely on the provision of such plants. Waste disposal has an obvious impact on human health and coastal marine biodiversity.

Solid and industrial waste disposal

Organic wastes are also a by-product of manufacturing in the Pacific (Table 4). Most countries have food and beverage factories and others have fish canneries, sugar mills and sawmills. The amount of organic waste discharged by these factories can equal or exceed that amount of human waste produced in a town. The long-term impacts of such wastes are not fully understood, but it is certain that, depending on the concentration of the effluent, they will affect nearshore marine organisms and human health. Such wastes use a great deal of the oxygen naturally occurring in the water, and this causes stress to other organisms (Sorlin, 1990:4-5).

Many of the waste disposal sites in the Pacific are located in valleys, nearby to coastal waters and streams. Some marine organisms are sensitive to chemical pollutants even at low concentrations. Surveys have shown that trace compounds in landfill gases, for example, include very volatile and harmful organic compounds, such as vinyl chloride, benzene and methylene (Stone, 1990:19).

Hazardous wastes

The major types of industrial wastes present in Pacific cities come from the storage and production of pharmaceutical wastes (e.g. pathogens and halogenated hydrocarbons), other chemicals, storage, manufacturing and use, fuel and oil storage, engineering and metal fabrication, paint manufacturing, storage and use, printing and publishing, the production of plastics, cement, paper, resin, fiberglass, electronic equipment, and from food processing (Stone, 1990:3-4). A member of the countries have very small industrial bases and are largely involved in food processing. The wastes from these industries are generally discharged into the harbours, rivers and lagoons, leading to nutrient overloading (Stone, 1990:3-4).

Chemicals and other hazardous wastes are often in very small quantities, such as from varnishes, glue, dyes, batteries, but the companies are very often careless in their disposal methods, frequently reusing containers which had dangerous chemicals, thus causing problems for the surrounding environment and the workers, or dumping these same
<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>ORGANIC POLLUTION PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Samoa</td>
<td>Disposal of rubbish and malfunctioning septic tanks, odours, effluents and odours from the two 1980s canneries.</td>
</tr>
<tr>
<td>Cook Islands</td>
<td>Disposal of waste from the fish canneries led to a reduction of fish and bionic diversity in seawater.</td>
</tr>
<tr>
<td>Federated States of Micronesia</td>
<td>Poor hygiene, shared toilet facilities, lack of sewer systems into water supply, no organised garbage collection.</td>
</tr>
<tr>
<td>Fiji</td>
<td>Unsanitary sewage disposal and depletion of coral communities through boom near sewage outlets. Disposal of rubbish and malfunctioning septic tanks, odours, effluents and change from food manufacturing plants in Nivo and Lamotrek, and raw cement in Levuka.</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>Discharge of domestic sewage and refuse into rivers and lagoons.</td>
</tr>
<tr>
<td>Guam</td>
<td>Sewage disposal, stormwater runoff and hazardous waste.</td>
</tr>
<tr>
<td>Kiribati</td>
<td>Pollution, physical degradation of the environment on which existence livelihood depends. Contamination of fish and lagoon from human waste.</td>
</tr>
<tr>
<td>Nias</td>
<td>Insufficient sewage disposal.</td>
</tr>
<tr>
<td>New Caledonia</td>
<td>Severe water pollution.</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Sewage disposal, improperly controlled effluent from industries and effluents from industrial and uncontrolled housing.</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>Liquid organic waste from palm oil processing plant pollutes adjacent sea; raw sewage disposed into sea.</td>
</tr>
<tr>
<td>Tonga</td>
<td>Septic tanks and seepage treatment.</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>Significant pollution of groundwater by human and animal waste.</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>Sewage pollution of Port Vila harbour and seepage of lagoon associated with growing urban population.</td>
</tr>
<tr>
<td>Western Samoa</td>
<td>Disposal of effluents from fish mill, the Aggie sewage system, septic tanks and flood sewage outlets.</td>
</tr>
</tbody>
</table>

Source: adapted from Centre-Sud, 1967 84; Holtum, 1990; Osawa, 1990.
containers where they may leak into the soil or groundwater (Scott, 1990:7). For example, in Fiji there have been several cases of large numbers of fish dying where factories discharge their wastes. The pressure to industrialize in order to diversify Pacific economies is likely to produce more environmental hazards if strict controls are not enforced.

Heavy metal contamination from mercury, chromium, lead and arsenic is a recognized problem in Pacific lagoons, particularly where there are metal processing industries such as electroplating, chemical conversion and metal coating. The effluents produced affect the marine environment to a greater or lesser extent depending upon concentrations and dispersal (Holthus, 1990:4). These heavy metals are also very toxic to humans through concentration in marine organisms. A number of emergencies through chemical spillage and leakage have been reported. In 1984-85 alone there was an arsenic spillage in Port Vila harbour; a cyanide spillage in the Fly River estuary in Papua New Guinea; the discovery of lead in paint used on roof catchments in Tonga, and the problem of disposal of a large number of disintegrating drums containing DDT, also in Tonga (Caruw-Reid, 1989:86). Such problems have continued into the 1990s with leaded paint widely used, unregulated disposal of chemical wastes and so on. There is little or no public information available to Pacific populations about the danger of such practices, and such laws as exist are unenforced and unsupported by broad spectrum community environmental education.

Apart from the chemical discharges from Pacific industry, the development of industries is necessarily close to the shore, due to land shortages. The alteration of the shoreline through reclamation, mangrove cutting and earth moving is having a major impact on coastal ecosystems due to erosion and contamination through silting. Again, this represents a loss of fish breeding grounds, particularly in mangrove areas and has an impact on the income and diet of the poor who frequently depend upon sea resources for both subsistence and cash earnings. Reef blazing is also carried out near harbours and tourist resorts, having a devastating impact on shorelines and coral growth.

The 'Tragedy of the Commons'

Under the Law of the Sea Treaty, coastal nations are bound to protect the marine environments under their control. They are also expected to participate in treaties aimed at controlling ocean pollution... including discharges and runoff from cities and agriculture, ocean dumping of wastes... air pollution..." (French, 1992: 158). Increasingly urbanized societies in the Pacific are clearly placing great strain on the inshore coastal resources. Urban populations without formal sources of employment glean the coastal zone for sea food, frequently harvesting undervalized shell fish, sea cucumber, crab, fish and seaweed. Whilst these urban dwellers who are often low-income earners, and also traditional land owners, can scarcely be given the sole blame for the exploitation of the inshore zone, they are nevertheless part of the 'tragedy of the commons'. These coastal areas are also under increasing pressure for recreation space (for example coastal villagers use reef flats at low tide for sports), settlements (such as in Papua New Guinea where the coastal villages of Hanabada and Kodi have expanded greatly in the past decade, placing a great strain on the lagoon from waste disposal), and of course the consequences of run-off from industry,
agriculture, energy, and both municipal and household drainage. The impacts for coastal fisheries, for the coastlines themselves, and the consequences for human populations through both the consumption, and the decline in coastal resources are immense.

Legal administrative basis of regulation and management of human settlements

Individual countries deal with human settlements planning through various laws, some of which come under Departments of Health, and others under the auspices of Departments of Town and Country Planning. In Fiji, for example, there are twenty-five urban environmental acts administered by fourteen different ministries. The Town Planning Act deals with EIA's, but land and water below the high water mark is the property of the State and administered by the Ministry for Lands and Mineral Resources through the Department of Lands and Surveys. Where, for example, a mangrove area is to be reclaimed for development purposes (say a container terminal or road), the application is referred to the Department of Town and Country Planning for comment, recommendation and suggested conditions if approved. The Director of Lands also refers the application to the Department of Fisheries for assessment of the resource and to the Native Fisheries Commission for arbitration of compensation (Chaps and Wattling, 1991:105).

In addition, the anti-pollution laws of Fiji are most ineffective. Prosecution of anyone causing any form of pollution has rarely been carried out, and although litter laws are now in force, the problem of enforcement continues to plague urban areas in particular. The lack of a litter, and general pollution education campaign must take some of the blame for it cannot be reasonably expected that a population will stop littering if they do not understand the environmental consequences.

On a regional level, although the SPREP Action Plan makes specific mention of urban environments, regional governments did not until recently view the problems of urbanization as a major priority, most being largely rural economies, heavily dependent on natural resources of the forests, mines and oceans. Emphasis in the SPREP Convention on pollution and dumping, however, and the concern expressed by most countries over waste disposal, have meant that SPREP, in its environmental monitoring and research, is apparently a little more concerned in the 1990s about changing urban environments, particularly the problems brought about by industrialization and the dumping and leaching of toxic chemicals and heavy metals.

Environmental legislation, regulation and management capacity

A number of regional laws and protocols for environmental protection have now been promulgated, but the major difficulty will be the enforcement of those laws. For example, the recognition that Environmental Impact Assessments (EIA) need to be carried out before
major developments are undertaken has been understood in the Pacific for some years but it is not always a requirement in law. In Papua New Guinea for example, the Environmental Planning Act requires an environmental protection plan for a development project to be submitted to the Department of Environment and Conservation for its approval before the project is implemented. In Fiji, EIA is supposedly carried out for any development project as part of the administrative requirement for approval by the Department of Town and Country Planning. Unfortunately these requirements are frequently bypassed or overlooked.

The problem of conducting EIAs largely comes about because of the lack of expertise, and also because the necessary background environmental and socio-economic data do not exist or are very limited. Even where the data are available, there is frequently no-one skilled enough to subject it to detailed analysis. Similarly, there is very little post-project assessment after a development project is completed.

Throughout the Pacific it is existing environmental legislation is examined it is often found that there are many laws, promulgated some years ago which may today be regarded as environmental laws but which suffer from lack of enforcement through inadequate staffing, inadequate penalties when they are enforced and lack of technical resources and funding (Chape and Watling, 1991:105).

Environmental legislation and management in Vanuatu: the dilemma of land tenure

The case of Vanuatu and the conflict between 'development' and traditional land tenure is a good example of the land/environment dilemma which is causing complications for modern human settlements such as Port Vila and Luganville.

Because a system of land tenure is not a physical process, a conflict of land use is a direct cause of environmental problems. The tenure system is determined not only at sea to land, which is identifiable at the development stage, but also within the land which is determined in the environmental management. In Vanuatu the significance of tenure goes further, for a primary relationship to land is fundamental in an-Vanuatu culture. There can be almost no discussion of land use in environmental management in Vanuatu without land tenure coming into the equation (Government of Vanuatu, 1991:25).

In Vanuatu, as in other Pacific countries, traditional land ownership can sometimes be viewed as an obstacle to not only development projects, but also to sustainable development. In Vanuatu the system gives custom owners the inalienable right to do as they wish with their land - even to damage it irreversibly (Government of Vanuatu, 1991:25). Thus there is a great challenge in Vanuatu to design and implement environmental legislation which suits all parties, both traditional owners and developers. As Connell and Lai point out, draft plans which have existed for Port Vila and Luganville for several years have not yet been approved because of disputes over urban land, and a lack of understanding over the purposes and effects of sanitation planning (Connell and Lai, 1993: 66).
Vanuatu is not yet at the stage of having an integrated package of environmental laws, but there is concern that what is developed is not only effective, but enforceable. The first major piece of environmental legislation was the Water Resources Act which came into effect at the end of 1991. This act gave the Department of Geology, Mines and Rural Water Supply the power to limit building in the infiltration zone for the capital city's Port Vila, groundwater aquifers (Government of Vanuatu, 1991:37). The problem is the absence of a reticulated sewage system for Port Vila's 20,000 inhabitants. Several areas of the harbour have levels of contamination above acceptable levels, and there are particularly high levels in areas of shellfish collection (Government of Vanuatu, 1991:33).

There is little other environmental legislation affecting urban areas being drafted in Vanuatu due to a shortage of legal draftsmen, although forestry and pesticide legislation currently being drafted will have obvious implications for urban water supply. There has recently been carried out a review of existing environmental law, which points the need for more integration in order to have effective management. In 1986 an Environmental Unit was established, firstly within the Ministry of Lands, and more recently moved to the Ministry of Home Affairs where it has become a part of the Department of Physical Planning and the Environment (Government of Vanuatu, 1991:40). Although there is little environmental legislation specifically related to urban centres (apart from waste and sewage controls), of major concern must be the issue of long-term leases of customary land. There is in existence a 75 year lease system, many of which have been signed since independence in 1980.

One worrying factor concerning the 75 year lease system is that few land owners are planning for their own land requirements 75 years into the future. At present rate of growth, a family of 10 will have 80 members in 75 years time, a village of 50 will need land to meet the needs of nearly 1,000 inhabitants. How many people are reserving land for these requirements? If these facts are not considered now, pressure will inevitably build up that will bring fundamental changes to the culture and lifestyle of the people and make self-sufficiency as a national goal increasingly difficult (Government of Vanuatu, 1981:94, quoting A. Dahl, 1989).

The growth of the urban centres of Vanuatu, possibly at over 10 percent a year, and the increasing pressure on land, housing, water and sewage, along with deterioration health for urban people, gives a hint of what is likely to happen in the future.

Environmental legislation and management in Western Samoa

In the Polynesian countries of Western Samoa, Tonga and Tuvalu, urban centres are also becoming important in terms of economic development and population concentration. To date there is no urban planning legislation in these countries, largely because of the fear of removing urban land from traditional land ownership controls (Las and Cornwell, 1994: 16). While Western Samoa may appear to be an exception, it is beginning to recognize the environmental problems facing urban areas, problems which are exacerbated by the pressure of population density, the actions taken to regulate and plan for urban growth are minimal.
In Samoa, as in Vanuatu, the traditional way of doing things, or fa'a Samoa, is still the central social force. The preservation and protection of the environment has been the traditional provenance of customary landowners, but recent population pressures and the need for development are placing the environment under stress (Government of Western Samoa, 1991:34). This can lead to conflict when laws are enacted. Villagers have been known to disregard court orders and to ignore laws when they disagree with them. For example, land in the Muliva stream catchment, designated for catchment protection for the purpose of supplying water to the urban centre of Apia, was illegally cleared and cultivated following construction of an access road. In another example, pigs roam free in Apia, despite laws to keep them penned and away from habitations. It has been suggested that a new form of dialogue, one not based on western decision-making models, needs to be found if environmental legislation is to be effectively implemented (ibid.:35).

There are a number of environmental acts in Western Samoa which have been designed to protect urban environments. The recently promulgated Lands and Environment Act is a broad act encompassing natural resource protection and environmental management and pollution controls. It includes legislation concerning EIA requirements for development projects, protection of coastal zones, water pollution and effluent discharge standards, solid waste disposal, hazardous waste and pollution controls and sanitation and sewage disposal. It is hoped that this act will serve to integrate previously diffuse environmental laws. Again, it is enforcement of laws which is a problem in Western Samoa. A number of acts exist which are designed to protect water resources for example, but customary land ownership makes enforcement almost impossible (ibid.:37).

As in other countries, there is a lack of coordination between departments concerned with environmental protection. To overcome this, a Division and Environment and Conservation has been established, under the Department of Lands and Environment. Ultimately the plan is to establish a full department of Environment and Conservation. So far the DEC is not able to use its full powers as it is underfunded and under-staffed, as well as facing the difficulties of coordinating a wide range of environmental issues which fall under the umbrella of several government departments. In addition, there is no municipal local government and thus urban management is centrally controlled.

Obviously in the Pacific, as elsewhere, urban management and its related environmental management needs to be carried out in consultation with communities, and with support (both financial and administrative) from central governments. Since municipal governments are normally in control of urban infrastructure, the management problems associated with these governments which generally lack resources, laws, power of enforcement, and general community and government support are immense. It is easiest, when faced with out of control coastal destruction, for example, to simply ignore the problem. This would appear to be very much the case in the small island Pacific at present.
Ways of addressing challenges or biodiversity problems caused by human settlements

• Developing a vulnerability index (IPPC)

Apart from improving commitment to urban management, and involving communities in the care and management of their coasts, governments need to be convinced of potential destructive impacts of all forms of development. One method suggested is the development of a vulnerability index. Vulnerability for coastal zones is measured largely with respect to the possibility of sea-level rise, although there are a number of other factors which make coastal biodiversity vulnerable to destruction and change. High population densities and their outputs are a major component of such vulnerability and no assessment of coastal change may be undertaken without an examination of human size and impact. Obviously the potential impacts of sea-level rise vary from country to country depending on not only physical parameters, but also social, economic and management practices. Vulnerability assessment is, therefore, a complex assessment exercise.

Vulnerability with respect to human settlements and biodiversity refers to numbers of people in the area compared with national totals and densities, and the impacts of those settlements on species diversity, biomass and valued species along the shoreline and areas adjacent to the shore. Apart from the development of cities and towns, vulnerability is also assessed by referring to the nature of the land tenure system, as this gives an indication of the measure of attachment (and presumably responsibility) which people feel towards their land. According to a vulnerability index used by SPRRP and the Government of Japan in their assessments of coastal vulnerability and resilience, a score of -3 demonstrates high concentrations of potentially damaging activities and populations.

In a relatively early attempt at assessing the 'susceptibility' of different island types in the Pacific to climate change, Pernetta (1990) found that impacts will be greater on small islands than larger ones, and on atolls rather than on volcanic islands (ibid.: 21). By providing approximately equal rating for altitude of the countries, numbers of islands, land area and island type, Pernetta produced a ranking for Pacific Island countries. Atoll countries, such as Tokelau, Marshall Islands, Tuvalu and Kiribati were considered to be in profound danger and may cease to exist. For the other countries, which include some atolls as well as high islands, the dangers of potential climate change and sea-level rise were seen as a danger not only to agriculture, but also to urban centres, fresh and safe water supplies, transport systems, health patterns, mangrove and coastal ecosystems, and to social relationships with the relocation of some peoples. Most of these changes would take place on coastal areas, and clearly are of major importance to human settlements.
• Better urban and metropolitan management.

Activities which affect coastal marine biodiversity (i.e. most human settlement activities) need to be planned in conjunction with overall landuse, coastal and development strategies and not in isolation. The large numbers of laws administered by numerous agencies are causing confusion in human settlements planning in most Pacific island countries. Clearly integrated planning combined with community involvement and education is a priority.

The role of the inhabitants as participants in the urban environment and in trying to deal with the increasing stress, is crucial to the future of the towns and cities of the Pacific. The Pacific has a multiplicity of ways in which it can deal with the complex issues of urban environmental degradation. Apart from the support of several powerful regional bodies, such as the South Pacific Commission, the South Pacific Forum, the South Pacific Regional Environment Programme and the University of the South Pacific, more important is what happens at the community and local government level. It is only through the involvement of communities which are daily involved in managing urban areas that laws proscribed by central and regional authorities can be truly enforced. Without full involvement and commitment of communities, coastal marine biodiversity in the tropical island Pacific will remain under threat.
Bibliography


