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Environmental Implications of Coastal Development in Fiji

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Fiji is beset by a host of development-related environmental problems. The most serious involve the degradation of coastal areas, especially mangroves, and the destruction of coral reefs. Land reclamation to grow sugar cane and rice on the two main islands of Viti Levu and Vanua Levu have been responsible for most of the loss of mangrove forests. And the islands' coral reefs are being smothered by increasing loads of sediment (mostly from poorly planned and executed development projects) transported into the coastal zones by rivers and streams. Clearly, Fiji needs a coastal zone management plan and the resources to carry it out.

The mention of Fiji conjures in the Western mind the image of paradise, of man living in total harmony with nature. In contrast to the pressures and demands on the environment from modern industrial societies, the Pacific is a region of relative tranquility. But this "state of grace" is not likely to continue much longer. Due to the rapid pace of economic development on the islands, great demands are being made on the limited resources of their fragile ecosystems. Unless more attention is paid to environmental issues, many of the problems associated with industrialization and development in the West are likely to be transplanted into the Pacific.

Fiji is a maritime, archipelagic nation consisting of approximately 330 islands extending from 10° to 25°S latitude and between 176°E and 173°W longitude. With the declaration of the 200-mile exclusive economic zone, Fiji's estimated sea area is about 1 135 000 km² with territorial waters of over 110 000 km². The land mass consists of higher volcanic islands, interspersed with elevated reefs and low-lying atolls covering an area of about 18 300 km². Coastal ecosystems include mangroves, algae and sea grass beds in shallow reef and lagoon areas, and various reef types such as barrier, fringing platform and atoll reefs.

Historically, Fijians settled mainly along the coast and depended upon the coastal zone for their sustenance. In primitive Fijian society, like other Pacific island societies, the people lived in relative harmony with their environment. However, population movements, traditional exchange economies (1), and shifting agricultural practices all had some negative impacts on the natural flora (2) and fauna (3) as well as on the coastal resources (4) of the Pacific. Coastal beach forests were modified with shifting agricultural practices (5) and the introduction of exogenous species such as coconuts, yams and other crops (6) altered natural ecosystems. The deliberate, as well as unintentional, introduction of animals also changed the fauna composition (7, 8). Though the changes were usually localized, they were nevertheless significant.

With the advent of Western civilization in the Pacific, the pace of change and demand on the environment intensified dramatically with each successive wave of European contact. Sandalwood traders encouraged the large scale forest clearing that led to extensive displacement of primary forests and resulted in severe soil erosion in some areas. It was the settlers, however, who had the greatest impact. The introduction of labor-intensive plantation economies based—in the case of Fiji—on copra, cotton and sugar cane, centered mainly in the coastal zone, had the greatest impact on the resources and the natural environment of the country, placing considerable stress on coastal ecosystems.

Today, the export-oriented sugar industry along with increased urbanization and concomitant industrial development, and the establishment of a tourist industry and its associated infrastructure, have all placed increasing pressure on already limited coastal resources. This is further accentuated by the apparent shortage of readily available land due to the land tenure system of Fiji, which has necessitated a push into marginal coastal areas.

This article discusses those developments which impinge on the coastal zone of Fiji and examines their impact on the natural environment, with particular reference to mangrove ecosystems and fisheries. Few detailed studies have been undertaken on these subjects, though circumstantial evidence indicates the gravity of the situation. Thus far, a piecemeal, problem-oriented approach has dominated coastal zone management, but to sustain balanced economic growth, a wider ecosystem approach is needed.

Fiji is badly in need of coastal zone management. One of the reasons is apparent from this aerial photo: Suva harbor is surrounded by a barrier reef which restricts the mixing of harbor water with the open ocean. This leaves a cocktail of domestic and industrial wastes in the harbor and also permits the build-up of sediment washed into the area by poorly planned and executed development projects. Photo: Morrison.

COASTAL DEVELOPMENT AND ENVIRONMENTAL IMPLICATIONS

Historically, human settlement and development, be it agricultural, urban or industrial, has largely taken place in the coastal zone of Fiji. In some cases isolated populations settled on such small islands, that virtually the entire land area fell into the coastal zone. Naturally, the impact on coastal ecosystems has varied depending on the activity, the scale of operation and the extent of development.

Agriculture

Since Fiji is essentially an agricultural country, the pressure on land is most significant in the agricultural sector. The sugar industry is the backbone of Fiji's economy and the largest exchange earner. Shortage of readily available land has forced cane farmers to expand into hilly areas and along marginal coastal zones.

Reclamation of Mangroves

Sugarcane farming began on a large scale in the 1880s under the Australian Colonial Sugar Refinery Company (CSR). It has been carried out predominantly on ten acre plots on the coastal plains of the two main islands, Viti Levu and Vanua Levu. But with increasing competition for land among the new generation of cane farmers and difficulty in obtaining new native leases, the need for more land has increased markedly. Apparently, to alleviate the problem of land shortage, the Government—under a World Bank loan in the mid-1970s—undertook a large mangrove reclamation project in the cane belt of the two main islands (the initial process of reclamation was started by the CSR around the turn of the century). Since then over 3900 hectares have been reclaimed and a further 500 hectares have been proposed for sugar cane reclamation in the near future. Since 1980, reclamation for sugarcane, and to a limited extent for rice cultivation, has accounted for over 74 percent of the reclamation. This is the single major cause for mangrove loss in Fiji (9). The irony of the situation is that, for the most part, mangrove land reclaimed in the name of agricultural development has still not been put to use; and where it has been, the yields have been very low (10). This is due, in part, to acid sulfate conditions, and the absence of any one authority responsible for the administration of coastal lands.

The problem of acid sulfates in mangrove-reclaimed soils is well documented (11) and has been the most important factor for the low yields noted. In some cases this condition developed because of incomplete drainage work. The Drainage and Irrigation Division of the Ministry of Agriculture and Fisheries undertook major drainage works in the mangrove areas with the understanding that the Lands Department would carry out further drainage before subdividing the land for lease purposes. This was not undertaken and the drains were not maintained, largely because sufficient funds were not allocated. Subsequently, the reclaimed soils became acidic and in some cases developed high salt contents, to which sugarcane and rice have no tolerance.

The acid sulfate problem was also encountered in prawn aquaculture ponds on reclaimed soil, despite the addition of lime on a regular basis. In the mangrove reclaimed areas a decline in mud lobster *(Thalassina anomola)* and mud crab *(Scylla serrata)* has been reported. The relationship between mangrove and fisheries is evidently not understood. However, it is known to be a very productive system and mangroves act as a combination nursery, feeding, and breeding ground for a number of commercially important fish and crustaceans in Fiji (Table 1) (12).

Soil Erosion

The poor agricultural practice of planting crops on slopes greater than 5-10° without proper contours, combined with slash and

burn subsistence farming, are responsible for large-scale soil erosion problems (13). There is a paucity of data on the extent of soil erosion. However, it is predominant all over the country (14)—from small islands where goat farming is prevalent to larger islands where construction of roads, urban development and agriculture have added large volumes of soil to the waterways. In these areas soil is also washed down the rivers after heavy rains.

Soil transported into the coastal ecosystem smothers coral reefs (15) and chokes off mangroves, causing a marked decline in fish populations. During the construction phase of the Pacific Harbor resort in the mid-1970s, heavy sediment input into the estuaries killed many coral colonies around the mouth of the Qaraniqio River (16). More recently, in 1982, soil washed down from a road construction site along the Suva-Nadi highway smothered *Brugueria* species in Serua Bay. It also caused stress on the adjacent coral reefs. Sedimentation is probably the biggest killer of coral reefs in the tropics (17).

Tourism

Tourism expanded rapidly after 1960. The number of tourists increased thirteen-fold from 14 272 in the 1960s to 184 000 by 1978 (18). To meet the tourist influx, a number of hotels were constructed. By 1977 there were 44 hotels with 3274 rooms, 67 percent of which were built during the boom years of 1970–1975. This development took place mostly in an *ad hoc* manner along Fiji's coral coast which includes some mangrove areas. Even as late as 1983, a major tourist development on over 400 hectares of mangrove coast (the only extensive mangroves in this important fishing area) was approved despite objections raised about the potential loss of fisheries.

In addition a number of small-scale offshore groynes or jetties have been constructed, most of which apparently have had insignificant influence on coastal processes (19). However, some have had dramatic effects. For example, along the coral coast—after an artificial island was created—a thick layer of estuarine sediment was deposited between the island and the hotel. Prior to construction the currents were strong enough to disperse sediment brought in by the river.

To better serve the tourist resort corridor along the coral coast, a multimillion dollar highway is under construction. Apart from soil erosion caused by poorly planned, steep embankments and cuts created for the highway construction, the road has been laid out through large areas of mangroves. The flow of seawater and freshwater was interrupted, and mangroves having positive salt requirements were killed (20).

Table 1. List of species of which 10 or more individuals were caught using 2-1/2" gill net in a mangrove creek during May 1982–April 1983; 42 families with 92 species were caught during the period.

Species	Number	Average Weight (gm)	Length Range (mm)
Mullidae			
Upeneus sulphureus	23	186	125–270
Upeneus vittatus	71	185	105–316
Parapeneus indicus	33	120	112–305
Gerridae			
Gerres macrosoma	94	104	125–185
Carangidae			
Caranx sexfasciatus	28	96	135–215
Caranx papuansis	35	111	130–230
Leiognathidae			
Gazza minuta	31	46	95–160
Leiognathus equula	107	53	80–180
Leiognathus fasciata	14	50	96–141
Siganidae			
Siganus vermiculatus	117	198	100–290
Lutjanidae			
Lutjanus argentimaculatus	45	429	116–470
Lutjanus fulvus	71	126	125–255
Lethrinidae			
Lethrinus harak	69	167	124–310
Mugilidae			
Velamugil seheli	72	337	190–420
Velamugil buchanani	37	268	140–271
Liza subviridis	77	203	185–340
Liza tade	19	200	185–276
Kuhlidae			
Kuhlia bilunulata	27	132	155–230
Polynemidae			
Polydactylis plebius	22	147	160–303
Acanthuridae			
Acanthurus xanthopterus	28	87	100–185
Theraponidae			
Therapon jarbua	22	147	135–195
Crustacean			
Scylla serrata	79	383	60–205
Portunus pelagicus	46	–	30–105
P. sanguinolentus	39	–	40–140

The effect of raw or partially treated sewage effluents discharged into the lagoon waters from tourist resorts is also of great concern (21). The effect of sewage on coral reefs is well documented in Hawaii (22), though there is no detailed information on the situation in Fiji. The combined effects of sewage nutrients and sediments in Hawaii have caused the death of corals along with many associated species and the proliferation of algae *(Dictyosphora cavernosa)*.

URBAN DEVELOPMENT

The impact of human settlements on the environment is especially marked around Fiji's urban centers. With an annual growth rate of 3.7 percent (23) Fiji's urban population accounted for 37 percent of the total in 1976 (Figure 1). Historically, these urban centers—which are concentrated on the two major islands—developed around ports serving the sugar cane belt and tourist areas. Over 90 percent of the urban population resides in the coastal areas. The two main cities, Suva and Lautoka—which have the greatest degree of industrialization and urbanization—contain 67 percent (146 674) of the urban population. The pressure of urbanization and demand for low cost housing has encouraged squatter settlements located mostly on marginal coastal land. Some of Fiji's squatters, who constitute 15 percent of urban dwellers (24), are settled in mangrove areas in Suva, Lautoka and Labasa. Recently, squatters have also been found on Fiji's only sand dune areas in Sigatoka. Coastal areas are Crown lands and therefore relatively more accessible to squatters.

Refuse and Sewage Disposal

With the development and growth of urban centers, the need for proper refuse and sewage disposal became manifest.

Mangroves, traditionally regarded as wastelands, have been used for domestic refuse and sewage disposal, either because of lack of foresight or a desire to acquire more waterfront land for future use. Little or no regard has been paid to the potential problem of pollutant leachate during periods of high rainfall. This can be seen, for example, at the refuse dumps at Lami (25), Lautoka and Tavua. No data on the type and level of pollution are available as both the polluting and monitoring agent is the local city or town council. However, water pollution around the dump sites is extensive.

The unavailability of suitable lands in close proximity to urban centers (and the requirement of soils rich in clay) has also encouraged the usage of mangrove soils for sewage treatment oxidation ponds (26). The use of mangrove soils for tertiary treatment of effluents gained further momentum during the early 1970s after its potential in treating sewage was demonstrated (27). The low cost of mangrove land has also been an important factor in its usage. As of 1980, 12 percent of Fiji's population was served by reticulated sewage systems in urban centers (28). Effluents from the treatment plants were either disposed of in mangroves or discharged into mangrove creeks (Table 2).

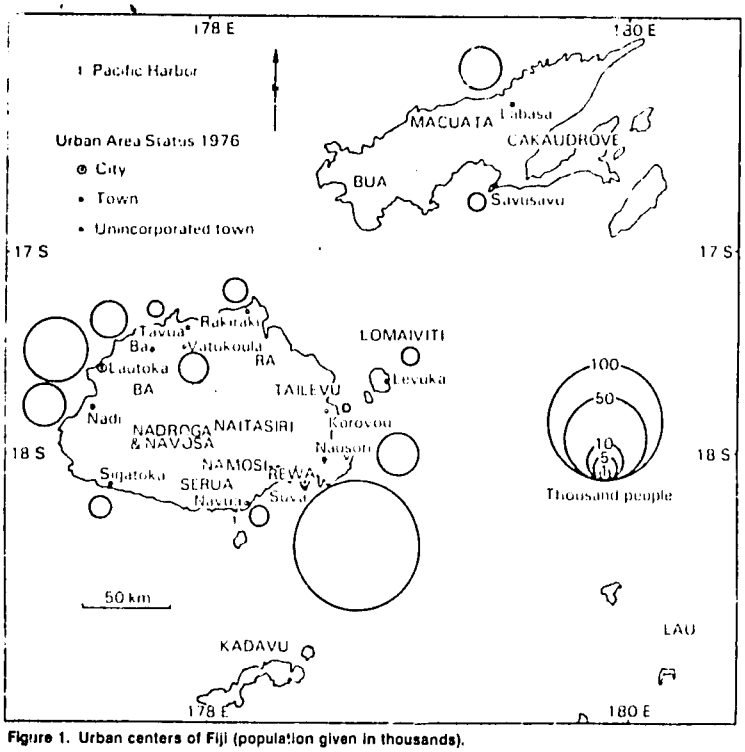


Figure 1. Urban centers of Fiji (population given in thousands).

Table 2. Urban sewage treatment plants and disposal of effluents in or amongst mangroves in Fiji.

Treatment plant	Type of plant	Population served (ultimate population served)	Disposal of effluent	Area of mangrove taken; ha (total area to be taken; ha)
Kinoya, Suva	Trickling filter (Secondary)	35,000 (250,000)	Present: Via 800 m long outfall on Mangrove coast. Future: Extend 1000 m outfall and then triplicate	6 (6)
Raiwaqa, Suva	Trickling filter	14,000 (15,000)	Into creek in mangrove	2 (2)
Nadi	Pasveer ditch (Secondary)	6,000 (60,000)	Present: Into river. Future: Possibly into mangrove area	– (40)
Lautoka	Oxidation ponds (12 1 2 day only)	25 000 (100 000)	Via 2 0 km long outfall to sea	16 (For 2 stages) (32)
Labasa	Oxidation ponds (full treatment)	2,000 (15 000)	Dispersal inside mangrove area	24 (24)
Sigatoka	Oxidation ponds (full treatment)	Not yet constructed (12 000)	Into estuary	7 (7)
Ba	Oxidation ponds (full treatment)	Not yet constructed (50 000)	Into creek in mangrove	– (33)
Nausori	Trickling filter with 5 day ponds	Not yet constructed (20 000)	Into river	–
Tavuni	Oxidation ponds	Not yet constructed (5,000)	Into creek in mangrove	(4)
		TOTAL		55 (148)

The actual mangrove area used for sewage disposal is small, but the effect of sewage effluents on local ecosystems can be significant. The effect of nutrient input on mangroves has not been quantified, though mangroves adjacent to sewage discharge points in Labasa showed signs of lush growth. These signs were similar to those observed along the North Queensland coast in Australia (29).

Increased nutrient loads in estuarine systems generally cause an increase in the chemical oxygen demand (COD) and biological oxygen demand (BOD) (30), with a noticeable decline in commercial fisheries (31). In Fiji, because of the lack of "before-and-after" studies, the actual effect of sewage effluent discharges is not known. However, circumstantial evidence does indicate that there has been a decline in species diversity and fish catch per unit effort (for example, in the Vatuwaqa River where part of Suva's partially treated sewage effluent is discharged). Mangrove crabs and oysters have virtually disappeared. The Kinoya Sewage Treatment Plant Study concluded that the impact of sewage effluents on coastal fisheries is minimal (32). This was based on very limited data and the discharge is in the heavily polluted Laucala Bay, adjacent to effluents from an electricity generating plant supplying power to Suva. Mangroves in the vicinity of the power plant show fewer leaves and larger prop root densities—symptoms similar to those observed in areas of thermal loading in Puerto Rico (33). From a subjective survey carried out by the Fisheries Division in 1982 (34), indications of decline in food fish and shellfish abundance were reported. Effluents from the Suva City Council's electricity plant and septic tanks are also responsible for the pollution of Nubukuloa Creek in the heart of Suva.

The effects on local ecosystems of pollutants from the plants are not known, however, and would depend upon the type and level of pollutants, species of affected organisms (35, 36) and the temperature of the water (37).

INDUSTRIAL DEVELOPMENT

Some of the urban centers grew up around industrial areas. Industrial development in Fiji, which took place initially on Crown and Freehold lands, later began to expand onto reclaimed coastal and mangrove land. Fiji's largest industrial areas in Suva at the Walu Bay and Vatuwaqa, developed in part on such reclaimed lands (38); this was also the case in other urban centers such as Labasa, Lautoka and Lami. On the island of Ovalau, Fiji's first capital, a fish cannery was built along the coast.

A number of industries discharge their wastes directly into coastal waters. These include wastes from flour mills, electroplating plants, fuel oil depots, shipbuilding and repair docks, sugar mills and a tuna cannery. The impact on Fiji's natural environment from industrial development is not widespread, instead the problems are very localized. The extent of the effects are not known. Fish caught off Suva Harbor on occasions have a distinct oily and kerosene flavor and the marine life in the

harbor has been degraded. Direct fish kills have been reported in the local press after large volumes of untreated or partially treated wastes have been discharged from sugar mills at Lautoka and Labasa. Effluents from abattoirs have also led to fish-kills due to increases in the BOD (39). Air pollution from sugar mills and the cement factory have also been reported. Fiji Industries Limited, which operates the cement factory at Lami, has illegally reclaimed about 11 hectares of mangrove and coastal land using factory waste sludge. The reclaimed area has been earmarked for a future industrial subdivision. The flora surrounding the cement factory is covered in dust from the plant's operations.

Coral sand dredging in Laucala Bay has also been carried out by the Fiji Industries over the last 25 years. From 1960–1979, about 123 million tons (dry weight) of coral sand have been extracted from 7 different sites (40). Dredging caused heavy mortality of turtle grass (*Syringodium isoetifolius*). A decline in fish species diversity and abundance has been observed in the dredged area as a direct result of the loss of seagrass (41).

The effect of suspended sediment caused by dredging appears to be minimal in comparison with sediment loads brought in from the Rewa River. With every heavy rain, large volumes of sediment are carried down the river, settling in Laucala Bay. There is no data available on this sediment deposition but most probably the coral reef system is under considerable stress if the sediment settles on the reefs.

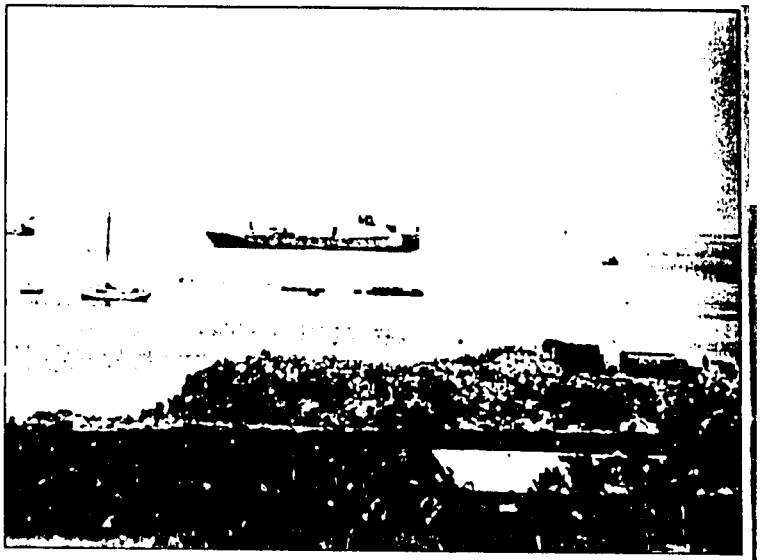
With increases in population and accelerated industrial development, the demand for oil has also increased tremendously. Fiji was reminded of the potential danger of oil pollution when a barge transporting fuel oil sank and polluted the coastline of Southern Viti Levu. With greater dependence on imported fuel oil (and heavier tanker traffic) possible oil spills pose a real threat to a country dependent on tourism and fisheries—the two industries most likely to be affected in the event of an oil spill. This threat is becoming more of a reality since oil exploration has commenced in Fijian waters (42).

Effect on the coastal fisheries

The shallow fishing grounds associated with mangroves, seagrass, estuaries and coastal lagoons are vital to Fiji's local fishing industry. Fiji lacks extensive shallow continental shelves. Although there are significant upwelling areas, they are not a dominant feature. At least 70 percent of the fish supplied to urban markets is caught in coastal and estuarine waters off urban centers. In 1981, 5000 tons of fish and shellfish were sold through urban markets. Over 90 percent of the subsistence fish catch (1400 tons in 1981) also originated in coastal areas (43). A clear decline in landings of fish from fishing grounds off Suva City and other urban centers has been observed over the last five years (44). The decline has been attributed to the effects of urbanization and degradation of habitats.

Destruction of mangroves, seagrass beds and coral reefs as a result of agricultural activities, tourism, and urban and industrial developments have already been mentioned. But there is another threat to coral reefs in Fiji: the proliferation of the reef destroying crown-of-thorns starfish (*Acanthaster planci*). Their population explosion has been attributed to dredging, dynamite fishing and the destruction of natural predators. Dynamite fishing—though illegal—is fairly common in Fiji, destroying large areas of coral reefs. The exploitation of crown-of-thorn predators, such as tritons (*Charonia tritonis*), for subsistence and the tourist industry has also contributed to the increase in their population (45).

Overfishing by commercial fishermen residing in urban centers may also be responsible for the decline in fish landings. The introduction of cash economies and efficient gear in rural areas has also led to depletion of certain fish species (46), for example, mullets (*Mugil* sp) and bêche-de-mer (Holothurian).



This waste dump on Suva harbor leaches heavy metals and other toxic waste into the coastal waters. Photo: Morrison.

INSTITUTIONAL IMPACT

A number of environmental problems related to coastal development arose partly because of institutional arrangements. There is no single piece of legislation or institution which deals specifically with coastal resources or environmental impact assessments. The multitude of institutions involved have generally used piecemeal, problem-centered approaches to finding solutions which often translate into conflicting uses of a particular resource. This situation arises partly from a conflict between traditional and modern (*ie* Western) concepts of ownership (47) and ideas about the ecosystem. In traditional Fijian society, adjacent reefs and lagoon ecosystems were seen as an integral part of the land (48). Under British law, imposed on Fiji since 1874, water and land were conceptually distinct entities. Thus, land below the highwater mark, which includes mangrove zones, belongs to the Crown. The Crown owns 7 percent (12920 hectares) of the land, which includes coastal areas, while native, communally-owned land comprises 83 percent of the total; the rest is "fee simple". Furthermore, the control over Crown coastal lands rests with various departments, depending on the usage under consideration.

In the first half of this century, for example, when mangroves were increasingly being used as fuel and timber, they were declared Forest Reserves under the jurisdiction of the Conservator of Forests (49). Harvesting mangrove forests was licensed by the Conservator, while the reclamation of coastal areas was permitted and leases granted by the Department of Lands. In 1968, mangroves near urban centers were de-reserved to allow local authorities greater flexibility in zoning. A Cabinet decision in 1974 de-reserved all mangroves after considerable pressure from the indigenous population. Mangroves have been used for a number of purposes, including timber for construction, firewood, dye, and fishing, activities which were not allowed under the forest reserve. With increasing reclamation and continuing loss of productive fishing grounds (and after considerable pressure from the native fishing right owners), the Fijians were granted compensation for each reclamation. This system was instituted in 1974 and an independent arbitrator appointed to determine compensation value. Though the Ministry of Lands has to obtain the views of the Departments of Forest and Fisheries, along with those of the Native Fisheries Commission, before a coastal lease is issued, such leases have often been issued "in principle" prior to the request for their advice. The independent arbitrator, recog-

nizing the shore stabilizing properties of mangroves, imposed a 30 meter "setback line" condition on all land reclamation.

Since 1975, at the national level, the government has not favored "large scale reclamation." However, the definition of "large scale" was left to interpretation; anywhere from 1 to 493 hectares of mangrove reclamation have been approved. When public pressure increased in 1980, a ban on "cutting" mangroves was imposed in the light of "recent awareness on the value of preserving forests." Despite this concern over mangrove loss, their reclamation by private individuals as well as the government has been permitted. The ban, which mainly affected subsistence users of mangroves, was lifted after local protests.

Now, for any development—be it on land or in water—which can be shown to have adverse effects on fisheries or fishing rights, compensation has to be paid to the native fishing right owners. This has to be determined after an impact assessment has been carried out by the departments concerned. Though some preliminary efforts have been made to give a dollar value to the loss in productivity of an area as a result of mangrove reclamation (50), the value determined has been largely arbitrary. It has ranged from $900 for 20 hectares to $9500 for 7.6 hectares. Thus instead of using this type of assessment as a tool for the evaluation of a project before approval is given, the projects are often approved "in principle" and the assessment is largely for the determination of the compensation. This was also the case with the extensive oil exploration carried out in Fiji's coastal waters. Approval for the oil drilling was given before the company undertook environmental assessments to gather baseline marine data and submit a contingency plan in case of possible oil spills. The drilling areas were surrounded by coral reefs and were within 20 km of major mangrove forests and some of the best tourist beach resorts. Mining is the only activity in Fiji for which an Environmental Impact Assessment is required by law.

CONCLUSION

Fiji's piecemeal, problem-centered approach to development has contributed to the environmental problems of the coastal zone. It is inevitable that human activity of any kind would, to some extent, modify the environment. But abrupt, *ad hoc* developments have greater negative impacts than those rationally planned out. In an insular island system where resources are limited and the island economy dependent on few natural resource endowments, any adverse impact on the environment becomes significant.

Fiji does not have environmental problems of the same magnitude as the developed world. However, with the present mode and pace of development, Fiji is destined to be rapidly subsumed into a technology-dependent, urbanized and polluted copy of the continental countries.

Fiji has not developed policies which are badly needed to adequately protect and use its coastal resources. Preliminary guidelines on mangrove utilization for national development plans do exist (51) and efforts are underway to develop national mangrove management plans though policies on comprehensive coastal zone management and pollution control are lacking. These are definitely needed if Fiji is to remain the idyllic site for tourists and live up to its self-proclaimed image expressed in the advertisements of its national airline: *Fiji, the way the world should be.*

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