

# ENVIRONMENTAL PROBLEMS

IN

WESTERN SAMOA

Lui A.J. Bell  
Fisheries Division  
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## INTRODUCTION

The basic social unit in Western Samoa within villages still remain the aiga (extended family), headed by the chiefly matai. Political organization within these villages rest largely upon the village council in which the heads of extended families and their chiefs join in dealing with local problems and order.

In the past, villages owned land adjacent to it from the mountain ridge down to the reef, and fishing grounds within the reef and lagoon had owners.

Today, most of the land is still held by customary rights while Government owned, WESTEC and Private Freehold lands account for less than 20% of the total. Article 104 of the Constitution provides that all land lying below the line of high-water mark is vested in the State.

Some concern on the environment was indicated in the contents of the Agriculture, Forests and Fisheries Ordinance 1959. Section 4(b) provides in particular that one of the principal functions of the Department is to promote the conservation, production, and development of the natural resources of Western Samoa..." Further concern was apparent with the establishment of Fish Dynamiting Act 1972, which makes it an offence for any person to use dynamite or other explosives to catch fish. In addition, the National Parks and Reserves Act 1974 provides for the establishment, reservation and administration of national parks and reserves for the benefit of the people of Western Samoa. Other legislation along these lines include the Land Ordinance and Health Ordinance 1959, Forests Act 1967 and Forests Regulations 1969 and the Land for Water Supply Ordinance 1955. The Fourth Five Year Plan 1980-1984 contained a chapter, 'Environmental Management for Development', which proposed the establishment of a small Environment Management Unit. Also the present (sixth) Development Plan (1988-1990) contains a chapter on 'Human Settlement and Environment'. The Fisheries Act 1988 provides for the conservation, management and development of fisheries in waters subject to the jurisdiction of Western Samoa, for the licensing and controls of foreign fishing and for related matters. Under Part 3 of the Act the Director may consult with fishermen, industry and village representative in the formulation of management and development measures. Furthermore, the Government Representative (Pulenuu) of any village may, on the advice of the village, make by-law for the conservation and management of fisheries in village waters. Towards the end of 1989, a one-man Environment Sector was established within the Lands and Survey Department.

## LAND ENVIRONMENT

The distribution of land falls into four categories in Western Samoa. The problems associated with the land environment are in most cases, reflections of these ownerships.

The land distribution is as follows (in percentages):

Customary land	80.5
Private Freehold land	3.7
WESTEC	4.5
Government land	11.3

This distribution reflects the people's attachment to their land. Although traditional tenure systems tended to encourage efficient use of the resources, in the past, it is facing difficulties in adapting to population growth and modern development requirements.

### i. Tree Felling and Land Clearing

#### (a) Commercial Logging

It has been estimated that about 50% of the total land area of Western Samoa is occupied by forests, and are predominantly under customary ownership. Estimates in 1984 indicated that of the total 150,000 ha of forests, only 95,000 ha was regarded as commercial forests. In 1988, a survey of Savaii alone indicated 21,500 ha of merchantable indigenous forests left there. This merchantable forest was estimated to be exhausted between the years 2000-2009 assuming constant consumption of the forests resource by harvesting and agriculture. But it was also estimated that if the rate of decline of merchantable sawlogs was projected using the lower 95% confidence limit, the forests would be exhausted at the turn of the century. The deforestations were estimated to be progressing at a rate of about 1,000 ha annually.

There are presently five commercial logging companies in operation, with four stationed on Savaii and one in Upolu although almost all of the logs are from Savaii. The current industry's demand for sawlogs is about 30,000 m<sup>3</sup>/yr.

Reforestation of logged over areas was initiated in 1974 and by 1980, about 3,100 ha of plantations had been planted on both Upolu and Savaii with fast growing, low density species such as *Eucalyptus deglupta* and *Anthocephalus chinensis*. Slower growing cabinet timbers, such as teak and mahogany account for a small percentage of the annual planting programme. By the end of 1988, 4409 ha out of the land bank of 10,594 ha had been planted. However it was also estimated that only between 1000 and 5000 ha are available for further planting. A bushfire in 1983 destroyed almost the entire plantation of about 1,600 ha in the Asau project which was

established under the New Zealand Government Aid programme since 1977.

It was estimated that no significant volumes will be available to industry from the plantations before 1995, after which a harvest level of about 18000 m/yr could be sustained until 2003 when production could rise to about 30000 m/yr, which is the current industry demand for sawlogs.

The information above indicate that most of the areas logged are not replanted. In most cases, this is due to the system of ownership, since most areas are customary, and many owners take logging as a means of land clearing for their agriculture plantation. However it also seems that the reforestation scheme is only concerned about meeting the production demand which is done with the introduction of exotic plant species. These replace indigenous species and thus changing the forests ecology. Since most of the areas logged are not replanted, soil erosion will be increased, which is in addition to erosion caused by access roads. Many sellers of timber are ignorant of the value of their forests as a source of revenue and for ecological consideration, and the low royalties seem to ensure that waste in the forests and the mill is maximized. The low prices encourage rapid progress through the forests by loggers who prefer to take only the cream of the logs. The regeneration programme is far below the logging activities.

(b) Agricultural Development

Land potential was estimated by Wright (1963) as follows:

Land with cropping potential	124,000 ha
Land with some potential for cattle grazing	71,000 ha

According to Pak Pay (1972):

Land suited for Intensive agriculture	141,000 ha
Land suited for cattle ranching	65,000 ha

So of the estimated 285,745 ha of land, about 200,000 ha is estimated as suitable for cultivation and cattle ranching. A total of about 123,059 ha was estimated as unsuitable for cultivation due to their steep nature, in addition to about 11,433 ha on Savaii due to recent lava flows. 60,000 ha was estimated to be under crops but an ADB mission (1985) estimated the total to be about 77,211 ha using 1966-1981 topographical sheets. Present figures would be higher. An earlier study, Wright (1963), which considered the soil types, suggested that a total of

about 98,000 ha may be found suitable for tree crops, part of which would be suitable for other crops and pastures. Thus it seems that some of the present tree crop areas are outside the suitable soil areas, showing that unsuitable soils are being used for tree crop cultivation.

Accurate and up-to-date figures for land use and potential do not exist. There is however a National survey being conducted to assess land use coverage.

Most of the logged-over areas on customary lands, have not been replanted as owners prefer leaving them for agriculture development. Demands for agriculture land depends on commodity prices and the recent high taro prices have stimulated land clearing. There is also a surge of competitive land clearing by neighboring villages and individuals in villages or districts for the purposes of establishing land boundaries and land claims. This has led to the destruction of some forests. Land along river banks and water-shed areas have also been effected by clearing for agriculture, although there is a law against this. This has caused considerable soil erosion.

## ii. Soil Erosion and Flooding

Although soil erosion is a natural process, the increased rates in a lot of areas has been due to human activities in efforts to develop the land. In most cases this thrust makes man ignorant of some consequences. The main limiting factors of Western Samoan soils includes:

- depth, which is generally shallow
- stoniness and rockiness, which is extensive, covering about 75 per cent of the area on which tree crops are grown
- the steep slope of the land, particularly in the central upland and upland regions of both islands.

Soil erosion presents a major problem, and rates are increased easily by land clearing for agriculture farms and especially those lands near river banks. Although there is an existing law forbidding clearing of river banks, most of these land are customarily owned and therefore law is virtually impossible to uphold.

Deforestation by loggers and construction of access roads have also contributed to the loss of soil from steep land. Coastal erosion has been accelerated by the removal of coastal vegetation, reclamation, road construction and sand mining.

Flooding has caused agriculture loss particularly with

vegetable garden.

During the dry season streams that were normally perennial are now starting to dry up.

### iii. Land and Fresh-water Pollution

The absence of a research unit responsible for water quality analysis has made it impossible to determine the presence, and if any, the extent of pollution from agro-chemical on the drinking water as well as those in the lagoons. However, the widely and the rather indiscriminately use of pesticides and herbicides in Western Samoa, together with the increased land clearing, create possibilities of land and water (including lagoons) pollution from these chemicals. The herbicide, paraquat, is not only used to control weeds in agriculture activities, but its use has expanded to controlling weeds near homes, which were normally pulled out by hand or cut with a bush-knife.

Increased land clearing including areas on river banks, has resulted in increase soil erosion. A lot of the soil is washed into river systems, which feed dams for drinking water. During heavy rains, especially on the south of Upolu Island, tap-water is unsuitable for human consumption, and in many cases, tap water does not run because of blockage from sediments.

### iv. Flora and Fauna Extinction

It had been observed that from west to east in the Pacific, there is a progressive decrease in numbers of animal species. Although Western Samoa has small numbers of wildlife, this lack of diversity is partially offset by their special scientific interest in that many of Samoa's animals, especially the land birds, are found nowhere else in the world. Mossman and Berg (1981) noted that within the Ole Pupu Pue National Park, 51 species are found, of which 21 are found nowhere else in the world but the Samoa Islands. Of these 21 species, 9 are found in both Western and American Samoa and twelve are restricted to Western Samoa. Furthermore, of these 12 species, 3 are only found on Upolu Island.

Due to extensive land clearing for agriculture and logging for timber, specific habitats for a lot of the native birds have been destroyed and certain bird species are now facing extinction. Uncontrolled shooting of certain species also contribute to this trend. A lot of the bird species are altitude-specific and therefore face the difficulty in adapting to higher altitudes when their natural habitats in lower altitudes are destroyed. Eventhough a number of the bird species are protected by law but such laws have nothing to

offer to stop habitats destruction. Some of the birds now becoming relatively rare, very uncommon or endangered, include: Australian grey duck ('toloa'), sooty rail ('vai'), many coloured fruit dove ('manuma'), friendly quail dove ('tuaimao'), white throated pigeon ('fiaui'), tooth-billed pigeon ('manumea'), Samoa white-eye ('tutumalili'), Samoan triller ('miti'), Samoan broad bill ('tolaiula') and the blue crowned lory ('segavao'). Populations of the fruit bat and the Pacific pigeon have also dramatically dropped due to hunting. The establishment of an export market for the fruit bat by very few individuals in Guam led to the increase killing of this species. Fortunately, the law now prohibits this export undertaking.

A lot of the important native trees are also becoming scarce and facing the possibility of complete disappearance. Again, it is possible that these trees could only adapt to their present low altitude habitats. Examples of plants of the indigenous forests that are becoming uncommon include: Calophyllum samoensis ('tamanu'), Neonauclea forsteri ('afa'), Instia bijays ('ifilele'), Alphitonia incooa ('toi'), Canavium samoensis ('maali'), Agave samoensis ('lagaali'), Bischofia javanica ('o'a) and Dysoxylum spp ('mamala').

The decline in populations of the fauna and flora are indications of environmental degradation. However there are some efforts to establish new reserves especially on Savaii, but it seems that the main one will be in an area of very high altitude which may not be suitable to harbour birds and plants from lower altitudes. There is also presently a programme within government to plant some of the native trees which are disappearing, in a reserve on Upolu Island.

#### v. Human Habitats

Like many island countries in the South Pacific, Western Samoa is fortunate that the rural (village) traditional way of life is of reasonable good quality. However, there are some problems associated with the urbanization movement from the rural villages of those expecting or desiring modern styles of life. This has led to some insanitary housing, increase water need and has created additional sanitation and pollution problems within the urban area. In addition, destruction of mangroves near and around the city through cutting for firewood, reclamation for land and dumping of rubbish, is very apparent. These settlements are almost always affected every year during the rainy seasons by floods.

## MARINE AND COASTAL ENVIRONMENT

### i. Use of Destructive Fishing Methods

#### (a) Dynamiting

The use of dynamite to catch fish in lagoons and on reefs has a long history in Western Samoa as it was reported by von Bulow in 1902. Although its use is now not as widespread and frequent (except in certain villages) as about 10-15 years ago, it still poses a threat to the marine environment and its inhabitants and also the lives of those that use them.

Two methods have been described as those used in Western Samoa. One involves throwing dynamite (3-4 sticks) from a boat at free ranging fish schools or aggregation of fish, and the other one employs a larger charge, wires and detonator. The most commonly used method now is that of hand throwing.

Several reasons have been given by blast fishermen as to their use of dynamites. These include: more efficient method, only method of catching certain fish species successfully, and high costs of proper fishing equipment. Some even claim that they do not have problems with the law in their areas. In some villages, even though illegal by law, fishing with dynamite continues to be practiced openly and is tolerated and in some cases, even encouraged. These are reflections of ignorance and putting short-term gain ahead of future benefit and are evidences of moral decline.

In 1988, two cases were reported in which men were blown up by dynamite intended to be thrown at schools of fish. There was one such case in 1989.

#### (b) Poison

The roots from the plant, Derris elliptica (ava niukini) which thrives in the bush and the fruit from the Barringtonia plant which is abundant along the coast of Western Samoa, are used traditionally to kill certain reef and lagoon fish species. The Barringtonia seed is not as effective and thus not widely used as the Derris root.

The Derris roots are pounded into a powdery form and wrapped up in small balls (of about 1 inch in diameter) using leaves, mainly those of Barringtonia. Normally, one or two fishermen are involved at a time taking for use about ten wrappings. One of the main target species is the marine eel-tail catfish (apoa) but small reef fishes are also included. The fisherman usually know where the catfish aggregate in holes (aga apoa) which is always in shallow waters, and visit those places at certain times of the year. The poisoning process is done by

opening the wrapping just above the hole and making sure that the contents fall in. In a matter of only few minutes (sometimes even less than a minute), the fish would swim out stunned and are easily picked up either by a small scoop net or by the use of a thin rod sharpened at one end. The same method is applied with small reef fish within corals, but here, sometimes, manual breaking up of corals may be necessary, to collect dead fish within.

The common household bleach and even some agricultural chemicals including the herbicide, paraquat, have been reported as being used to kill aquatic animals in some areas. One such case which led to the prosecution of some fisherman, was the use of the slug controlling chemical, Ambush, to kill fresh water prawns in a river which fed the drinking water for the Apia town.

The use of the Derris roots has dramatically decreased in the past few years and is most probably because of the declining and/or disappearance of the target species, particularly, the eeltail catfish. There is an awareness in villages of the destructive effects of chemicals and a lot of them have taken steps in preventing fishermen from doing so. Sources reported that in most cases, fishermen who use or used to use chemicals were doing these in other village's reefs.

(c) Manual Destruction of Corals

In addition to the manual breaking up of corals to extract poisoned fish as mentioned in (i) b above, there are two traditional methods of fishing on the reef that are destructive to coral reefs. These are locally known as 'faamoa' and 'tuiga'. Briefly, these involve a number of people equipped with wooden poles which are driven into corals, smashing them, to drive fish out and into a set net. One of these is specific to one or two specie of the genus chromis, known locally as 'tuu'. It is uncertain (to the author) whether any of the methods are still practiced in any village but it is apparent that they have declined in use. This decline and/or discontinue in use is believed to be due to the disappearance or dramatic decline of target species population as well as the habitat.

ii. Pollution

(a) Sedimentation (Siltation)

Sediment production is a natural process, as wind and rain have been washing soil into rivers and streams and into the marine environment. However, certain human activities which come under the term 'development' tend to intensify sediment production rates (Hodgson and Dixon, 1987).

Johannes (1982) stated that "the soil that is a precious resource on the land becomes a pollutant when deposited on corals". Wells (1984) reporting on dredging, noted that 'such activities increase turbidity, alter water circulation and even cause the destruction of entire reef systems'. King (1989) listed the major effects of silt as; (a) kills plants by reducing the amount of sunlight penetrating the water, (b) kills fish by damaging their gills, and (c) kills coral by smothering it. In addition silt may also alter vertical distribution of plants and animals on reefs or in lagoons, kill some filter-feeding animals when their clearing capacity is exceeded by siltation and smother possible breeding habitats for some marine animals.

In Western Samoa, high sedimentation in the marine environment is brought about by soil erosion from streams due to poor upland agricultural and possibly logging practices, dredging for sand for construction within the lagoons and coastal erosion due to reclamation etc. Destruction of reef communities and deterioration of fisheries in some districts in Western Samoa are suspected as being associated with soil erosion from upland (Bell 1985). Gauss (1981) reported that comparison of seabed depth contours from bathymetric surveys done in 1975 and 1981 for the Apia harbors, suggest that the sea-bed has shallowed by up to five feet in the central and eastern parts of the harbour in six years. One of the hydro-power reservoirs within the country might be closed due to high sedimentation from soil erosion resulting from land clearing for agriculture and from access roads (Titimaea 1989, personal communication). The disappearance of a sea slug Dolabella sp (gau) within the Vaiusu Bay is suspected to be due to high siltation from the dredging operations in the bay in addition to other pollution mentioned in (b) and (c) below.

(b) Industrial Wastes Discharges, Agricultural Pesticides

Vaitele has been ear-marked as the Industrial Zone. Unfortunately the thrust for industry and the concentration of industries in one area has not come together with a thrust to regulate discharges into the sea from these industries. Traditionally the marine environment has been treated as the 'dumping site' for any type of 'waste'. Dumping at sea has been probably thought of as the sure and safe way of getting rid of rubbish, due to its vastness and the fact that the 'rubbish' thrown into the sea gets eaten by fish, or sinks to the bottom and out of sight or floats away and lands somewhere else or washed off-shore. Wastes from the country's brewery is directly discharged into the adjacent bay. Acetylene production nearby does the same. This is probably the case also with the beef canning factory, feed mill etc located in the same area. In addition, the only Boat craft is along the shore together with a few saw mills which treat timber and

either dump their wastes into the sea or are easily leached into it.

Perhaps one of the major problems associated with agriculture development is created by the use of pesticides and herbicides. Pesticides are used widely and rather indiscriminately in Western Samoa. As a result, the herbicide, Paraquat, is not only used to control weeds in agriculture development but also on any weeds that needs controlling. The grass that was usually cut by bush-knives is now being sprayed with paraquat. This is often along road-sides near drainage very close to the shore line. (Note: most of suicide cases within the country involve the drinking of paraquat). Agricultural chemicals are available to everyone where as in the US, DDT pesticide has been prohibited since 1972 and the use of some of these are only allowed for qualified specialists. Dr. Karl Marshall of Western Samoa was reported as conducting some experiments demonstrating that exposures to low levels of DDT can, over a period of weeks, lead to the gradual deterioration and ultimate death of reef corals. Even at sublethal levels, it can concentrate in edible bivalves to the point where they become unsafe for human consumption.

Industrial waste discharges into the Vaiusu Bay is probably one of the contributing factors responsible for the disappearance of the Dolabella fishery within the bay as mentioned in (ii)a above. The widespread uncontrolled use of pesticides with the increase rates of run-off from the land, indicates a potential pesticide pollution in the lagoons.

#### (c) Urban Waste Disposals

A steady increase in population in the urban area of Apia has been reported which has resulted in an increase in load of human waste. Presently, waste from septic tanks is disposed off on land, which sometimes includes use for vegetables gardens. It has been proposed that Apia's sewerage be discharged off Mulinuu point with a discharge point 800 m clear off the reef in about 40m of water. It is not clear whether a proper study on wave and current patterns were undertaken for this proposal.

The urban area garbage (solid) disposal is about half a mile on the west coast from the town at Vaitoloa. This is right in the middle of a mangrove marsh, on the coast of the Vaiusu Bay, which also harbour dredging operations and industrial development (see (ii) a & b above). A second unauthorized garbage disposal is appearing very close to the town at Fugalei, and sadly, also in a mangrove marsh. The solid dump at both sites, particularly Vaitoloa, has resulted in destruction of a lot of mangroves and pollution of the bay. There is an important bivalve fishery nearby and the decline in one or two bivalve fisheries and Dolabella within the bay

could have been caused, in part, by this, in addition to other pollutions from other sources.

### iii. Loss of Mangroves

This important but very limited resource in Western Samoa is under stress from various human activities. A rough estimate from Government topographic maps indicated that coastal swampy areas and mangroves come to less than 1,000 hectares. There has never been any assessment done on mangrove coverage but this resource has certainly declined through the years.

There are presently three major factors that threaten to increase the decline of mangroves in Western Samoa. The operating systems of ownership of mangroves seems to relate to the three factors. Firstly there is an increase in numbers of land reclamations which in a lot of cases, are on mangrove areas. Although approval has to be sought first from the Land Board for any reclamation, the Land Board does not have routine checks around the islands. It is believed that the Land Board, in most cases, can only consider applications for reclamation. Secondly, garbage disposal sites as directed by the responsible government department, and as started off by some individuals, have in most cases been in mangrove areas. It is quite obvious, that no consideration of the value of mangroves was taken into account when the department concerned selected the site for the dump. There also seems to be a lack of awareness in general of how important mangroves are. Lastly, cutting of mangrove trees for firewood and construction materials proceed almost without any control.

### iv. Crown of Thorns Starfish Infestation

Although researches so far have not pin-pointed factors that might be responsible in triggering infestations, there are indications that infestations appear to be associated with an upset of the reef environment and damage to the food chains either through natural happenings and/or through activities by humans.

Infestations by Acanthaster starfish on reefs in Western Samoa dates back to the early 1930's. Another invasion was reported to have occurred in the late 1960's through to the early 1970's, affecting several points on the south, west and east coasts of Upolu. A heavy one was reported from Satoalepai village in Savaii in June 1985.

A preliminary study conducted in 1987 indicated that the crown of thorns starfish occurs in varying abundances on virtually all the reefs through out both islands with some reefs been badly devastated. The only exception found was the reef adjacent to Neiafu village on the south west coast of Savaii

Island. It was noted that the village (land and reef) is isolated with little land development.

v. Overfishing and Fauna Extinction

The failure to manage the marine resources has led to the decline in catches of certain fish and shellfish species. This decline is indicated by longer fishing time fisherman now have to spend in the catching process, utilizing legal methods of catching. There is therefore a decrease in catch per unit effort. Although it has also been observed that the catch rates from reefs is not low by the standards of coral reef fisheries, however, it is noted that the fish are much smaller on the average. Fishermen and even divers almost invariably comment on the lack of large fish in the lagoons and reefs of a Samoan village. This is an indication of the presence of pressure on the stocks. In addition, the composition of catches from the reefs have changed, which again is an indication of affected fish stocks. Certain fish species of the deep-water snapper resource of Western Samoa is known to be declining. Lagoon fish species, e.g. mullet, are also known to be generally decreasing and becoming scarce. In addition, a variety of bivalves and molluscs are on the same trend in certain areas. The giant clams, Tridacnas, is one example of a bivalve that has dramatically dropped to uncomfortable low levels. In fact, Hippopus hippopus, the horse shoe giant clam, is believed to have become locally extinct as a vast number of shells are brought up in quarry operation and yet no live specimen has been located. Some fisheries were specific to certain villages, and a lot of these have disappeared, e.g. the red-lipped mullet fishery of the Satoalepai village which used to have an annual run every year has disappeared.

It is not possible at this stage to quote exactly the main causes of the declines and disappearance of certain fisheries within the lagoons and reefs, but one obvious major contributing factor is the use of destructive fishing methods which not only kill the big fish and destroys habitats, but also kill juveniles and larvae which would be the basis for future stocks. However for certain marine animal species, over-fishing has played a role in the decline and/or disappearance. The present trend in the deep-water bottom fish resource is attributed to overfishing by having too many boats operating with the dramatic increase in effort, especially when these fishermen tend to target on one area at a time. It is a possibility that the maximum sustainable yield has been passed for one or two of the deep-water snapper species.

## REMARKS

Monasterio (1987) wrote:

" Nature does not recognize national borders and political ideologies. Capitalism and socialism do not exist for ecosystems, and there are no such things as development and underdevelopment. All there is, is the effect on the environment of these things".

Gilson (1970) noted that " considering the Samoan pattern of life, along with the population, the physical environment seemed indeed to have provided, in the PAST, an ideal basis for comfortable and convenient settlement". However, the customary system of land and sea ownership at present seems to have difficulty in adapting to population growth and the requirements of modern development.

As is in many island countries, rapid economic development and efforts to increase the standard of living have never taken into account their impacts on the environment. These issues have not been a priority in government plans. It is suspected that the sustainability of renewable resources, forests, mangroves, coral reefs and fisheries is already threatened

Commercial logging activities are occurring in the country without an equivalent regeneration programme. Although customary land ownership is blamed for this, however it seems that the thrust of the programme itself is in the introduction of exotic tree species to meet only the demand with possibility of export. Land owners whether interested in regeneration or not, should be made full aware of the consequences of extensive logging without equivalent regeneration. Like-wise systems for agriculture development should be developed and introduced in which maintenance and sustainability of the environment are considered.

A system needs to be devised to control the unregulated and readily availability of pesticides to everyone.

Reduction and possibly elimination of destructive fishing methods would be possible through stronger enforcement not only by the law but also through the village chief council. This could mean giving more authority to the village council.

The Vaiusu Bay supports some very important fisheries not only for fin fish but also bivalves and mollusks. Unfortunately, the bay harbours, effluents from industries, commercial lagoon sand extraction (dredgings) for construction and the urban solid garbage disposal (on mangroves). Steps should be taken to ensure minimization of pollution from the effluents, probably, through effluent treatment. Alternative dredging and garbage disposal sites, need to be located in less productive areas so as to relieve the pressure on the mangrove and lagoon resources in the Bay. Likewise, any reclamation or commercial activity affecting mangroves or reefs should be discouraged.

Although the Agriculture Forests and Fisheries Ordinance 1959 provided in the past in particular, that one of the principal functions of the Department is to provide the conservation, production and development of the natural resources", undertakings under these headings have not been considered in good proportion. Various other Acts and mentions of environmental plans in Development Plans, seem to indicate concern over the environment. However environmental considerations are not integral to the economic effort here. Perhaps, one of the major issues as far as the environment is concerned, has been the absence of a single authority to implement management measures. On the coastal zone, e.g. there has been an overlapping of responsibilities and conflicting jurisdiction among government departments. This brings in the problem of conflict of interests. It is fortunate that an Environmental Sector has been established within the Lands and Natural Resources Department and hopefully it will minimize departmental overlapping. However, whether this Unit gets the support it deserves is still another question. Economic reasoning should not blind policy makers on the issues of maintenance of the environment and the sustainable uses of the resources.

Due to the very nature of the islands, small, the ecosystems are closely interrelated. Thus disturbances in one, would potentially affect the others. This has become very apparent especially where activities on the land is concerned. Land clearing and extensive logging accelerate soil erosion and surface run-off which enter river systems and pollute drinking water. Eventually silt would reach the marine environment and causes pollution there.

Morrison (1983) raised concern for ecosystems in the South Pacific. He noted that in terms of the ability to sustain human life, South Pacific ecosystems are FRAGILE by the very nature of the region. We are dealing with large number of SMALL ISLAND SYSTEMS SEPARATED BY CONSIDERABLE EXPANSES OF OCEAN.

"In large continental countries, if one ecosystem or part of an ecosystem is damaged by either human or natural activities, others can be called upon to fill the gap until recovered. This "fall-back" option is simply unavailable in many Pacific countries".