

# Country Report for UNCED

## Tuvalu

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National Reports to the United Nations Conference on Environment and Development (UNCED) were prepared under the direction of the National Task Forces in 12 Pacific island countries with the financial and technical assistance of the Asian Development Bank and United Nations Development Programme. This assistance was coordinated by Gerald Miles through the South Pacific Regional Environment Programme (SPREP). For Tuvalu, this report was drafted by Tausasa Taalaki, Ventabo Neemia and Randy Tharman, and endorsed by their government for presentation to the United Nations.

June 1992

South Pacific Regional Environment Programme (SPREP)  
Apia, Western Samoa

## FOREWORD

There is increasing global, regional, national and local recognition that environmental degradation and associated human ecological problems, in their various forms (e.g., deforestation, soil erosion, pollution, waste disposal, global warming, overexploitation of marine resources, loss of biodiversity, overpopulation, poverty and malnutrition), are among the major constraints to sustainable development. Because of this recognition, on 22 December 1989, the 44th Session of the United Nations General Assembly adopted a resolution to convene a two-week United Nations Conference on Environment and Development (UNCED) or "Earth Summit" to coincide with both the twentieth anniversary of the United Nations Conference on the Human Environment held in Stockholm, Sweden in 1972 and with World Environment Day, 5 June 1992. The General Assembly accepted the offer of the Government of Brazil to host the conference in Rio de Janeiro in June 1992.

The purpose of UNCED is to set the international agenda and priorities for the implementation of environmentally sound and sustainable development. Because of the importance and the scope of the decisions to be taken at UNCED, the General Assembly also established, by the same resolution, a Preparatory Committee (PrepCom), open to all member States at the Heads of State or Government level, to prepare for the conference. The UNCED, the "Earth Summit", is expected to be the largest summit-level conference ever held.

At the Intergovernmental Meeting of the South Pacific Regional Environment Programme (SPREP) held in Noumea from 24 to 28 1990, the 27 member countries reached a strong consensus on the critical importance of UNCED to the Pacific Islands, particularly since no Pacific Island states were represented at the 1972 Stockholm Conference. In order to ensure that the priorities and concerns of Pacific Island Developing Countries (PIDCs), in relation to the promotion of sustainable development, are clearly represented in Brazil and incorporated into a global strategy for sustainable development, SPREP, with funding from the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP), is coordinating, in cooperation with National Task Forces, the preparation of National Reports by PIDCs for presentation at UNCED.

The following is the Report for Tuvalu for submission to UNCED. It is based on a review of the available literature and documents and consultations with governmental officials, public servants, aid agencies, NGO representatives, community leaders and other persons with relevant knowledge. Particular thanks is given to SPREP, ADB and UNDP for their support in producing the report, those persons who contributed their time and expertise, the the National Task Force for its work in reviewing and strengthening the report, and in particular the Consultants, Uentabo Neemia and Professor Randy Thaman of the Institute of Pacific Studies and the Geography Department of the School of Social and Economic Development of The University of the South Pacific, respectively, for their



assistance in producing the Report. Because of the breadth of information required to adequately assess constraints and opportunities for sustainable development in Tuvalu, the report is necessarily general in its coverage, although detailed information in Appendices and a Bibliography of relevant sources are provided. It is hoped that the report accurately expresses the diverse concerns of the government and people of Tuvalu in relation to their shared commitment to environmentally and culturally sustainable development in the atoll environment.

Through this National Report, the Government and people of Tuvalu express their strongest support for the principles and objectives of the United Nations Conference on Environment and Development (UNCED) and the promotion of environmentally and culturally sustainable development, globally, regionally and in the atoll country of Tuvalu. Through this Report we also express our hopes that the deliberations of UNCED will be fruitful and will foster a return to more sustainable lifestyles that will ensure that future generations will be able to live out of the some resources that we currently have at our disposal.

Tuvalu mo te Atua

The Honourable Bikenbeu Paenui, KMGC  
President of Tuvalu and Head UNCED  
Task Force  
Vaiaku, Funafuti, Tuvalu  
January 1992

176°E

178°

180°

Nanumea

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# Tuvalu

• Niutao

• Nanumanga

• Nui

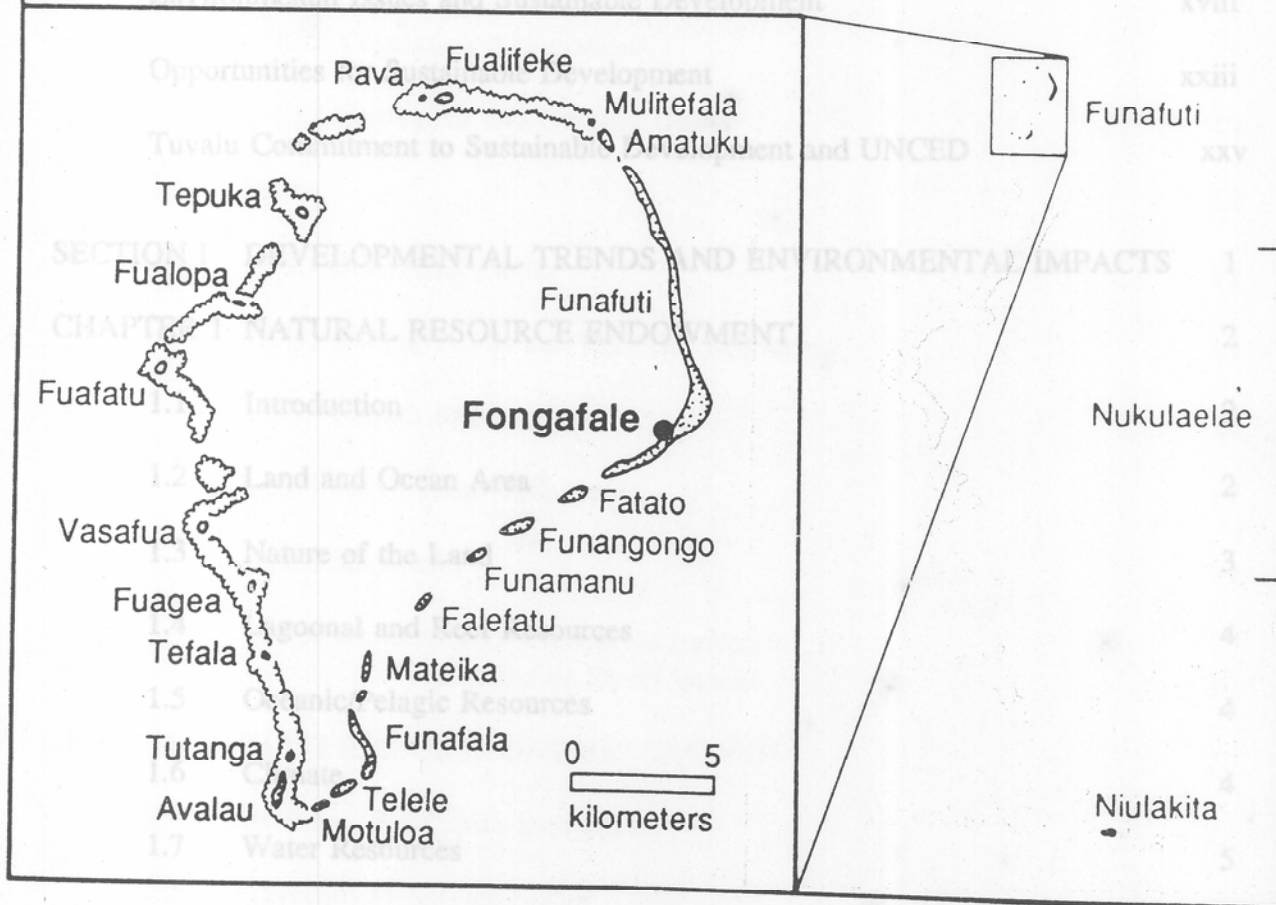
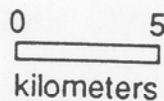
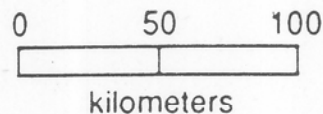
• Vaitupu

• Nukufetau

Funafuti

Nukulaelae

Niulakita



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**LIST OF ABBREVIATIONS**

ADB	Asian Development Bank
AIDAB	Australian International Development Assistance Bureau
EEC	European Community
EEZ	Exclusive (Extended) (200-mile) Economic Zone
ENSO	El Nino (Ninyo) Southern Oscillation
ESCAP	Economic and Social Commission for Asia and the Pacific
FFA	Forum Fisheries Agency
FSP	Foundation for the Peoples of the South Pacific
NDP	National Development Plan
NGO	Non-Governmental Organisation
NOAA	US National Oceanic and Atmospheric Administration
PEDP	UNDP Pacific Energy Development Programme
PIDC	Pacific Island Developing Countries
SOPAC	South Pacific Applied Geoscience Commission
SPACHEE	South Pacific Action Committee for Human Ecology and the Environment
SPC	South Pacific Commission
SPREP	South Pacific Regional Environment Programme
TOGA	Tropical Oceanic Global Atmosphere Programme
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNICEF	United Nations Childrens Fund
USAID	United States Aid in Development
USP	University of the South Pacific

## EXECUTIVE SUMMARY

### COMMITMENT TO SUSTAINABLE DEVELOPMENT

Tuvalu is comprised, almost entirely, of extremely small low-lying atolls rising only a few metres above sea level. Because of the fragility of its ecosystems, the scarcity of its terrestrial resources and the vulnerability of the environment and subsistence and commercial economy to the forces of external development beyond its control, environmental planning, management, protection and the promotion of sustainable development are of utmost importance.

Consequently, despite the absence of a comprehensive environmental protection plan, the Government of Tuvalu has accorded environmental protection and management a very high priority. In a May 1991 "Speech from the Throne" (a tradition within the Commonwealth whereby the Head of State addresses Parliament), the Governor General of Tuvalu, Sir Toaripi Lauti, stressed:

. . . given the vulnerability of Tuvalu to the hazards of environmental degradation especially with regard to global warming and the sea level rise and interference in the natural ecology of life in the sea, my government has now placed this sector as one of its priorities. Accordingly, my government has adopted a two-tier strategy, firstly to use all international fora to publicise its views on the dangers of environmental degradation and to seek the assistance of its development partners . . . in monitoring domestic activities and minimising the adverse effects of growth and development on the environment. . . The vital requirement to safeguard the natural environment while improving the economic productivity of the nation's resources implies that environmental considerations should be more effectively integrated into the development and planning process.

The Prime Minister, The Honourable Bikenibeu Paeniu, also strongly reiterates, in most of his important speeches, Tuvalu's priority concern for the promotion of environmentally sustainable development and stresses the unwavering record of Tuvalu in supporting SPREP and regional and international initiatives in this direction.

### GEOGRAPHY

Tuvalu's nine islands, which extend over 560 km from north to south, have a land area of a mere 25.9 sq km, and an estimated population of 9,250. Funafuti, the capital

island, has an area of only 2.8 sq km, one third of which is taken up by the airstrip and borrow-pits which were excavated to obtain fill for the airstrip, both 'relics' of World War II. About 3,000 people or 32 per cent of the total population live on Funafuti.

Five of the islands (Nanumea, Nui, Nukufetau, Funafuti and Nukulaelae) are atolls with central lagoons and encircling barrier reefs and reef islets. The other four (Nanumanga, Niutao, Vaitupu and Niulakita) are raised limestone reef islands with encircling fringing reefs. All the atolls and limestone islands have some fringing reef and reef slope resources. These are of critical importance for subsistence and also support some commercial fishing. The pelagic tuna resources of the EEZ are a major source of foreign exchange.

Island elevation rarely exceeds three metres above mean sea level, with most land at or close to sea-level. Tuvalu is, thus, exceptionally vulnerable to high spring tides, storm surge, seismic sea waves and the projected sea level rise resulting from global warming.

Some atolls have passages into the central lagoons which provide secure anchorage for vessels. Others have no passages or offer few safe anchorages. The only airfield is on Funafuti.

Lying within the Tradewind belt, Tuvalu has an average rainfall varying from 2000 mm for the drier islands to the north, to 3000 mm for the wetter southern islands. Prolonged droughts occur occasionally. Frequent high winds and rough seas seriously limit fishing efforts throughout the group. Although Tuvalu was previously thought to lie outside the "hurricane belt", it experienced widespread destruction and loss of life from Tropical Cyclone Bebe which hit Funafuti in October 1972, and formed an extensive rubble rampart 18 kilometres long. There are also records of an even larger rampart formed by a more powerful tropical cyclone which hit the island in 1894. Recent shifts in weather patterns over a large part of the Pacific, in the forms of increased incidence of tropical cyclones and increased rainfall in some areas and prolonged drought in others, have been associated with the occurrence of El Nino (pronounced Ninyo) Southern Oscillation (ENSO) conditions and associated increasing atmospheric instability over the central equatorial Pacific due to cyclical warming of the eastern Pacific Ocean. ENSO conditions seem to have intensified in recent years, thus possibly reinforcing the potential negative impacts of projected sea level rise due to Global Warming.

## NATURAL RESOURCES AND PRODUCTION SYSTEMS

The natural resources of Tuvalu are either extremely limited, in the case of terrestrial, lagoonal and near-shore resources, or vast and difficult to utilise in the case of its oceanic marine resources within its extended exclusive economic zone (EEZ).

**Water:** Apart from a number of landlocked brackish saltwater lagoons, such as that on Niutao, and salt pools, there are no surface freshwater resources in Tuvalu. The only permanent freshwater resources are groundwater in the form of "lenses" of often slightly brackish freshwater, hydrostatically "floating" on the higher density saltwater beneath the

islands. The lenses are replenished only by rainfall, and in times of drought water shortage is a serious health problem and constraint to development.

**Soils:** The limited soil resources of Tuvalu are among the most infertile in the world. Derived from coral limestone, atoll soils are shallow, alkaline, coarse textured and lack most nutrients required for plant growth. Water-holding capacity is very low, and plant nutrition is highly dependent on the humus cycle and the maintenance of the vegetation cover with a radical decrease in the relatively high organic levels of undisturbed soils following vegetation removal or fire.

**Minerals:** There are no known minerals of economic potential, and the potential for finding commercially significant polymetallic manganese and cobalt rich crusts, as in Marshall Islands and Cook Islands, is small. Sand, gravel, limestone rock aggregate and reef coral are also limited, and their exploitation has been increasing for infrastructural development (e.g., seawalls and buildings). These materials are often obtained at considerable environmental cost to limited land resources and to productive reef areas; negative impacts could be minimised by more careful selection of extraction areas. The 1972 "Hurricane Bebe" deposit is currently being used for this purpose.

**Flora and Fauna:** Tuvalu's indigenous terrestrial flora and fauna are among the poorest on earth. This is compounded by serious degradation due to long settlement, the promotion of coconut monoculture and, in the case of Funafuti, urbanisation and wartime degradation by the Allied Forces. Of an estimated less than 200 plant species, a maximum of 50 may be indigenous. None is endemic, and up to 50 per cent are endangered or severely restricted in distribution. The natural vegetation associations are limited to coastal strand vegetation; limited mangroves and coastal marshes; and relict inland woodland or forest.

The main indigenous land animals are birds, land crabs and insects. There are no indigenous land mammals. Except for a few introduced species, the bird life is comprised almost entirely of sea birds or migratory species for which Tuvalu serves as an avifauna flyway. The 28 indigenous species reportedly present in Tuvalu belong to only ten families. Insects constitute the majority of the animals found in Tuvalu, although the diversity is poor with only 22 species of butterflies, for example, compared with 12,000 in Australia. Tuvalu is relatively free of insect pests, and the Papuana taro beetle which seriously affects banana and taro production in areas of Kiribati, has not been found in Tuvalu.

**Marine Resources:** In terms of marine fauna, Tuvalu is not as impoverished, with an estimated 300 to 400 species of finfish. Other marine life of importance includes turtles, crabs, prawns, lobsters and other crustacea, shellfish (both bivalves and gastropods) and holothurians. Fish and fishing are central to life in Tuvalu with fish constituting the main dietary protein source. Marine resources also represent the sole opportunity for substantial economic development. Tuvalu's EEZ is large (1.3 million sq km) and difficult to fully utilise given existing financial, infrastructural and technological capabilities. Reef and lagoon resources, especially on Funafuti, are heavily exploited, with most commercial potential lying with pelagic and deepwater species.

There are nesting areas on some islets and sandbanks for both the hawksbill and green turtles, although turtles are generally scarce. Both species are hunted for food and the shell used in handicrafts; turtle eggs are eaten as a delicacy. The lobster resource is considered to have commercial importance for airfreighting to nearby Pacific Island tourist destinations. The most important shellfish in the diet are spider conch (Lambis trochata) and giant clams (Tridacna spp.), while a large range of shells are prized by collectors and for local handicraft production. There is increasing pressure on marine resources, both locally, and, in the case of giant clams and sea turtles, from foreign poachers to supply Asian markets.

Seaslugs (holothurians), one of the first export products following European contact, still offer potential for commercial development, although this is limited by the small localised habitats of the more valuable species (in the deep water passages of the reef). The culture of eucheuma seaweed (Eucheuma cottonii) is in the experimental stage and considered to have export promise.

Industrial fishing makes a major contribution to the national economy through licensing fees from foreign fishing vessels and the periodic operation of the Tuvaluan fishing vessel, 'Te Tautai'. Small scale commercial fishing is an increasingly important source of cash income. Offshore seamounts are known to have significant deepsea snapper resources but these are often difficult to fish because of strong currents, rough seas and absence of airlinks to markets.

**Agriculture and Subsistence Production:** Despite limitations of soil and water, Tuvaluans have developed a sophisticated subsistence agroforestry system based of coconut, bananas, breadfruit and pandanus. Other food plants include sweet potato, cassava, pumpkin, limes, papaya, bush hibiscus spinach (Hibiscus manihot), sugarcane and a range of cabbages, pulses and cucurbits. Of particular importance is the ceremonial staple, giant swamp taro or pulaka (Cyrtosperma chamissonis) which is cultivated using an intensive pit cultivation and mulching system. However, due to increasing salinity and the declining importance of pulaka (primarily because of cash employment and consumption of imported foods) a large proportion of the pits on some islands have been abandoned. There are currently a number of projects encouraging the cultivation of short-term vegetables and appropriate food trees and to promote increased production of pigs and poultry to widen the local nutritional base, especially in rapidly urbanising Funafuti.

Commercial export cropping is restricted to the coconut palm for the production of copra, the world price of which continues to fall relative to the cost of imported goods. Whereas 15 years ago a tonne of copra bought Tuvalu 100 barrels of oil, it now buys only 10, a reality imposed on Tuvalu and other developing countries by the unchanging nature of world trade relationships. Despite decades of coconut replanting and rehabilitation programmes to replace senile palms and to expand plantations, copra production continues to fall.

There is virtually no forestry activity, although there is considerable interest in mounting appropriate coastal reforestation and agroforestry programmes, both for their economic and cultural value and their role in ameliorating the potential impact of global warming and sea level rise.



A particularly important role of the agricultural system is the production of a wide range of other useful products such as medicines, beverages, animal feed, fuelwood, fertiliser, tools, fishing equipment, handicrafts, construction materials, canoes, fencing, fibre and cordage, dyes, oils, perfumes, body ornamentation and toys, the value of which, when added to the value of subsistence fishing, is estimated to constitute between 20 to 80 per cent of the real incomes of Tuvalu's rural, outer island communities. The protection of this time-tested subsistence production system is seen as a priority because of the limited opportunities for cash income in rural areas, and because the replacement of these products with imported substitutes would either be impossible or extremely expensive and subject to the same deterioration in terms of trade and inflationary pressures affecting all imports.

## DEMOGRAPHIC TRENDS

Ethnically, Tuvaluans are Polynesians who are believed to have inhabited the islands for 2,000 years or more. There has been some Micronesian influence due to long contact with Kiribati. Population densities are high; averaging 368 per sq km nationally and 1070 per sq km for Funafuti. The annual growth rate is estimated at 3.2 per cent. Infant mortality is 43 per 1000 live births and the average life expectancy at birth is 59 years.

There are no reliable data on internal migration or emigration. But it is known that until the early 1970s the population of the outer islands of Tuvalu remained almost static indicating the rate of migration was about equal to the rate of natural increase (about 1.8 per cent). This was mainly to Funafuti, although a number of contract workers emigrated to the phosphate mines of Banaba and Nauru. Currently there are about 1,000 Tuvaluans working in Nauru, a number in Kiribati and several hundred merchant seamen working overseas on foreign vessels. When mining ceased on Banaba in 1979, many Tuvaluans returned home. Mining is likely to stop on Nauru near the turn of the century with most Tuvaluans working there expected to return home. This will place further pressure on the already strained resources, and at the same time eliminate a source of remittance income.

## ECONOMIC PROFILE

Tuvalu's economy is highly constrained by its tiny size, narrow resource base, very small population, the dispersed nature of its islands, and its isolation from markets. It is highly vulnerable to external market forces beyond its control. Yet, despite international economic downturns in 1982/3 and 1985/6, GDP increased by an average 5.2 per cent per year over the period 1981-85, and was estimated at A\$7.59 million in 1989 (at current market prices), or A\$870 per capita.

Bureaucracy, aid, social services and remittances play the dominant economic roles. Government services is the largest sector of the Tuvalu economy accounting in 1989 for 34.7 per cent of the total economic output. Over the period 1981-86 it grew at a rate of 25 per cent, slightly faster than the economy as a whole. This growth was financed substantially by increased foreign aid. Since 1986, whilst still the dominant sector in the



economy, the contribution of this sector has declined noticeably in percentage terms. It is important to note, however, that other major sectors (e.g., electricity, transport and communications, as well as a large proportion of other items in GDP) derive wholly or to a large extent from Government or Government agencies.

The dominance of the Government sector in the economy is also evident in the proportion of GDP accounted for by Government recurrent expenditure, which in 1989 was 66 per cent.

Government recurrent expenditure in 1989 was A\$5.5 million. Development expenditure derives almost wholly from official aid flows. Total development expenditure in 1990 was A\$5.023 million, of which A\$1.579 million (31.4 per cent) was absorbed by the Productive sector. Fisheries development dominated spending in this sector in 1990 accounting for 23.8 per cent of the total development expenditure. The other major subsector within the Productive sector is Agriculture which had a share of a mere 2.7 per cent of the total development spending. It should be noted that agriculture and fisheries (which are the main productive sectors) together accounted for only 10% of national income in cash terms. However, as stressed before, subsistence agriculture and forestry probably account for a high as 80% of real rural incomes (cash plus non-cash) in rural, outer-island areas.

Only 2 per cent of the total development expenditure related to environmental management over 1981-87. But it should be noted that expenditure in 1987 was 79 per cent greater than that in 1981, reflecting an increase in the importance attached to the environment by government.

It is evident that a high degree of aid dependency has been a feature of the economy. Tuvalu has the highest per capita aid of any Pacific Island nation (A\$1777 and A\$850 per capita in 1988 and 1989 respectively), with 15 donors in 1990. Over 50 per cent of aid over 1981-87 was committed to capital infrastructure projects, which has led to heavy recurrent costs in the Tuvalu budget.

The Tuvalu Government derives revenue from direct taxes, customs duties, philatelic sales and licensing fees for foreign fishing vessels. These sources supplied some 80 per cent of the recurrent budget in 1990 with some topping-up from external grants.

The Government has sought to diversify its sources of recurrent revenue and in 1987 established the Tuvalu Trust Fund which serves as a capital resource, the income being used for recurrent expenditure. The Fund has grown from A\$27.7 million on 30 September 1987 to A\$41.6 million on 30 September 1991, a return of 11.8 per cent per year for four years.

The sale of postage stamps is the main export. Copra, fish, and handicrafts, the only primary exports of note, are of minor importance. Copra exports, once the mainstay of the rural economy, were valued at only A\$73,400 in 1989.

Although the trade deficit in 1989 was estimated to be A\$4,859,000, this was more than offset by current transfers in the forms of aid and remittances amounting to

A\$6,742,000. However, the long-term economic situation in Tuvalu remains fragile and highly vulnerable to often unpredictable aid transfers, overseas labour markets and the strength of the world economy over which Tuvalu has little control.

## **ENVIRONMENTAL ISSUES AND SUSTAINABLE DEVELOPMENT**

The major constraints to sustainable development in Tuvalu are its limited resource base and the susceptibility of atoll environments and societies to external disruption and degradation, much of which is beyond our control. Current development models do not seem to be sustainable even in the resource-rich continental environments they were designed for, let alone in the atoll environment.

There are two main sets of environmental issues which constrain sustainable development in Tuvalu. One set, which will require assistance from the international community, includes: the threat of possible inundation from sea-level rise resulting from global warming; dangers associated with nuclear pollution and the disposal of hazardous waste by industrial nations in the shared oceanic environment; and the management and protection of Tuvalu's extensive EEZ. The second set concerns the high population density and growth rate, particularly on Funafuti, and its adverse impact on scarce terrestrial and marine resources and the environment. To address these constraints will require strengthening of national infrastructural, legal and educational capabilities in the area of environmental protection and management, as well as continued support of international initiatives to evolve less polluting and more sustainable models for development both in the Pacific region and globally.

### **Global Warming and Sea-level Rise**

There is grave concern that the atolls of Tuvalu will become uninhabitable as a result of global warming and associated sea level rise. This has caused serious concern at all levels in the community, and threatens the very existence of atoll societies. There is uncertainty as to the amount and rate of sea level rise; but a cautious 'best guess' projects sea-level rise to be 20 cm by the year 2030 and 30 to 100 cm by the end of the next century. Although evidence from El Nino phenomena shows that the sea-level near Tuvalu has risen from time to time as much as 40 cm higher than its current average level, the question now is whether Tuvalu could cope with a similar El Nino rise superimposed on higher average levels associated with global warming.

While issues of climatic change should not be overdramatised, it is clear that the likelihood of sea-level rise must be given priority consideration in planning for sustainable development in Tuvalu. Even if protective coral reefs continue to grow upwards at a rate greater than that of rising sea levels, the coastline will become more prone to tsunamis, storm surge and erosion; freshwater resources and agricultural and subsistence production systems will be subject to increased saltwater incursion and seaspray; engineering structures will be threatened; and the construction of new infrastructure near the shore subject to greater risk.

Tuvalu, thus, views the problem of Global Warming (Climate Change) and associated sea level rise with grave concern and believes there is great urgency to address the problem immediately. Tuvalu is actively involved in global efforts to monitor climatic change and rising sea levels, and will also participate in the South Pacific Forum network of sea-level monitoring stations.

**Nuclear Pollution and Hazardous Waste Disposal:** Of particular concern is the long term impact of nuclear weapons testing and nuclear pollution on the peoples of Tuvalu and other Pacific peoples, their island environments, and on the shared oceanic environment. As shown by experiences in the neighbouring Marshall Islands, even very low levels of nuclear radioactivity resulting from past and present nuclear testing constitute a severe long-term health hazard and obstacle to habitation of our islands. There is similar concern over the negative impacts of the disposal of hazardous and military wastes in neighbouring island groups and in the oceanic environment, and the inability of Pacific nations to control such actions.

**The EEZ:** Tuvalu is almost wholly dependent on its ability to sustainably exploit its extensive EEZ and reef-slope or island platform fishery if it is to increase its economic self-reliance. The constraints to expanding national commercial fishing activity are primarily those of infrastructure, both at sea and onshore, but also inappropriate fishing methods (e.g., pole and line tuna operations with a shortage of baitfish), and seasonally rough seas. Of particular importance for taking advantage of the more lucrative markets in Hawaii and Japan for sashimi and deep-water snapper is the lack of dependable air transport capacity.

**Coastal erosion:** All islands except Niutao have urgent coastal erosion problems with rates of loss up to an average of one metre per year. There is evidence that the blasting of reef passages or boat channels has accelerated erosion in some areas. In response, the Government has mounted a thus far unsuccessful coastal protection programme involving the use of 300 cm x 300 cm cement blocks which have been displaced by waves as small as one metre. Inadequate supply of local fill materials, the high cost of imported cement and other materials, and the lack of equipment needed to transport and emplace larger, more effective blocks are major constraints to programme success.

**Population Growth and Urbanisation Impact:** High population densities and rapid urbanisation, particularly in overcrowded Funafuti have led to problems of: (a) landlessness, competition for land and the appearance of shanty settlements; (b) overfishing of reefs and lagoons; (c) deforestation and overexploitation of terrestrial resources; (d) breakdown of traditional food and subsistence production systems and knowledge, and associated problems of increasing economic dependency and incidence of malnutrition and nutrition-related non-communicable diseases such as heart disease, stroke and diabetes; (e) water scarcity and groundwater depletion and pollution; (f) sewage and waste disposal; and (g) increasing energy dependency.

**Landlessness:** Landlessness is a major issue in Tuvalu, especially on Funafuti. Immigrant groups from the outer islands are particularly disadvantaged; their presence has led to high-density, shanty settlements on Fogafale islet. Urgent attention to culturally

acceptable birth control measures is needed if the consequences of the likely return of many Tuvaluans from Nauru (when the phosphate mines close within the next decade) is to be allayed.

**Land reclamation:** With the rapidly increasing population and chronic land shortage, the reclamation of the 52 ha of degraded land in the form of 'borrow-pits' excavated by US troops in World War II in the construction of airstrips on Fogafale, the main islet of Funafuti, is a priority. The identification of environmentally less damaging sources of suitable sand and aggregate fill for the borrow pits is a particular problem, but land tenure problems also exist. A SOPAC pilot study reclaiming 2500 to 5000 square metres of borrow pits, using a specially designed dredge, will commence in 1991 to assess the feasibility of reclamation in terms of the availability and suitability of fill materials dredged from the lagoon.

**Fisheries Overexploitation:** Over-exploitation of in-shore fisheries stocks and reef resources is most serious in Funafuti Lagoon and nearby offshore areas. Elsewhere, there is some evidence of overexploitation of giant clams, spider conch or kalea (Lambis trochata) and a range of finfish species, although the impact on the outer islands is limited by the inadequacy of suitable storage and transport. These limitations are being actively addressed by the government, with external technical and financial support. As a result there is improved fish storage and marketing infrastructure and greater availability of fish from outer islands in Funafuti which could take pressure off stocks there.

**Deforestation and Overexploitation of Terrestrial Resources:** Overexploitation of terrestrial resources includes deforestation and the associated scarcity of many culturally and ecologically important plant species. Of major concern are the removal of mangroves for fuelwood and the endangerment of a wide range of native trees due to an overemphasis on the expansion of coconut monoculture and coastal deforestation. Such practices have led to increased coastal erosion and soil deterioration. Also of concern are the overexploitation of the bird's-nest fern or laukatafa (Asplenium nidus), a traditional delicacy, and of sea birds for human consumption, and the associated adverse effect that this has on the ability of fishermen to locate tuna schools.

**Breakdown of the Traditional Food and Subsistence Production System:** Infant malnutrition, iron-deficiency anaemia, obesity and nutrition-related non-communicable diseases, such as heart disease, stroke and diabetes, among adults are increasingly serious health problems in Tuvalu. The main causal factor is a shift from a traditional diet to a diet of imported foods which are high in sugar, salt, alcohol and animal fat, and low in vitamins, minerals and fibre. This shift is due in part to the breakdown in the traditional food system and a change to a sedentary lifestyle, particularly on Funafuti.

The breakdown in the traditional food and subsistence production system not only affects health, but also the provision of fuel, medicines, handicrafts and many other products. The loss of these products has made Tuvalu very dependent on expensive imported products at considerable expense in scarce foreign exchange, and is seen as a major constraint to sustainable development.

**Water and sanitation:** Many of reported health problems in Tuvalu stem from contamination of water supplies through poor disposal of human and animal wastes, and from inadequate supplies of water suitable for domestic purposes. Rainwater supplies most of the domestic needs and the Government initiated a water storage target in 1986 of 50 litres per head per day and required all new private and public buildings to have suitable rainwater catchment and storage facilities. Government controlled storage is to be increased, in the long term, to 11 million litres and private household storage to 28 million litres. A United Nations Water Project is currently improving household and community water catchment and storage systems in Funafuti and the drier northern and central islands.

Because of the susceptibility of groundwater to pollution, and the limited area of land, waste disposal is a considerable problem. There are no controlled sewerage systems or treatment plants in Tuvalu. Liquid wastes and sewage are dumped at sea by two sludge tankers or disposed in soakways, septic tanks or pit latrines.

**Solid waste disposal:** Solid waste disposal is a major problem given the susceptibility of groundwater and marine resources to pollution and increasing pressure from metropolitan powers to dispose of hazardous waste in atoll and oceanic environments. There is extremely limited land available for landfill sites; a lack of disposal facilities for hazardous waste; increasing dependence on imported non-biodegradable products and packaging; a lack of information on the nature and origin of waste and its environmental impacts; and a lack of legislation controlling toxic and non-biodegradable waste. Inability to stop use of neighbouring islands and oceanic areas as waste disposal/reduction sites (e.g. Johnston Is. for JICADS) is also a major concern. Tuvalu has a "Can Care" project to collect aluminium cans for local compaction and shipping to Australia for recycling.

**Energy Dependency:** Tuvalu is entirely dependant on imported diesel fuel for electricity generation, and motor vehicle and marine vessel fuels are imported at very high cost to the country. However, the use of solar power, particularly solar lighting has been promoted through the Tuvalu Solar Electric Co-operative Society Ltd, established in 1984 and successfully established on each of the eight outer islands. However, kerosene or benzene pressure lamps still provide lighting for most households and for night fishing in rural areas. Solar photovoltaics now also power the inter-island telecommunications system, and solar-powered refrigerators are also being introduced for outer island health clinics.

In terms of non-commercial energy, fuelwood is used for 90 per cent of cooking in the outer islands and also by most families on Funafuti. Increasing population and the high cost of kerosene and fuelwood substitutes have led to overexploitation of fuelwood, particularly mangroves (an important pig feed) and an increasing dependence on nutritionally inferior processed foods which require no cooking.

**Legislation:** Tuvalu does not have comprehensive national environmental legislation. However, there are a number of sectorally related acts and orders which provide regulations for land and land management; coastal management and reclamation; water, sanitation and environmental health and hazardous substances; the protection of sea birds and turtles; and the establishment of wildlife reserves. Although there is a need for



strengthening and updating, there is considerable scope under existing legislation for initiatives which would support sustainable development and conservation interests. Umbrella environmental legislation would, however, be beneficial, particularly with the inclusion of a provision for mandatory EIA procedure.

**Institutional:** Currently, each Ministry deals with environmental issues falling within its own area of responsibility. There is no single body with responsibility for environmental protection and management. An attempt is now being made to initiate such co-ordination through the Office of the Prime Minister and the National Planning Coordinating Committee. However, even within that Office, the spread of responsibilities of existing staff across a range of issues other than environmental, necessitates the creation of an environmental unit as a planning and co-ordinating body with multi-sectoral environmental responsibilities. The operations of this unit could be strengthened by the extension of the inter-ministerial co-ordinating body, the National Planning Coordinating Committee, to become the environmental unit's advisory committee.

## OPPORTUNITIES FOR SUSTAINABLE DEVELOPMENT

The main issues, constraints and opportunities for sustainable development have been tabulated in Appendix V.

The prospect of a significant rise in sea level is the area of greatest long-term concern to Tuvaluans, threatening as it may the very existence of Tuvalu. Other areas of immediate concern for sustainable economic development are the marine resources development and management, especially offshore pelagic resources and nearshore reef-slope and island platform fisheries resources. The pelagic and deep ocean fishery is underutilised despite many years of exploitation by foreign fishing interests. Tuvalu has only one fishing vessel of its own (pole and line) but a severe shortage of baitfish and periodically rough waters limit its utility in Tuvalu waters. There is also scope for permitting further fishing by foreign vessels, provided that suitable licensing arrangements are made and substantial fees paid. The resources of prawns, deep-snapper and other demersal species of the reef-slope and island platform fishery are also open to far greater utilisation. Ensuring that the resource is exploited fully but sustainably requires close monitoring and continued surveillance of all fishing activities. For this, Tuvalu must continue to rely on the Forum Secretariat, SPREP, FFA, SPC and other regional agencies.

On shore, the over-riding concern will continue to be issues arising from overpopulation and the impact of urbanisation on limited terrestrial and near-shore fisheries resources, particularly on Funafuti. Related to this is the accelerating breakdown of the traditional subsistence production system which has, for hundreds of generations, given Tuvalu's people resilience and protection against natural and economic factors beyond their control.

The promotion of culturally acceptable birth control measures is of highest priority, followed closely by the need for water supply and waste disposal improvement and the promotion of local food production and consumption to address serious environmental-health and nutrition-related health problems. Greater emphasis on tertiary education to

better prepare Tuvaluans for well-paid employment both at home and overseas is needed and would complement the resettlement programme in terms of relieving pressures on Funafuti.

Given the problems of saltwater intrusion, depletion and pollution, further tapping of the underground lenses for domestic water supply has limited potential. Most household water needs can be met by improving rainwater-catchment systems, and restricting the pumping of groundwater to periods of very special community need, such as extended drought.

Government emphasis on sustainable production systems will move away from coconut palm monoculture for copra production (for which there is a very depressed world market price) and towards more traditional agroforestry systems which incorporate a range of tree crops, long- and short-term ground crops and other plants of economic, cultural and ecological importance. The promotion of appropriate food and fuel species, particularly on Funafuti is of high priority.

Such developments will require a balance between international initiatives to address concerns of more global concern such as climate change and sea level rise and management of our EEZ resources, whereas other actions must take the form of local initiatives which can be implemented at the community level with little or no external financial or technical assistance. Others will require major funding and international co-operation.

Local initiatives would include:

1. Adoption of population birth control policies.
2. Active promotion of water conservation policies and encouragement of rainwater collection and desalination technologies.
3. Appropriate seawall construction, land reclamation and reforestation.
4. Development of institutional infrastructure and resources for environmental management such as an autonomous cross-sectoral environmental unit or council.
5. Drafting and appropriate strengthening of environmental legislation and regulations with the mandatory incorporation of EIA procedures in all development planning processes and project appraisal.
6. Adoption of a strategy for making training in environmental management a priority for manpower planning for all sectors.
7. Local media campaigns for educating the public on the importance of resource conservation and biodiversity preservation as a basis for sustainable development.



8. Establishing a system of conservation areas which takes into account both the nature of the resources and their importance for subsistence.

## **TUVALU'S COMMITMENT TO SUSTAINABLE DEVELOPMENT AND UNCED**

Sustainable development in Tuvalu must be seen as a partnership between the people and Government of Tuvalu and international agencies which helps gain for our people the more appropriate technological and social benefits of modern urban industrial societies, while at the same time protecting, to the best of our ability, the social systems, knowledge and the terrestrial and marine resources that have allowed us to sustain atoll life in the past. The overall aim is to achieve the optimum balance between modern economic development and cash employment (including the maintenance or enhancement of the Tuvalu Trust Fund) and the protection of our traditional subsistence base so that future generations will have the same opportunities that we have had to be healthy and to realise a reasonably high standard of material and cultural wellbeing. Moreover, it is stressed that many of these initiatives, including international treaties and accords, collaborative research, strengthening national environmental management capabilities, and the restructuring of the world economic order and current development thinking, along lines which will foster environmentally sound and sustainable development will require a truly multidisciplinary, cross-cultural and international effort.

To this end, the Government and people of Tuvalu reaffirm our commitment to objectives of UNCED and other international initiatives designed to promote sustainability, environmental protection and the alleviation of poverty worldwide. Tuvalu firmly believes that the UNCED Earth Summit may be the singly most important initiative towards realising the goal of environmentally sound and sustainable development in the history of the human race. Tuvalu is thus honoured to participate in the UNCED deliberations, and through this document lends its full support to any resolutions that will enhance the chances for human kind, particularly the countries of the developing world, to address the environmental problems of our age for the benefit of future generations.

## **SECTION I**

### **DEVELOPMENTAL TRENDS AND ENVIRONMENTAL IMPACTS**

This section provides an overall picture of the potential for sustainable development in Tuvalu (formerly the Ellice Islands of the British Gilbert and Ellice Islands colony). It includes chapters on: 1) the natural resource endowment of the country; 2) patterns of economic development over the past two decades; 3) population and demographic trends; and 4) major environmental and cultural issues or constraints to sustainable development.

## CHAPTER 1

### DEVELOPMENTAL TRENDS AND ENVIRONMENTAL IMPACTS

This chapter provides an overall picture of the potential for sustainable development in the independent country of Tuvalu (formerly the Ellice Islands of the British Gilbert and Ellice Islands Colony) in terms of: 1) the geography and natural resource endowment of the country, 2) population and demographic trends, 3) the patterns of economic development over the past two decades, and 4) the major environmental issues in terms of the impact of modern development on the natural environment and the demographic structure and the economic and social consequences of these impacts.

#### 1 NATURAL RESOURCE ENDOWMENT

##### 1.1 Introduction

The natural resources of Tuvalu are either extremely limited, in the case of terrestrial, lagoonal and near-shore resources, or extremely vast and difficult to utilise in the case of its oceanic marine resources within its extended exclusive economic zone (EEZ). There is, consequently, a pressing need for improved development and management, on a long-term basis, of these resources to serve the commercial and subsistence needs of current and future generations of Tuvaluans. To do so most effectively, there is a need for practical developmental research on the living and non-living terrestrial and marine natural resources of Tuvalu. Such research might include: 1) generation of data on the extent, nature and current use or development and conservation status of its natural resources; 2) evaluation of current and potential development or management strategies (both traditional/local and modern/imported); and 3) assessment of the impact that different development or management alternatives might have on its resources or the management of these resources on a sustainable basis by the people of Tuvalu. Without such data, resource development, management and conservation is problematic.

This chapter attempts to summarise the current state of information on the non-living and living resources available to Tuvalu. The resources that will be covered include: 1) total land and ocean area, 2) nature of the land, 3) climate, 4) water resources, 5) soil resources, 6) mineral resources, 7) vegetation, 8) fauna, 9) fisheries resources and 10) traditional agricultural resources and land use systems. The analysis will include: 1) the economic and social uses of these resources, 2) their environmental significance, 3) the nature of their ownership, and, 4) rates of change.

##### 1.2 Land and Ocean Area

Tuvalu consists of only nine small islands with a total land area of only 25.9 km<sup>2</sup>. It is located between 5 and 10 deg. S. latitude and 176 and 179 deg. E. longitude, about 1100 km north of Suva, Fiji and about 250 km south of Kiribati. The islands are isolated

and fragmented, covering an ocean territory of some 1.3 million km<sup>2</sup> and extend over 560 km in a winding line from Nanumea in the north to Niulakita in the south. There is, thus, very limited land area, spread over a million km<sup>2</sup> of deep ocean.

The nine islands, from north to south, are Nanumea, Niutao, Nanumanga, Nui, Vaitupu, Nukufetau, Funafuti, Nukulaelae and Niulakita. Five (Nanumea, Nui, Nukufetau, Funafuti and Nukulaelae) are reportedly true atolls with central lagoons, with encircling islets of varying size and shape. Nanumanga, Niutao, Vaitupu and Niulakita are raised limestone reef islands or "table reefs" with no deep lagoons within an encircling barrier reef. Niulakita, with a maximum elevation of about 5 m, is slightly higher than the other islands in the group.

The sizes of individual islands range from Niulakita, which has an area of only 41 ha to Vaitupu with an area of 5.6 km<sup>2</sup>. The main and most populous island and administrative centre of the group, Funafuti, has an area of only 2.8 km<sup>2</sup>, of which one-third of the largest and easternmost islet, Fongafale, is unavailable for development due to the presence of the air strip and the highly-degraded "borrow pits" from which sand and aggregate was excavated to build the airstrip during the War.

### 1.3 Nature of the Land

In general, true atolls, such as Nanumea, Nui, Nukufetau, Funafuti and Nukulaelae, usually have an uplifted fringing limestone reef in the wave zone on the ocean side, which may be covered by a sandy beach. This runs up to a raised rampart or shingle ridge of boulders and coral fragments deposited during storms. This is commonly the highest portion of the island, or the individual islets that comprise the atoll, and no more than 4 m above mean sea level. Inland of the rampart and extending to the lagoon is an area of windblown sand. Toward the lagoon shore, the increasingly finer deposits are of lagoonal origin. Limestone outcrops with little or no soil and lowlying swampy areas are often found on islets.

Nanumea, in the north, has two main islets, Lakena and Nanumea, located 5 to 6 km apart. Nui is a 16 km long, crescent-shaped atoll running from north to south with two islets, one at the end of each horn. Nukufetau is an oval-shaped atoll with about 37 islets on its reef, which surrounds a large lagoon about 38 km in circumference. Funafuti is pear-shaped, and has about 30 reef islets surrounding a lagoon about 30 km long and 18 km wide. The islets on the eastern side form an almost continuous line, with many wide gaps on the west. Nukulaelae is an atoll with about 24 islets and a largely submerged reef on the western side.

The limestone or table reef islands generally consist of a single island, uplifted from 3 to 5 m above sea level, no barrier reef encircling a deep central lagoon, and often have saline lakes or lagoons in the lower central portions of the island. Nanumanga, a very small island, only 2.5 by 1.5 km, has three such lagoons, two small ones to the north and south, and the much larger Vaiatoa Lagoon, which measures about 400 by 600 m, in the centre. Niutao is roughly triangular in shape and little over 1.5 km at its widest part, and has a tiny lagoon, or brackish lake, in its centre. Vaitupu, Tuvalu's largest atoll, is pear-

shaped and about 5.5 km long and 3.25 km at its greatest width. It has two central lagoons and is completely surrounded by a fringing reef which is dry at low tide. The small reef island of Niulakita, has no lagoon, is about 5 km in circumference and slightly higher than the eight larger atolls, at about 5 m above sea level. The soils of Vaitupu and Niulakita are better than those in most of the group.

In terms of safe anchorages, the large lagoon of Nukufetau, which was once suggested as a base for amphibious aircraft, can be entered by ships through a channel on the western side. There are three entrances into Funafuti's large lagoon, all which require local knowledge. There is only one small passage into one of Vaitupu's lagoons, which is only navigable by small craft at high tide, and an anchorage in seven fathoms off the main village. There is a sheltered anchorage of the northwest end of Lakena on Nanumea. In 1979 the reef on Nui was blasted to widen the 122 m boat passage into the lagoon. There have also been attempts to clear the lagoon to create a safe anchorage and a landing site for amphibious aircraft. There is no entrance to the lagoon at Nukulaelae, and landing is difficult on Nanumanga. Niulakita, a reef islet, has no lagoon, and landing is difficult except by canoe.

#### **1.4 Lagoonal and Reef Resources**

Most of Tuvalu's islands have protected lagoons with significant sand and subsistence fisheries resources. Only Niulakita, a reef islet, has no lagoon. All islands have some fringing reef and reef slope resources, all of which are of critical subsistence importance, as well as being of limited, primarily local commercial importance, particularly in the case of the deep-water snapper resource. These will be discussed in detail below under fisheries resources.

#### **1.5 Oceanic/Pelagic Resources**

Tuvalu's EEZ of over 1.3 million km<sup>2</sup> has potential for pelagic fisheries development, and, to a lesser extent, for the harvesting of deepwater corals. There is also limited potential for mineral resource development in terms of the occurrence of polymetallic manganese nodules and cobalt-rich crusts, which will be covered below. In both cases, however, Tuvalu lacks the technology, capital, and, in some cases, the knowledge of the nature of these resources, and must depend on outside assistance to negotiate the most appropriate aid-funded, joint-venture or leasing arrangements to exploit these resources. These resources will be discussed in detail below under mineral resources and fisheries resources.

#### **1.6 Climate**

Climatically, Tuvalu is located in the southeast Tradewind belt, just south of the dry belt of the equatorial oceanic climate zone. It has mean daily temperatures ranging from 22 to 38°C in the shade, but usually varies between 26 and 32°C. Annual rainfall varies, both annually and between islands, with annual averages ranging from about 2000

mm for the drier islands such as Nanumanga and Niutao in the north to about 3000 mm for the wetter islands such as Funafuti and Nukulaelae in the south.

Prolonged droughts, are experienced occasionally, but not of the severity as those experienced in Kiribati, which periodically kill off breadfruit trees and severely limit coconut production. Although Tuvalu was previously thought to lie outside the "hurricane belt", it experienced widespread destruction from Tropical Cyclone Bebe which hit the island of Funafuti in October 1972. The cyclone killed six people, left 800 persons homeless, wrecked four ships, destroyed thousands of coconut trees and other subsistence crops, caused widespread coastal erosion, destroyed extensive areas of living coral, and formed a huge rubble rampart 18 kilometres long on Funafuti. Most recently, Funafuti has been affected by less destructive Cyclones Ofa and Val in February 1990 and December 1991 respectively.

Recent shifts in weather patterns over a large part of the Pacific, in the forms of increased incidence of tropical cyclones and increased rainfall in some areas and prolonged drought in others, have been associated with the occurrence the El Nino (pronounced Ninyo) Southern Oscillation (ENSO) conditions and associated increasing atmospheric instability over the central equatorial Pacific due to cyclical warming of the eastern Pacific Ocean. ENSO conditions seem to have intensified in recent years, thus possibly reinforcing the potential negative impacts of projected sea level rise due to Global Warming.

## 1.7 Water Resources

Apart from a number of landlocked brackish saltwater lagoons, such as that on Niutao, and salt pools, there are no surface freshwater resources in Tuvalu. The only permanent freshwater resource is groundwater in the form of a "lens" of often slightly brackish freshwater, hydrostatically "floating" on the higher density saltwater beneath the island. The height of the lens above sea level and the level of salinity vary in relation to the elevation, shape and width of islets and the amount of water use and rainfall. Replenishment or recharge of the lens is dependent on rainfall. In areas where the lens is close to the surface, pools are often found during excessively wet periods, especially during high tides. The location and degree of development of the groundwater resource influences the nature of the vegetation as well as the location of village wells and cultivation pits.

## 1.8 Soils

The atoll soils of Tuvalu are among the most infertile in the world. They are young, shallow, alkaline, coarse textured and have carbonatic mineralogy. Because of their immaturity, they are similar to the original coral-limestone parent material. They are composed of a variable layer of organic matter and coral sand and fragments overlaying a limestone platform. They range from 25 cm to 1 m or deeper, with some accumulation of clays and  $H_2S$  near the centre of islets near the water table. Potassium levels are often extremely low, and pH values of up to 8.2 to 8.9 and high  $CaCO_3$  levels make scarce trace



elements, particularly iron (Fe), manganese (Mn), copper (Cu) and zinc (Zn), unavailable to plants. Activity of soil micro-organisms is limited, soil water-holding capacity is very low because of coarse texture, and ground water is often saline. Fertility is, thus, highly dependent on organic matter for the concentration and recycling of plant nutrients to lower soil pH, and for soil water retention in the excessively well-drained soils. These factors together make conventional agriculture, as practiced on other larger Pacific islands, very problematic in Tuvalu.

Although levels of organic matter can be relatively high in undisturbed soils under natural vegetation, they can decrease dramatically as a result of clearance by fire or replacement by coconuts or other introduced plants.

Scattered throughout Tuvalu, are areas of phosphate-rich soils and phosphate deposits, which seem to have originated from guano deposits accumulated over long periods of time under Pisonia grandis groves, a favoured seabird rookery species. These soils are often more acidic and darker than the surrounding soils. The guano deposits on Niulakita were mined near the end of last century.

In some low-lying areas on the islets, there are poorly developed, but relatively fertile, wet soils. Vaitupu, the largest island in the group, has the most fertile soils, possibly related to a more well-developed freshwater lens.

## 1.9 Mineral Resources

The mineral resources of Tuvalu include: 1) sand, gravel and limestone rock aggregate; 2) guano deposits; and 3) undetermined, but probably economically insignificant unexploited concentrations of deep-sea-bed polymetallic manganese nodules and cobalt-rich crusts.

Although abundant, sand, gravel, limestone rock and coral for construction and reclamation purposes are often obtained at considerable environmental cost. In the case of sand mining, the excavation of sand from environmentally sensitive areas can lead to accelerated coastal erosion and losses of considerable areas of land. Nevertheless, if done in the most appropriate areas, the acquisition of these materials can be done with minimum impact, and in the case of excavating new pits for the cultivation of Cyrtosperma taro and other food and non-food plants, can have a beneficial impact on sustainable development. On Funafuti, where the demand for construction materials is greatest, the 1972 "Hurricane Bebe" deposit is currently being crushed for this purpose.

One possible source of sand for construction and reclamation, which is being explored for the purpose of filling the "borrow pits" on Tuvalu is through appropriate dredging of sand on the bottom of lagoons. SOPAC is currently planning a pilot dredging project to determine the feasibility and the environmental impact of lagoon dredging in Tuvalu.

Niulakita, and possibly other islands in Tuvalu, have deposits of fossilised sea-bird guano, usually formed under groves of Pisonia, a favoured sea-bird rookery and roosting



species. The deposits on Niulakita were mined in the late-1800s by foreign interests. Such deposits, where they exist, could provide sources of guano for local food production, and could, in the future be of considerable benefit for sustainable development.

There is reportedly only limited potential of finding polymetallic manganese nodules and cobalt-rich crusts of any economic importance in the EEZ of Tuvalu. Even the relatively extensive cobalt and polymetallic manganese deposits in Kiribati's EEZ area are not as extensive and economically attractive as the cobalt and polymetallic manganese deposits in the EEZs of the Marshall and Cook Islands, respectively. There is, however, a need for further investigation of sea-bed mineral resources, including the economic potential of deepwater corals in Tuvalu's EEZ, which are discussed below under fisheries resources.

### 1.10 Vegetation and Flora

The indigenous vegetation and flora of the atolls of Tuvalu are among the poorest on earth. Moreover, long settlement and monocultural expansion of coconut palms have led to serious degradation, disturbance, and displacement. Although little has been published on the vegetation and flora of Tuvalu, the summary here is based on reconnaissance studies by Hedley (1896) last century, studies of the vegetation of Nui Atoll and Tuvalu by Woodroffe (1985, 1991) and personal reconnaissance on Funafuti by the authors in 1991.

#### 1.10.1 Flora

It is estimated that the total flora of Tuvalu would consist of under 200 species of which a maximum of 50 could be possibly indigenous, and none of which are endemic; the balance is comprised of ornamentals, weedy exotics, food plants, and a limited number of other useful cultigens. Woodroffe (1985) found 83 species on Nui Atoll, of which about 45 were possibly indigenous. This compares with the flora of the main Gilberts group of Kiribati to the north of Tuvalu, which consists of approximately 306 species, of which only 83 are possibly indigenous, none of which are endemic.

Although greatly outnumbered by exotics, indigenous species still dominate some of the most disturbed habitats, as well as constituting the most culturally-utilitarian and ecologically-important species.

Due to the unique adaptability of indigenous Pacific island plants to the harsh conditions of atoll environments, and their cultural and ecological utility, it is argued that the protection and enhancement of the indigenous floras are crucial to the ecological integrity and cultural survival of atoll societies.

### 1.10.2 Vegetation Associations

The terrestrial vegetation associations of Tuvalu are limited to: 1) coastal strand vegetation; 2) limited areas of mangroves and coastal marsh vegetation; and, 3) relict stands of inland woodland or forest. Secondary and cultural vegetation associations include: 4) coconut-palm-dominated agricultural lands under various stages of cultivation and fallow; 5) houseyard and village gardens; and 6) extensive and variable areas of ruderal vegetation.

The coastal strand vegetation of Tuvalu has been severely modified through thousands of years of habitation and selective removal of indigenous species for construction, boatbuilding, firewood and other purposes; the expansion of monocultural coconut groves for export production of coconut oil and copra; and the expansion of coastal settlements, which in urban Funafuti, occupy much of the lagoon coastline.

The coastal seaward rampart vegetation is dominated by Scaevola sericea, which commonly forms an almost unbroken belt in areas away from settlements. Other dominant species include Tournefortia argentea, Pandanus tectorius, and occasionally Guettarda speciosa and Cordia subcordata, which are usually found as isolated specimens or in small groups, and the ubiquitous coconut. Herbaceous species include Lepturus repens, Fimbristylis cymosa, Vigna marina, Ipomoea pes-caprae, Triumfetta procumbens, Euphorbia chamiissonis, and the parasitic Cassytha filiformis, often growing on Scaevola. Infrequently present are the naturalised aboriginal introduction, Tacca leontopetaloides, and Eragrostis amabilis. On the inner borders of the rampart vegetation, particularly on bare limestone or conglomerate or sandy areas, almost pure stands of Pemphis acidula are found.

Along the much more highly disturbed lagoon shores, vegetation includes T. argentea, S. sericea, and Guettarda speciosa, bordered by coconuts, the lianas Vigna marina, Ipomoea pes-caprae, I. macrantha, Canavalia microcarpa and the grasses L. repens and F. cymosa in wetter sites.

Shallow-water lagoon-shore habitats with muddy bottoms, protected from strong wave action, have limited monospecific stands of Rhizophora stylosa and isolated pockets of Lumnitzera littorea. Such areas are commonly bordered by Pemphis acidula.

In areas of inland swamps close to the fresh water lens, and in man-made swampy depressions and Cyrtosperma and Colocasia taro pits, the dominant species are Paspalum distichum, Cyperus sp. and Ludwigia octovalvis.

There is essentially no remaining primary forest or woodland in Tuvalu, with most of it, except for the rare relict stand or individual tree, having been replaced by coconut-dominated vegetation associations. Evidence indicates that the dominant inland forest species were probably Pisonia grandis, Hernandia nymphaeaeifolia the former which covers most of the interior parts of the reef islets, and the latter which occurs at several sites, on Nui Atoll. Other dominant elements include Calophyllum inophyllum and Cordia subcordata, plus Guettarda speciosa, Ficus tinctoria, Morinda citrifolia, Neisosperma oppositifolia, Acalypha amentacea var., Pandanus tectorius, Pipturus argenteus, Scaevola

sericea, Premna serratifolia, and the ferns Asplenium nidis, Nephrolepis acutifolia and Polypodium scolopendria as important understorey species.

Coconut groves are the major vegetation type in Tuvalu. They are found on both the major inhabited islands and on uninhabited islets. In most cases, the plantations are comprised of randomly scattered trees of varying heights and ages. More recent plantings, many of which were done under the Department of Agriculture's coconut rehabilitation schemes, are more regularly-spaced and of single age-classes. These plantings now constitute a significant proportion of the area under coconuts.

In poorly-maintained groves, coconut seedlings and fallen leaves and husks dominate the understorey. In the more well-maintained groves, the soil surface has a sparse cover of grasses and herbs including Thuarea involuta, Lepturus repens, Stenotaphrum micranthum, Fimbristylis cymosa, Euphorbia spp., Boerhavia spp., Triumfetta procumbens, and the exotic Cenchrus echinatus. Coconut stands near the seaward sides and towards the centres of islets are often more open. They contain a greater number of understorey or shrubby species including Tournefortia, Pipturus, Pisonia, Acalypha, Ficus, Guettarda, Pandanus, Premna and Scaevola, with young coconuts, and denser, almost continuous stands of the same grasses and herbs often present. Cassytha filiformis and Laportea ruderalis are occasional, while Asplenium nidis, Nephrolepis acutifolia and Polypodium scolopendria are more often found in the shade and at the bases of coconut trees. The density and composition of such vegetation varies, of course, depending on the maintenance and density of coconut plantings.

Trees occasionally found as scattered individuals, but most certainly more numerous in the past, possibly as components of the dominant pre-settlement and pre-European-contact vegetation, include Barringtonia asiatica, Calophyllum inophyllum, Cordia subcordata, Hernandia nymphaeaeifolia, Hibiscus tiliaceus, Neisosperma oppositifolia, Pisonia grandis, Terminalia samoensis and Thespesia populnea. These species have been almost totally replaced in the drive, over the past 40 years, to extend coconut plantings, and now often only exist as isolated individuals, sometimes in houseyard gardens.

Houseyard and village gardens contain a greater proportion of aboriginal cultigens and recently introduced exotics. Although exotic ornamentals are common in areas immediately surrounding dwellings the Tuvalu, particularly in urbanised Funafuti, the dominant plants are important tree crops: coconut palms (often planted for toddy production), pandanus, papaya, and breadfruit (Artocarpus altilis), and useful indigenous non-food trees, such as Hernandia nymphaeaeifolia of Hibiscus tiliaceus. Other food plants found in village gardens include giant swamp taro (Cyrtosperma chamissonis), which is also cultivated in pits within villages. Less widely cultivated food plants include sweet potato, pumpkin (Cucurbita pepo), rough lemon (Citrus hystrix or C. limon), sugarcane, hibiscus spinach (Hibiscus manihot), and a range of short-term vegetables, such as cabbages (Brassica spp.), long beans (Vigna sequipedalis), sweet capsicums (Capsicum annuum var. grossum), chillies (Capsicum frutescens) and cucumbers. The latter group have been promoted in the UNICEF Family Food Production Programme to increase supplies of nutritious vegetables.

Ornamental species include Acalypha amentacea var. wilkesiana, Catharanthus roseus, Clerodendrum inerme, Codiaeum variegatum, Crinum asiaticum, Dracaena spp., Ixora casei, Gardenia taitensis, Lantana camara, Mirabilis jalapa, Pedilanthus tithymaloides, Plumeria spp., Polyscias spp., Pseuderanthemum carruthersii vars., Russelia equisetiformis and Tecoma stans.

Extensive areas of highly disturbed ruderal vegetation are found in Tuvalu. Major contributing factors include: 1) long settlement; 2) increasing urbanisation and transportation network development (e.g., roads, causeways and the airfield); and, 3) the widespread practice of keeping villages and plantations clean by continuous burning, sweeping and clearing of vegetation. These have created extensive areas of ruderal vegetation in settlements, waste places, along roadsides and the airstrip. The dominant species in most areas are grasses, annuals and shrubby weedy species.

In the central areas of the islands, and in and around villages, are extensive areas of pits for the cultivation of the ceremonial staple, giant swamp taro or pulaka (Cyrtosperma chamissonis). These pits have been excavated to the level of the freshwater lens, through the limestone bedrock to depths of 1.5 to over 4 m. Due to increasing salinity and the declining importance of pulaka relative to copra production, cash employment and imported food, a large proportion of the pits on some islands have been abandoned.

### 1.10.3 Ecological and Cultural Utility

Although highly disturbed, outnumbered and, in some ways, "enriched" by introduced exotics, the vegetation and flora of Tuvalu still constitutes a critical ecological and cultural resource and a basis for sustainable development. This is particularly true for the indigenous species, virtually all of which had wide cultural utility within the subsistence economy.

In terms of the more specific ecological attributes of coastal plant resources, the most important functions include the provision of shade and animal and plant habitats, protection from wind, erosion, flood and saltwater incursion, land stabilisation, protection from the desiccating effects of salt spray, soil improvement and mulching.

Shade is important to humans, plants, and animals, especially in highly reflective low-lying coral island and lagoonal environments, and in villages and urban areas. As populations increase, shade and the role that trees and other coastal plants play as habitats for other important animal and plant species will become more important. Of particular importance are mangrove ecosystems which contribute either directly or indirectly, through primary and secondary productivity, to the nutritional requirements of a high proportion of marine food species. Research has shown that over 60% of commercially important marine food species live in mangroves or depend on mangrove food webs at some stage in their life cycle. Destruction and reclamation of mangroves have deleterious effects on fisheries yields, with studies in the Malacca Straits indicating that mangrove reclamation for industrial expansion led to a substantial drop in catches per effort and to offshore



fisheries' yield declines of 50 to 80%. Mangrove leaves are also an important pig feed in Tuvalu.

Damage from wind, erosion, and flood are increased when forests are removed; and mangrove and coastal strand forests stabilise tidal-zone soils and reduce the impact of storm surge and ocean salt spray. In Truk, in the Federated States of Micronesia, where mangroves were completely removed by Japanese woodsmen before World War II, the coast was washed away rapidly and left with coconut trees in various stages of falling into the sea. The role of coastal plants in soil stabilisation is critical to the success of land reclamation and other low-cost coastal engineering works. Species already used for land reclamation in various areas of Asia and the Pacific include Bruguiera gymnorhiza, Calophyllum inophyllum, Casuarina equisetifolia, Cocos nucifera, Hibiscus tiliaceus, Lumnitzera littorea, Rhizophora spp. Scaevola sericea, Sonneratia alba, Terminalia catappa and Tournefortia argentea. Many of the coastal herbs, grasses, sedges, vines and shrubs are also of considerable importance for coastal stabilisation and land reclamation.

One of the most important ecological roles played by coastal plants is the protection of inland agricultural areas, non-coastal vegetation and fauna, settlements, and water supplies from saltwater spray and storm surge. Of particular value because of their remarkable tolerance to high levels of salinity, are plants with particularly high tolerance to salt spray and saline soils. In this respect, farmers throughout the Pacific purposely leave strand or mangrove forests intact seaside of their gardens, as they know that to remove these trees would make farming problematic. In the Gilberts stands of Pemphis acidula are left seaward of agricultural areas to provide protection from salt spray and Casuarina equisetifolia has been planted to protect newly planted coconuts. Species commonly used for living fences or hedging include Clerodendrum inerme, Cocos nucifera, Ficus tinctoria, Hibiscus tiliaceus and Premna serratifolia. Crinum asiaticum is commonly used for garden borders. Low-growing Hibiscus tiliaceus cultivars are planted as windbreaks, and plant products such as woven coconut leaves or roots are used for sandcreens. Such practices will become even more important if a projected sea level rise due to global warming becomes a reality.

Soil improvement and the provision of organic material is also important to the success of agriculture in nutritionally poor and highly permeable coastal soils, particularly atoll soils, which are among the least fertile in the world. Organic material increases soil waterholding capacity, reduces soil pH to more favourable levels at which minerals become more available to plants. Organic matter also reduces runoff, water and wind erosion and water loss to evaporation. Consequently, Tuvaluans have evolved sophisticated systems of fertilisation and mulching using the leaves of coastal plants along with other leaves and topsoil, as part of an elaborate mulching system for giant swamp taro Cyrtosperma chamissonis, pandanus and breadfruit.

In terms of specific cultural utility, the most widely reported uses for atoll plants are for medicine, general construction, body ornamentation, fuelwood, ceremony and ritual, cultivated or ornamental plants, toolmaking, food, boat or canoe making, dyes or pigments, magic and sorcery, fishing equipment, cordage and fibre, games or toys, perfumes and scenting coconut oil, fertiliser and mulching, woodcarving, weapons or traps, food parcellisation, subjects of legends, mythology, songs, riddles, and proverbs,

domesticated and wild animal feed, handicrafts, cooking equipment, clothing, fish poisons, items for export or local sale, adhesives or caulking, and musical instruments. Appendix I shows the results of a study of the utility of atoll and coastal plants in Melanesia, Polynesia and Micronesia. The analysis shows that there are some 75 different purpose/use categories for coastal plants, with the total frequency of usage for 140 plants being 1024, an average of 7.3 purpose/use categories per plant, ranging from no reported uses for only two species to as many as 125 for the coconut, if distinct uses within categories (e.g., tools with distinct functions) are counted (see Appendix II). Next in order of importance, all with 20 or more reported uses, are Hibiscus tiliaceus, Pandanus tectorius, Calophyllum inophyllum, Cordia subcordata, Guettarda speciosa, Scaevola sericea, Pemphis acidula, Thespesia populnea, Rhizophora spp., Tournefortia argentea, Casuarina equisetifolia, Premna serratifolia, Morinda citrifolia, Pipturus argenteus, Terminalia catappa and Ficus tinctoria . . . all species found in Tuvalu. Another 11 species, found in Tuvalu, have at least 7 uses each (Appendix II).

It must be stressed that the analysis is based on traditional uses, many of which have lapsed or are only employed in emergency, because modern technology has pre-empted them. Modern medicine, clothing, fishing lines, matches, crockery, plastic bags, soap, and emergency food rations (food aid) have, for example, replaced traditional plant-derived products. Moreover, many of the current generation, schooled in the modern educational system and living in the cash economy, often know few of the traditional uses of plants, let alone their vernacular names . . . a state which could be referred to as "devegetation of the mind" . . . and which has undoubtedly contributed to the degradation of the indigenous and long-established aboriginal vegetation of Tuvalu.

Of particular note is the importance of traditional food and beverage crops, the abandonment of which, for highly imported foods such as sugar, white rice and flour, cabin biscuits, noodles, canned fish, softdrinks, alcohol and tea, has led to dangerous levels of food dependency and some of the highest, or most rapidly increasing, incidences in the world of vitamin and mineral deficiency and nutrition related diseases. Diseases such as iron-deficiency anaemia, vitamin-A-deficiency-induced night blindness, diabetes, cardiovascular disease, hypertension and stroke, gout and hyperuricaemia, some forms of cancer and dental disease, which were rarely encountered in the past are now serious causes of morbidity and mortality in Tuvalu, and among other atoll populations.

It is argued that, while floristic degradation in Tuvalu appears to be among the most severe in the Pacific, the vegetation and flora of Tuvalu still constitute a strategic ecological and cultural resource that must be protected. Unfortunately, despite the undeniable developmental importance of vegetation protection in Tuvalu, there is still a need for planners and national development plans in Tuvalu to place a high priority on vegetation protection as a basis for sustainable development.

### 1.11 Fauna

There are great extremes in the comparative diversity and uniqueness of the fauna found in the Pacific. There is a general attenuation (filtering out or decrease in number) of species diversity from west to east, from New Guinea, where the fauna is among the



richest in the world, with a very high rates of endemism (occurrence of unique species not found elsewhere), to the small atolls of the eastern Pacific whose faunas are among the poorest. For example, Tuvalu's native terrestrial fauna has no reported endemics and no indigenous land mammals. Papua New Guinea, in stark contrast, has about 100 species of mammals (mostly marsupials), 70 species of snakes, crocodiles, over 65 species of birds, and a very rich insect fauna which includes some of the rarest and largest moths and butterflies, and the dreaded malaria vector, the Anopheles mosquito, which is fortunately absent in Tuvalu.

In terms of marine fauna, Tuvalu is not as impoverished, although there is still an attenuation of species with distance from Papua New Guinea, where there are about 600 species of finfish, but probably only between 300 to 400 in Tuvalu, and only about 125 further east in French Polynesia. Tuvalu's marine fauna, however, is probably more impoverished than that of Kiribati because of more limited habitat diversity, with important subsistence species such as the ark shell (Anadara maculosa) and the giant clam (Tridacna gigas), which are present, and an important food species, in Kiribati, being absent from Tuvalu.

#### 1.11.1 Terrestrial Fauna

There are probably no indigenous land mammals in Tuvalu, with the Polynesian rat (Rattus exulans) being probably an aboriginal introduction. The main indigenous land animals consist of birds, insects and some land crabs. Some of these constitute resources of considerable importance to sustainable development, both in terms of their cultural utility and their possible commercial importance in the development of national reserves and a limited tourist industry.

In terms of bird life, with the exception of a few introduced by humans, most are either sea birds or migratory species which nest primarily on uninhabited islets. Although little data exist on the avifauna of Tuvalu, the group probably serves as an important marine avifauna flyway. This includes migratory species that use the north-south oriented island chains to stop and feed as well as those species that find the isolation, flora and atolls habitats ideal for breeding and nesting.

In terms of animal protein, Tuvaluans have long supplemented their mainly fish diets with a number of species of avifauna. The birds reportedly present in Tuvalu belong to less than ten families. These include: 1) petrels and shearwaters (Procellariidae), 2) tropic birds (Phaethontidae), 3) boobies or gannets (Sulidae), 4) man-o'-war or frigate birds (Fregatidae), 5) herons (Ardeidae), 6) plovers (Charadriidae), 7) sandpipers and their relatives (Scolopacidae), 8) gulls and terns (Laridae), and 9) the migratory cuckoo (Cuculidae).

The 27 indigenous species reported present in Tuvalu include: white-tailed tropic bird (Phaethon lepturus), Pacific reef heron (Egretta sacra), great crested, black-naped and sooty terns (Sterna bergii, S. sumatrana and S. fuscata), brown and black noddys (Anous stolidus and A. minutus), common fairy tern (Gygis alba) and Pacific pigeon (Ducula pacifica), which are permanently resident; lesser golden plover (Pluvialis dominica),

wandering and Siberian or gray-tailed tattlers (Heteroscelus incanus and H. brevipes), bristle-thighed curlew (Numenius tahitiensis), ruddy turnstone (Arenaria interpres), sanderling (Calidris alba) and long-tailed cuckoo (Eudynamis taitensis), which are migratory winter (from the bird's perspective) residents during the non-breeding season; Christmas and Audubon's shearwaters (Puffinus nativitatis and P. lherminieri), red-tailed tropic bird (Phaethon rubricauda), masked, brown and red-footed boobies (Sula dactylatra, S. leucogaster and S. sula), great and lesser frigate birds (Fregata minor and F. ariel), whimbrel (Numenius phaeopus), spectacled or gray-backed tern (Sterna lunata) and blue-gray noddy (Procelsterna cerulea), which are present as migrants or vagrants (Pratt et al., 1987). The seldom flying banded rail (Rallus philippensis), which was recently discovered on Niulakita, could also be of indigenous origin, although possibly a recent introduction (McQuarrie, 1991).

Some of these species are increasingly rare due to increasing population density, habitat destruction and human predation. Although birds were probably protected under former Gilbert and Ellice Islands Wildlife Ordinances, enforcement is difficult.

Although the insect fauna constitutes the majority of the terrestrial animals found in Tuvalu atolls, it is very poor compared to that of Australia, which has 12,000 butterfly species compared to only 22 in Tuvalu. Many insects are important to the functioning of atoll ecosystems, whereas others such as mosquitoes, flies, which spread disease, cockroaches, are noxious pests. Agricultural pests such as the Papuana taro beetle, which seriously affect the production of Cyrtosperma and Colocasia taro and bananas in Tarawa and Butaritari in Kiribati, have not been found present in Tuvalu.

#### 1.11.2 Marine Fauna and Fisheries Resources

Fish and fishing are extremely important in Tuvalu. Although industrial fisheries make little contribution to the national economy, apart from licensing fees from foreign fishing vessels, small-scale fisheries are an increasingly important source of cash income and have important nutritional and social roles to play in sustainable development.

In terms of subsistence, the sea provides virtually all the animal protein in the diet, with terrestrial resources (formally land birds, lizards, dogs and rats, and today pigs, chickens and sea birds) comprising an insignificant part of the diet. Virtually all non-toxic finfish species over a few centimetres in length and a majority of the non-fish marine organisms are eaten, and various shells, teeth and other hard parts are used in the material culture. On atolls with well-developed lagoons, lagoon and reef fish are more important, whereas on lagoon-less islands such as Niutao flying fish and tunas are more important.

Because of the limited terrestrial protein and carbohydrate resources, fish consumption is among the highest in the world, with an estimated average consumption of 565 g/capita/day on rural atolls, thus satisfying both the minimum daily protein requirements and much of the daily energy requirements (Zann, 1983).

Although living marine resources are also important to the larger island countries, they are for many of the smaller countries, such as Tuvalu, the sole opportunity for

substantial economic development. The main categories of fisheries resources in Tuvalu include: 1) the lagoonal and reef, or "inshore" fishery; 2) the "offshore" fishery, which include both the pelagic and near-shore deep water fisheries; and 3) mariculture or aquaculture, which is not a tradition in Tuvalu, but which offers some potential. Appendices III and IV list some of the more important finfish and non-fish species found in Tuvalu.

Some of Tuvalu's islands have protected lagoons with significant subsistence and small-scale fisheries resources. Some islands, however, like Vaitupu and Niulakita, are table reef or limestone islets with no large central lagoons. All islands have some fringing reef and reef slope resources, all of which are of critical subsistence importance, as well as being of limited, primarily local commercial importance. Some islands have offshore banks or reefs which are favoured fishing grounds. There are also off-shore seamounts in the northern and southern sectors of the country's EEZ, which have shown to have significant deepsea snapper resources. Both of these are often difficult to fish because of strong currents and rough seas.

The reef and lagoon resources of most inhabited islands in Tuvalu are heavily exploited, with most of the potential for increased commercial catches being from deep water near-shore and pelagic species. Some islands in the main Tuvalu group have lagoons, inland ponds or areas that can be developed for mariculture (mariculture of milkfish, giant clams and Anadara cockles is currently being investigated).

The main categories of lagoonal and reef resources include: 1) a wide range of finfish; 2) a range of marine non-fish resources, including turtles, crustaceans, shellfish, holothurians (beche-de-mer), sipunculid sea worms and jellyfish; and 3) marine seaweed and other plants. Tuvalu's EEZ of over 750,000 km<sup>2</sup> has some potential for pelagic fisheries development (mainly tuna), and for the increased exploitation of deepwater snappers and sharks (mainly for the export of sharkfin, because shark is rarely eaten in Tuvalu), and harvesting of deepwater corals. Studies in the mid-1980s confirmed that there are commercially exploitable deepwater snapper resources in Tuvalu, particularly in the areas of unexploited seamounts. It has also been argued, however, that, because of the relatively limited area of suitable fishing grounds, it is unlikely that a sustainable export-oriented fishery can be developed in the near future. (See Appendices III and IV for some of the species of considerable importance in the lagoonal, reef, deepwater and pelagic fisheries).

The main traditional fishing methods consist of: 1) reef gleaning at low tide in the intertidal zone; 2) poling and trolling for small surf and schooling tunas using pearl-shell lures; 3) the use of gill nets and encircling nets for catching mullet, milkfish, etc.; 4) handlining for reef and lagoon fish (rarely at depths greater than 50 m); 5) underwater spearfishing; and, 6) scoopnetting for flying fish at night by the light of storm lanterns. Within these categories fishermen have developed many specialised techniques involving different types of nets, hooks and lines, baits, lures, spears, nooses, traps and fences, poisons and gleaning strategies, with as many as 33 distinct techniques having been recorded for some atolls.

On most islands, fishing is carried out from traditional sailing, or more rarely paddling canoes. In some areas, particularly in Funafuti, these have been superseded by motorised skiffs and diesel launches, which are used mainly for trolling and deepsea handlining.

More modern methods include: use by local artisanal fishermen of improved tackle, boats, nets and ice boxes; one single pole-and-line vessel, "Te Tautai", which has been redeployed to fish in Melanesia because inadequate baitfish resources in Tuvalu made it uneconomical; and the use of improved deepwater handreels for commercial deepwater snapper fishing.

### 1.11.3 Finfish Resources

The more important finfish species for subsistence and local sale in Tuvalu include: 1) a wide range of shallow-water snapper, rockcod, grouper, or coral trout species (Cephalophlis, Epinephelus and Lutjanus spp.); 2) emperors or breams (Lethrinus spp.); 3) goatfish (Mulloidichthys and Upeneus spp.); 4) mullets (Liza spp. and Valamulgil seheli); 5) trevally or jacks (Caranx, Carangoides and Seriola spp.); 6) small herrings, cardinal fish, fusiliers, sprats and their relatives (Aterinidae, Spratelloides, Caesio and Paracaesio spp.); and the larger deepwater or pelagic species including; 8) tunas (see below); 9) sharks (Carcharhinus and Galeocерdo spp.); 10) barracudas and seapikes (Sphyræna spp.); 11) billfish (Istophorus platypterus and Makaira spp.) and, 12) flying fish (Cheilopogon and Cypselurus spp.).

Other important species or groups of species include: parrotfish (Scarus spp.), rabbitfish or spinefoot (Siganus spp.), surgeonfish (Acanthurus spp.), squirrelfish (Adioryx, Holocentrus and Myripristis spp.), stingrays (Aetobatus narinari and Himantura sp.), milkfish (Chanos chanos), wrasses (Cheilinus and Halichoeres spp.), silver biddy (Gerres sp.), moray eel (Gymnothorax sp.), rays (Aetobates narinari and Himantura sp.), barred garfish (Hyporhamphus dussumieri), topsail drummer (Khyphosus spp.) and unicornfish (Naso unicornis).

The pelagic species of increasing industrial, export or local commercial in Tuvalu importance include: the tuna species, skipjack (Katsuwonus pelamis), yellowfin tuna (Thunnus albacares), and dogtooth tuna (Gymnosarda unicolor); the tuna-like species (also members of family Scombridae), bigeye scad (Selar crumenophthalmus), queenfish (Scomberoides spp.); and a number of other species including rainbow runner (Elagatis hipinnultaus), wahoo (Acanthocybium solandri), and dolphin fish or mahimahi (Coryphaena hippurus). Skipjack stocks seem to be sufficient to sustain a both a smallscale commercial fishery and the existing subsistence and artisanal fisheries, although baitfish stocks seem to be the main limiting factor on commercial skipjack tuna development in Tuvalu.

Of particular importance to the tuna industry, is a wide range of baitfish species required for commercial skipjack tuna development. The most important species include: blue sprat (Spratelloides delicatulus), which comprises the bulk of the catch, and cardinalfish (Apogonidae), hardyheads or silversides (Atherinidae), fusiliers (Caesio and



Paracaesio spp.) and Selar crumenophthalmus. These, however (as mentioned above), do not seem to be in sufficient abundance to support a locally-based commercial pole-and-line skipjack tuna fishery. Furthermore, because some of these species are also an important subsistence food resource or play important roles in food chains, a serious conflict of interest could arise if commercial-scale bait-fish operations affect this resource.

The deepsea demersal species of increasing commercial importance include jobfish (Aphareus spp.) and the deepsea snappers (Aprion, Etelis, Pristipomoides and Tropidinus spp.).

A range of other finfish species of more local or minor importance, which together also constitute a critical nutritional resource is listed in Appendix III. It should also be mentioned that many of these species, often in their juvenile stages, such as the damsel, angel and butterfly fishes (Chaetodon and Pomacanthus spp.) are highly desired by tropical fish collectors and could be exported from Tuvalu, given improved air transport.

#### 1.11.4 Non-fish Resources

Marine non-fish species of considerable importance in Tuvalu include: turtles; a range of crabs, shrimps, prawns, lobsters and other crustaceans; shellfish, including both bivalves and gastropods; holothurians or beche-de-mer; and a number of other marine organisms (Appendix IV).

Both the hawksbill and green turtles (Eretmochelys imbricata and Chelonia mydas) are present in Tuvalu, with nesting areas on a number of small islets and sandbanks. The green turtle is considered to be endangered and turtles, in general, seem to be scarce. Despite international efforts to protect these overexploited and endangered species, both are actively hunted and eaten and the shell used for handicrafts. Turtle eggs are also eaten and considered a delicacy.

Crustacean catches are generally limited and primarily for subsistence purposes, although lobster (Panulirus spp.) is a potential commercial resource which could be shipped by airfreight to nearby Pacific Island tourist destinations. There are a range of crabs, including the coconut crab (Birgus latro), and the mantis shrimp (Lysiosquilla maculata) is also commonly sought after and considered a delicacy (Appendix IV).

Of the shellfish, the giant spider shell (Lambis truncata), turban shells (Turbo spp.) and a range of bivalves are most important. Most are collected at low tide in the intertidal zone. The ark shell or te bun (Anadara maculosa), which is by far the most commonly consumed and marketed marine shellfish and, perhaps, the most commonly consumed marine food in Kiribati, is not present in Tuvalu. Studies are currently under way to determine if it can be introduced into Tuvalu.

Also of major subsistence importance in terms of percentage of catch are giant clams. The two species present in Tuvalu include the rugose giant clam (Tridacna maxima), which is most common, and the fluted giant clam T. squamosa). Neither are in great abundance, and evidence of fishing pressure on these stocks can be seen in the size-

frequency distributions at varying distances from villages, and by the abundance of freshly dead shells. Evidence for the presence of T. gigas in the recent past was found in dead shells collected from the northern part of Nukufetau 15 years ago and from accounts of older people (Braley, 1988).

Giant clams are generally under heavy pressure, both for subsistence and commercial purposes (commonly through poaching by Taiwanese tuna or clamming vessels because of the high demand for giant clam meat in Taiwan), with some species, such as T. gigas, also extinct or close to extinction in Fiji and Tonga, and H. hippopus being a recent extinction in both Tonga and Fiji, where its shells are found in coastal middens (Lewis et al., 1988).

Because of heavy subsistence pressure on the resource, it has been suggested that commercial fishing for giant clams in Tuvalu should not be promoted, and would only lead to a rapid depletion of stocks (Braley, 1988). In response to serious overfishing of giant clams by Asian fishing vessels, giant clam aquaculture has been promoted and shown considerable success in a number of areas in the Pacific and offers considerable potential in Tuvalu (Munro, 1986), where experimental mariculture of introduced T. derasa is underway in Funafuti Lagoon.

Tuvalu also has a large range of shells, both marine and terrestrial, of value to collectors. Some, such as trochus (Trochus spp.), turban shells (Turbo spp.) and pearl oysters have considerable demand for use in the Asian mother-of-pearl industry. Many are used throughout the Pacific to make necklaces and in other handicrafts. Most can be gathered using relatively simple techniques, such as reef gleaning, netting, trapping or dredging or diving. They can be marketed, locally and possibly overseas and form the basis of an important, and potentially sustainable, village-based industry. In the Philippines, an estimated 30,000 people make their living directly or indirectly in the specimen and commercial shell industry, as collectors, vendors, or in the shell jewellery and ornament trade (Parkinson, 1984).

Shells high in demand include not only the gastropods or common sea shells, but also free-swimming cephalopods, such as the highly desired chambered nautilus shells (Nautilus pompilius) (Parkinson, 1989)

Larger more decorative species, such as the nautilus, murexes, tritons and strombs or conches are favoured for ornamental purposes, whereas a much wider range, including smaller shells, both marine and terrestrial, are favoured as specimens for shell collectors. Although many collectors specialise in the more attractive shell groups, such as the cowries (Cypridae), cone shells (Conidae), conches (Strombidae) and murexes (Muricidae), many of which are very rare and valuable, there is increasing popularity in mitres (Mitridae and Volumitridae), augers or terebras (Terebridae), olive shells (Olividae) and many of the other more common shells, including bivalves, which are found in Tuvalu. Due to the abundance of books on shells and the increasing knowledge of the wide range of shells available, even the more common shells could form the basis for specimen shell industry in Tuvalu (Parkinson, 1989)

Although Tuvalu has a poorer shell fauna (malacofauna) than those of the larger Melanesian and Polynesian countries, there is a significant range of species of value for



the handicraft industry, sale to tourists and export for ornamental value and to serious collectors. A one-month survey in Tuvalu in 1983 recorded 119 specimen shell species from 14 families commonly sought by collectors; the total reported species from 21 families commonly sought by collectors is 186. Some of these fetch reasonably high prices from overseas collectors. For example, the giant spider shell (Lambis truncata), which is a common food species in Tuvalu, is also popular with collectors, with good specimens fetching US\$20, and the golden cowrie (Cypraea aurantium), which is found on Nukulaelae, is valued at between \$US 200 to 500. Similarly, although there is only one species of olive shell in Tuvalu (compared with over 30 species of olive shells (Oliva spp.) in the western Pacific), this is a rather unusual form of Oliva miniacea, which could be of considerable interest to collectors. This lack of diversity is often compensated in other ways such as a high degree of coloration. For example, the honey cowrie (Cypraea helvola) in Tuvalu, is more brilliantly coloured than those occurring in Fiji (Parkinson, 1984, 1989).

Shells of increasing interest to collectors that do exist in good numbers in Tuvalu are mitres, of which there are almost 50 species, compared to about 100 in Fiji. These include particularly scarce mitres such as Scabricola vicdani and Vexillum rubrocostatum, formerly not known to exist east of Papua New Guinea. Auger shells or terebras (genera Terebra, Duplicaria and Hastula) are also found throughout the region. As suggested above, most of these shells can be found almost anywhere and in almost all habitats using relatively simple collecting techniques, available to even outer islanders. Unfortunately, few people, except a few who live in urban areas or near tourist resorts know the true value of shells, except for some of the more well known species, some of which can fetch from US\$500 to 2000! Part of the problem is that, although there are local vernacular names for most shells, to commercialise the resource there is a need for a universally recognised set of names, so that the owners of the shell resources know what they are selling and can, thus, receive a fair price. Latin nomenclature, which is known by few islanders, is used for this purpose (Parkinson, 1989).

Another important constraint to the commercialisation of shell resources is that the living coral, upon which many of the more valued shells live, is very susceptible to damage and pollution.

In terms of the development of the industry in Tuvalu, because tourism development is so limited, the main avenues for development of a high-value specimen shell industry would be to promote catalogue sales to collectors throughout the world or to export shells or shell handicrafts, like the Philippines do to other Pacific countries which have established tourism industries. Packs of ten different shells, with accurate names and locality data, for example, sold well in Papua New Guinea and Australia. The quality of shells is also important in obtaining maximum returns to the seller and the country. Finally, in terms of maintaining the resource, shell collecting if done correctly can insure sustainability. Practices that should be encouraged include keeping only high quality shells and returning poor specimens to their original habitats, leaving very young shells, returning all stones or pieces of coral disturbed during collecting to their original places, and rotating the areas where collecting is done to allow the resource to breed and recover (Parkinson, 1989).

Seaslugs or beche-de-mer (holothurians), which were one of the first export products from the Pacific Islands after European contact, are also present in Tuvalu, and offer some potential for commercial development. Studies carried out in the 1970s indicated that at least four commercially valuable species were present. These were lolly fish (Halodeima atra), eyed sandfish (Bohadschia argus) and the two most valued commercial species, white teatfish (Microthele fuscogilva) and black teatfish (Microthele nobilis) (Disney, 1977). These are eaten in Polynesia and Melanesia and are considered a delicacy in Southeast Asia and areas where ethnic Chinese communities exist (Eys and Philipson, 1989). Some species are eaten in Tuvalu. A recent study in Tuvalu on Nanumea indicated, however, that only one commercially valuable species, Actinopyga mauritiana, was found (Langi, 1990).

In Fiji, most species are of some subsistence value, are occasionally marketed locally, and are heavily harvested for local processing and export. The export value of these species from Fiji has increased so dramatically over the past years, that concern over the potential overexploitation of these resources, has led to legislation banning the export of giant clam meat, sandfish, and any beche-de-mer under 3 inches in length being introduced in 1989. Licences are now issued only to members of a Beche-de-mer Exporters Association to encourage more responsible exploitation of these resources.

Although the density of these species in Tuvalu is comparable to other Pacific lagoons, the overall potential of beche-de-mer as a money earner is limited due to the small localised habitats where the more valuable species occur, e.g., Microthele spp. in deepwater passes. It was suggested, however, that a small-scale industry based initially on the relatively small localised stocks of the above species, could be established, while the potential for the more common species found in the lagoons should be investigated (McElroy, 1990).

Other species of subsistence and local commercial importance include octopus, squid and sea urchin. Other species are of primarily subsistence importance. Of particular interest is the nereid annelid seaworm or palolo (Eunice viridis). The reproductive parts or epitokes of the worms "swarm" each year on the last quarter of the moon in October and November to release eggs and sperms, all of which, including the epitokes are collected and eaten as a delicacy.

#### 1.11.5 Seaweed

A range of indigenous marine seaweeds or algae constitute an important nutritional and commercial resource in many areas of the Pacific, with a number of species being traditionally eaten in Tuvalu. The artificial production of the exotic eucheuma seaweed (Eucheuma cottonii) also offers considerable commercial export potential for coastal villages and is currently being investigated.

The most important of the indigenous species is sea grapes or nama (Caulerpa racemosa) which is an important subsistence food and commercial product for local sale in Fiji and is considered a delicacy when eaten raw with lemon juice, chillies, and fermented

coconut flesh (kora), or alternately plain or with coconut cream (lolo). It is an important source of income, especially for villages in the Tailevu areas of the northeast coast of Viti Levu. It is increasingly sold as a delicacy in better restaurants and tourist hotels.

Of particular interest is the mariculture of eucheuma seaweed (Eucheuma cottonii), on otherwise unproductive backreefs. Eucheuma is sundried for export overseas, where it is processed into carrageenan, a food additive for stabilising milk products such as ice cream and yoghurt. In Kiribati, for example, the export of eucheuma has just surpassed copra as the most important export crop.

#### 1.11.6 Importance of Marine Resources to Sustainable Development

As suggested above, these diverse marine food resources, which have helped sustain the people of Tuvalu since their first arrival some two thousand years ago, constitute a renewable subsistence and commercial nutritional resource if managed wisely. The potential sustainability of the resource is evidenced by the fact that, despite thousands of years of almost daily "reef gleaning" at low tide, it is still possible, even in Funafuti and other densely populated areas, for poor families to glean their daily protein needs from the intertidal zone and fringing reef areas.

However, the scarcity of certain marine organisms, such as turtles, large reef cods (*Serranidae*) and giant clams (*Tridacna* spp.), the spider conch or kalea (*Lambis trochata*), and smaller catches and decreasing average size of species individuals, indicate that atolls have been overfished in the past. There is also evidence of declining yields of flying fish, possibly due to local overfishing, and in yellowfin tuna, attributed to overfishing by long-liners and purse-seiners.

Of perhaps greater concern, is that increasing commercialisation of many of these species, such as tuna, baitfish, giant clams, and a wide range of other finfish and crustaceans, has put increasing pressure on these resources, thus underlining the need for protective legislation and sustainable production strategies.

Fortunately, the conservation ethic remains strong among most of Tuvalu's rural peoples and the wide range of conservation practices still in use indicates that Tuvaluans traditionally attempted to manage their marine resources on a sustainable basis. This was based on an extensive knowledge of fish, fishing technology, and the sea. Some of the main mechanisms included secrecy about fishing grounds and techniques, temporary or seasonal taboos or bans on species or fishing grounds, restrictions on the consumption of certain species (e.g. some species such as turtles or giant clams were reserved for chiefs or priests), fines or penalties for resource abuses, and clan tenure or limited access to reef and lagoon areas.

Unfortunately, the principle of limited access and some of the other marine resource management mechanisms are breaking down. The main factors seem to be the amalgamation and relocation of settlements during the colonial period, increased use of motorised boats capable of fishing in the open ocean, and increased emphasis on commercial fishing, modern education and development along Western lines.

## CHAPTER 2

# PATTERNS OF ECONOMIC GROWTH

An analysis of the economy and the potential for economic growth in Tuvalu must take into account the country's small size, its narrow resource base, geographical isolation and fragmentation, and its openness and vulnerability to external economic factors and forces beyond its control. To a large extent, the predominance of the public sector and the high degree of dependence on aid in the Tuvalu economy seem to conform to Bertram and Watters' (1985) model of a MIRAB economy in which migration, remittances, aid and bureaucracy play the dominant economic roles.

### 2.1 GDP AND PER CAPITA INCOMES

Tuvalu's estimated GDP (at factor costs) for 1989 was A\$8.035 million (US\$1 = A\$1.33). Over a four-year period from 1981 to 1985 GDP increased by 22.5 per cent or 5.2 per cent per annum. This was despite the downturns in the international economy which occurred in 1982-3 and 1985-6, and which were reflected in the country's poorer economic performance in 1982 and 1985. The most severe drop in national income was felt in 1982 when real GDP per capita (per capita income) was estimated at A\$279. In real terms, per capita incomes for Tuvalu fell by 15 per cent over the 1981-85 period, which does not auger well for sustainable development given increasing dependency on inflation-prone imported products.

GDP fell by 3.2 percent in 1989 due largely to declines in the contribution of the Government Services sector of 9.6 percent on the previous year, an 11.1 percent drop in the Construction sector and a very significant drop of 93.5 percent in the Fisheries sector. These decreases were offset by increases in the contributions of the Trade, Hotels and Restaurants and Other Services sectors of 10.2, 175.8 and 31.9 percent respectively. In the preceding two years, 1987 and 1988, GDP had grown 12.4 and 18.1 percent, respectively. After adding Indirect Taxes and subtracting Subsidies, GDP at market prices amounted to A\$8,404,533 which was down by 8.8 percent over 1988. Taking into account compensation of expatriate employees the GDP of Tuvaluans at market prices in 1989 amounted to A\$7,595,038, a per capita GDP of A\$870, a drop of 3.2 percent from 1988. In real terms, after deflating by the Consumer Price Index, the decline was 6.0 percent.

The structure of the national economy in terms of the major sectors, capital investment and the role of aid are discussed below.

### 2.2 GOVERNMENT SERVICE SECTOR

In line with the characteristics of a "MIRAB economy" (an economy dominated by Migration, Remittances, Aid and Bureaucracy)(Bertram and Watters, 1985), the largest sector in the Tuvalu economy is the Government Services sector, which accounted for



approximately 45 per cent of the total economic output in the four-year period from 1981 to 1985, and which grew 25 per cent over that period, a slightly faster rate than the economy as a whole. A substantial proportion of the growth in the government services sector was financed by an increased inflow of foreign aid.

Apart from Government Services, it is important to note that many of the items listed in the GDP estimates (for example, electricity, transport, communication and a large proportion of items in "other" sectors) derive wholly or to a large extent from Government or Government agencies. Thus it is difficult to accurately estimate the proportion of GDP derived from non-government sources. Fisk (1986: 26) has estimated this to be less than 20 per cent (\$1,100,000), thus, underlining the insignificant role played by the private sector in Tuvalu. It is very likely that the proportion of government to non-government contribution has remain unchanged in recent years, with around 80 per cent of the monetised economic activity in Tuvalu still being derived from government current and capital expenditure, including official assistance in its various forms.

In 1989 Government Services continued to dominate Gross Domestic Production making up 31.4 percent of GDP. This percentage represents a trend from the previous three years of a decline in the proportion of GDP contributed by Government Services. Over the years from 1986 to 1988 Government Services' share of GDP had decreased from 39.2 to 35.5 to 33.6 percent.

### 2.3 AGRICULTURE, LIVESTOCK AND FISHERIES SECTORS

Agriculture, livestock and fisheries are the major productive sectors involved with the direct exploitation of the country's natural resources, including the production of copra and fisheries products for export. Together, however, they accounted for only 18.7 per cent of GDP in 1989.

Over the period 1981-85, the output from these "productive" sectors increased by only 40 per cent, despite being the predominant activity of the population of Tuvalu. Although this increase is significant percentage-wise, it represents only a small increase in overall primary productivity in real terms given the small size of this sector relative to the public sector.

From 1986 to 1989 the contribution of these productive sectors fluctuated considerably. To a large extent, this can be attributed to the volatile behaviour of fisheries (surprisingly small totals in 1987 and 1989) due to large and fluctuating losses of the National Fishing Corporation.

Considerable effort is currently being focussed on the expansion of the fisheries sector. Major projects include the construction and equipping of the fisheries market on Funafuti and the provision of equipment to small-scale fisheries, including the construction and testing of fishing vessels. The development of larger-scale, export-oriented fisheries will, however, depend largely on the availability of overseas markets and transport (both air and sea) and technical considerations related to the nature of fisheries resources within Tuvalu's EEZ.

The major component of the agricultural sector is household coconut consumption (including consumption by livestock) which accounts for 30.6 percent of Gross Value Added in agriculture. Pig production constitutes 24.8 percent and chicken/egg Production 21.7 percent. While poultry production has increased sharply, it has also contributed to an increase in imports because of the heavy dependence on costly imported feed. Increased agricultural production is constrained mainly by the infertility of the soil and water availability. Research and development for coconut improvement and rehabilitation is a major, and ongoing, priority of the agriculture sector. Other activities include research and extension work on other food crops, such as short-term vegetables, sweet potato and fruit trees, and small livestock, including pigs, poultry and goats. Most of these activities have, however, been scaled down in recent years.

## 2.4 OTHER SECTORS

**Manufacturing:** The level and potential of manufacturing in Tuvalu is limited and severely constrained by distance from markets and sources of raw materials, lack of infrastructure, and the small size of the domestic market. There is limited cottage industry development, mainly in the form of local handicraft production, which has survived in this difficult commercial environment. There is also a small commercial garment producer exporting mainly to Australia. Total Value Added from manufacturing amounted to A\$224,096 in 1989, an increase of 5.2 percent on the previous year.

**Electricity:** Diesel generation of electricity is limited to the capital, Funafuti. The demand for electricity is increasing with the expansion of the Government's operations and the building of new houses. The total Value Added for the provision of electricity in 1989 was \$190,000, an increase of 46.3 percent over 1988. This amount includes, however, the provision of some solar power, which is being promoted, particularly in the outer islands.

**Construction:** The Value Added by Construction fell by 11.1 percent in 1989 due largely to the reduction in the provision of new public sector buildings.

**Trade, Hotel and Restaurants:** This sector is dominated by two items, namely the Philatelic Bureau and the Vaiaku Lagi Hotel. The Philatelic Bureau has had fluctuating fortunes and suffered a dramatic fall in its value added to GDP in 1989 due to increased competition from other producers, lower demand and management problems. A new hotel is currently being built, with Taiwanese Government funding.

## 2.5 AID AND REMITTANCES

In the last few years there has been a significant increase in Capital Formation in both the Private and Government sectors. The bulk of this is in the form of aid and remittances. In 1989 Government Capital Formation, which is totally financed by aid, made up 87.7 percent of the total. Private Buildings showed the largest percentage



increase, up almost four-fold in two years. Government Buildings, Other Construction and Transport Equipment also showed major increases. All Government Capital Formation is financed through aid. Private building is financed mainly through repatriations and remittances by seamen and other offshore workers.

An important feature of the Tuvalu economy is the extremely high proportion of Capital Formation to GDP of 64 percent. This is a function of the large capital imports associated with development which is not part of domestic value added.

Public sector development expenditures are, however, funded almost entirely from external assistance, through bilateral and multilateral arrangements, and are approximately twice as large as recurrent government expenditures. The main aid donors have been the United Kingdom, Australia, New Zealand, Japan, USA, Canada, West Germany, EEC, United Nations Development Programme (UNDP), and the Asian Development Bank (ADB). Tuvalu has, thus, been heavily dependent on bilateral donors, which generally have policies tying the procurement of materials and personnel to their own industries and nationals. Commenting on the effect of tied aid by procurement, the current National Development Plan observed that:

of the A\$31.7 million spent on development projects between 1981 and 1987, approximately 60 per cent did not pass through the Government's accounts, but was spent overseas directly by the donor (4th NDP, 1988-91:26).

The high degree of aid dependency, particularly on bilateral funding has been a major constraint to sustainable development.

In 1991 development spending was estimated at A\$9,871,000. Of this, only A\$100,000 (about 1 percent) was contributed by Tuvalu. The rest was aid from external sources. The breakdown of development expenditures by sector has fluctuated from year to year. In the period 1981 to 1987, of the total development expenditures of A\$31,675,000, over 50 per cent (or A\$17,914,000) was committed to infrastructure projects (capital development), with the transport sector alone accounting for more than the total development expenditures for all projects in the Economic (productive) sector put together. Transport alone accounted for 21.9 per cent (or A\$6,923,000) of the total development expenditure opposed to 17.9 per cent (or A\$5,667,000) for Agriculture, Fisheries and Trade. In 1990, the pattern changed slightly with the Productive sector becoming the major sector and accounting for 31.4 percent of the Development Budget, or A\$5,023,192. Within this sector, 75 percent of the expenditure (or 23 percent of the total Development budget) was allocated to Fisheries alone, with the major project being Commercial Fisheries Research.

The balance of the 1990 Development Budget was distributed to other sectors as follows: Social Services and Infrastructure 25.5 percent, Physical Infrastructure 21.5 percent, and Administration 21.5 percent. In 1991 the dominant sector was Physical Infrastructure which accounted for 38.5 percent of the total budgeted development spending of A\$14,774,000. The major project in this sector is the upgrading of Funafuti

Airport which has been estimated to cost A\$3,600,000. Estimated expenditure on other sectors were: Productive sector A\$3,972,697 or 31.4 percent, Social Services and Infrastructure A\$2,573,193 or 17.4 percent and Administration A\$2,534,405 or 17.2 percent.

With the emphasis of development still largely on Physical Infrastructure, the implication of this development expenditure pattern is clear: that is, without major developments in the productive sectors, strong pressures will continue to be imposed on the Government's recurrent budget. Much of the pressure derives from the recurrent costs of development projects, particularly infrastructural and associated maintenance costs.

## **2.6 DEVELOPMENT AND AID CO-ORDINATION**

The role of aid in Tuvalu cannot be overstated. As stressed above, development expenditure of Tuvalu is funded largely through foreign aid. Of the independent Pacific Island countries, Tuvalu has received the highest aid per capita for every year since 1981. In 1988 and 1989 the levels of aid per capita were A\$1777 and A\$850 respectively.

Since independence in 1978, the number of donors has increased significantly, with Tuvalu receiving assistance from 15 donors in 1990. As a consequence of the increase in the number of donors, there was a need for the coordination of aid resources to ensure that they comply to national objectives in bringing about sustainable development, and that the long term management and maintenance of aid-funded development projects does not create an unbearable burden upon the recurrent budget.

In 1990 Tuvalu had its first Aid Coordination Meeting. Donors represented at this meeting included Australia, Canada, France, Japan, New Zealand, UK, USA, and several international and regional development organisations. Twenty projects worth a total value of A\$57.7 million were submitted by the Tuvalu government for consideration by the donors. Of these 60 per cent were in the infrastructure sector, 31 per cent in the finance sector and 6 per cent in the social sector. For an aid-dependent country such as Tuvalu, the Development Coordination Meeting did not only afford the Government the opportunity to 'educate' its donors on its development priorities but also helped it to tighten up and fine-tune its development planning process.

## **2.7 RECURRENT REVENUE AND EXPENDITURE AND THE TUVALU TRUST FUND**

The Recurrent Budget is used to fund day to day costs of Government. Roughly half of the recurrent expenditure is spent on wages and salaries, which has a strong flow-on or multiplier effect on other parts of the economy.

Given its extremely narrow economic base which precluded any substantial increase in existing revenue sources or the identification of new sources of recurrent revenue, the Tuvalu Government has continued its efforts to diversify the sources of recurrent revenue. Between 1980 and 1983 the internally generated proportion of the

recurrent budget remained constant at 65 per cent. Recently there has been a noticeable increase, with around 80 per cent of the recurrent budget derived from internal sources in 1990.

As part of its wider efforts to diversify internal financial resources and to reduce dependence on budgetary grants and aid, the Tuvalu Government established the Tuvalu Trust Fund in 1987. The Fund serves as a capital resource, the income from which can be used for recurrent expenditure. The major contributors to the fund have been the United Kingdom, the European Development Fund, Australia, New Zealand, Japan, Canada, South Korea and UNDP. The Trust Fund is seen as an important means of maximising the local benefit of aid on a sustainable basis.

The Fund has grown from A\$27.7 million on 30 September 1987 to A\$41.6 million as of 30 September 1991, a return of 11.8 percent per annum over its four years of existence. The amount available for automatic distribution from the Fund was A\$873,000 in 1987 and A\$1,353,000 in 1989. In 1988 and 1990, however, no automatic distribution was made as the Fund had not maintained its real value during the previous years.

In 1991 the proposed Budget set total expenditure at A\$5,413,579 and revenue at A\$4,432,500, leaving a deficit of A\$981,079. The 1991 budgeted expenditure represented an increase of 9.4 percent in nominal terms over 1990. A breakdown of expenditure by ministries showed that the major areas of expenditure were in Public Works and Communications at 37.4 percent of the total expenditure (an increase of around 28.3 percent over 1990) and Community Affairs at 26.2 percent.

The major sources of revenue in 1991 were: Import Duties 19.7 percent of the total, Fisheries Licences 14.9 percent and the Nivaga II (a Government-owned ship) 14.7 percent.

## 2.8 EXPORTS AND EXTERNAL TRADE

The Tuvalu export economy suffers severely from lack of diversification. Copra, fish and handicrafts are the only significant primary exports, with the export of postage stamps (philatelic sales) constituting the major source of "export" income. In 1989 Tuvalu recorded its first garment export valued at A\$100,000. Copra production, the traditional mainstay of the rural economy, has remained low. Although the export value of copra was A\$308,000 in 1984, the value of copra export fell below A\$20,000 per year during the period 1985 to 1988. In 1989 copra was worth only A\$73,400 in export revenue.

The major category of imports is Machinery, Equipment and Manufactured Goods, which made up 40 percent of the total imports in 1989. The next largest category was Food, Beverage and Tobacco, which accounted for 33.2 percent. Between 1984 and 1988 imports of food, beverage and tobacco increased by 68 percent. The three major source countries for imports are Fiji, Australia and New Zealand.

While Tuvalu has consistently ran huge deficits on its balance of trade with imports constituting 16 times the value of exports, these deficits are more than offset by

official and private transfers, the latter in terms of remittances from Tuvaluans working abroad, particularly seamen employed in overseas merchant shipping. Powell (1991) has calculated that the trade deficit of A\$4,859,000 in 1989 was more than offset by current transfers from the rest of the world amounting to A\$6,742,000. Still, the economic situation of the country remains very fragile and highly dependent on often unpredictable aid transfers and overseas job markets.

## **CHAPTER 3**

### **DEMOGRAPHIC TRENDS**

#### **3.1 INTRODUCTION**

The high population densities and demographic characteristics of Tuvalu constitute a major constraint to sustainable development. Population growth, degree and rate of urbanisation, emigration, off-island work opportunities and the ethnicity, health and nutritional status of the population constitute major considerations in assessing the opportunities for sustainable development.

Ethnically, the indigenous peoples of Tuvalu are Polynesians, who have probably inhabited the islands for up to 2000 years or more. There has also been Micronesian influence due to long contact with Kiribati to the north. Of the current estimated 1991 population of 9,250 about 98% are Tuvaluan, the balance comprising I-Kiribati (people of Kiribati descent) and a number of expatriates working temporarily in the country. Thus, common culture, a common language, a common environmental and land use tradition, and the absence of significant ethnic divisions in the country constitute a favourable demographic consideration in the promotion of sustainable development.

#### **3.2 THE NATURE OF ATOLL DEMOGRAPHICS**

As stressed by Bakker (1990), in his paper "Some demographic characteristics of the atoll populations of the South Pacific", of the total population of approximately 6.2 million in the developing countries of the South Pacific Region in 1990, only a very small fraction lives on atolls. These include the populations of the countries of Tuvalu, Kiribati, the Marshall Islands and Tokelau, which live entirely on atolls, and parts of the populations of some other countries which also live in atolls. These include atoll peoples in the Tuamotu Islands of French Polynesia, the northern Cook Islands, the atolls of Yap, Chuuk and Pohnpei in the Federated States of Micronesia, and the "Polynesian outlier" atolls of Solomon Islands and Papua New Guinea. In 1990, the total size of the population in the South Pacific living on atolls was probably not more than about 160,000 persons or about 2.6% of the entire population of the region.

#### **3.3 POPULATION DENSITIES**

Although atoll people make up only a small proportion of the total population of the Pacific islands, because of the very limited land area, they constitute some of the highest crude population densities in the world. The following Table 3.1 gives 1990 estimates for the atoll populations of Tuvalu and three other Pacific island atoll countries (including figures for urbanised Funafuti, the main Gilbert Islands group, urban south

Tarawa). As can be seen from these figures, population densities are extremely high, especially on Funafuti and on highly urbanised South Tarawa, Kiribati where population densities are expected to rival those of Hong Kong by the late 1990s.

Such population densities are a particularly serious obstacle to sustainable development, given the extreme infertility of the soils and scarcity of fresh water on most atolls, and constitute "nutritional (physical) population densities" (the average number of persons per unit of arable land) that are significantly higher than the crude population density figures indicate (Bakker, 1990)

Table 3.1 Estimated 1990 populations for Tuvalu and three other atoll countries (plus Funafuti, the Gilbert Islands and urban South Tarawa) in the South Pacific Region.

Country	Population	Land Area	Population Density
Tuvalu	9,000	25.9 km <sup>2</sup>	347
(Funafuti)	(3,000)	2.8 km <sup>2</sup>	1071
Republic of Kiribati	70,000	822.8 km <sup>2</sup>	85
(Gilbert Islands)	(67,200)	278.4 km <sup>2</sup>	241
(Urban South Tarawa)	(30,000)	7.2 km <sup>2</sup>	4167
Republic of the Marshall Islands	47,000	171 km <sup>2</sup>	274
Tokelau	2,000	12.2 km <sup>2</sup>	164

Source: Adapted from Bakker, 1990; Douglas and Douglas, 1989.

### 3.4 BASIC DEMOGRAPHIC TRENDS

As stressed by Bakker (1990), it is difficult to derive estimates of the basic demographic trends. e.g., fertility, mortality, and particularly internal migration of atoll populations. A reasonably accurate estimate of the size and growth of these populations can only be made from censuses which are taken at regular intervals of usually about 10 years. In Western countries, intercensal and post-censal estimates can normally be obtained through "demographic bookkeeping", i.e., adding births and in-migrants to, and subtracting deaths and out-migrants, from the base (the census) population. Registration of births, and particularly deaths, is, however, far from complete in most developing



countries and Tuvalu seems to be no exception. Registration of internal migration (transit statistics) is non-existent in the region. Consequently the trends described here are, to a very large extent, based on analysis of census data and estimates of the size and growth of the Tuvalu population, given projections of the natural increase (fertility and mortality) and external migration rates derived from the most recent census (Bakker, 1990).

### 3.5 AGE STRUCTURE AND DEPENDENCY RATIOS

As Bakker (1990) reports, the populations of Tuvalu, and other atoll countries, have an age-sex structure which is broad to very broad at the base. This means that the percentage of the population under the age of 15 is high to very high and consequently youth dependency as well as overall dependency ratios are high, and the median age low. These indices, based on the age-sex structure for these countries, are given in Table 3.2.

Table 3.2. Selected structural characteristics of the populations of Tuvalu, Kiribati, the Marshall Islands and Tokelau at the time of the most recent censuses.

Country	% of pop. in age group			Dependency Ratio	Median Age
	<15	15-59	60+		
Tuvalu	32	60	8	66	22
Kiribati	39	55	6	81	20
Marshall Islands	51	44	5	126	14
Tokelau	43	45	12	119	20

Source: Adapted from Bakker, 1990.

The increasing youth of the population and increased dependency ratios are partly due a rapid decrease in mortality since World War II. This decline has, however, shown signs of levelling off.

### 3.6 MORTALITY, FERTILITY AND LIFE EXPECTANCY

Generally speaking, mortality of atoll populations remains fairly high by Pacific standards. The situation in Tuvalu, however, is not as bad as in the Marshall Islands and Kiribati, which has the highest rate of infant mortality and the lowest life expectancy among the four atoll countries under consideration (Table 3.3).

The difference between fertility and mortality is natural increase. If the rate of natural increase is adjusted for net-migration, the annual rate of growth is obtained. Table 3.3 provides some basic indices of fertility and mortality of the same four countries as in Table 3.2. The rate of natural increase and the rate of growth at the time of the most recent census are also shown.

Table 3.3. Selected indices of fertility, mortality, natural increase and population growth in Tuvalu, Kiribati, the Marshall Islands and Tokelau at the time of the most recent censuses.

Country	Indices Of					
	Fertility		Mortality		Pop. Growth	
	Total Fert. Rate	Net Repr. Rate	Infant Mort. Rate ( <sup>0</sup> /oo)	Av.life expect. at birth (yrs) (%)	Rate of natural increase (%)	Annual rate of growth
Tuvalu	2.8	1.2	43	59	1.8	3.2
Kiribati	4.9	2.1	82	53	2.4	2.1
Marshalls	7.2	3.0	57	61	4.1	4.2
Tokelau	-	-	37	-	1.5	1.4

Source: Adapted from Bakker, 1990.

The age-sex structure of the Tuvalu population is broad at the base because of high fertility. The built-in potential for growth or momentum of the population is, thus, very large. Although the "fertility transition" (from high to lower fertility) has started for Tuvalu (Table 3.3), even in the very unlikely event that the fertility level would decrease even more during the next decade or so and reach replacement level fertility (that is a net reproduction rate of 0), the population would continue to grow for a very long time. It is of course possible (although undesirable from a development perspective) that mortality will start to increase again and bring the future growth rate down.

### 3.7 MIGRATION TRENDS

Although reliable figures on internal migration do not exist, up until the early 1970s the population of the rural outer islands of Tuvalu remained virtually static. This suggests that there has been considerable outmigration from the rural outer islands to urban Funafuti and to work as contract workers in the phosphate industries of Banaba and Nauru. With the cessation of mining on Banaba in 1979, many Tuvaluans have returned to their home islands. However, as suggested above, there continues to be considerable migration from outer islands to urban Funafuti.

There is very limited opportunity for permanent outmigration overseas. There are currently about 1000 Tuvaluan contract workers in Nauru, a large number in Kiribati, and several hundred seamen who work as merchant marines on overseas ships, and a small number of highly trained Tuvaluans working for regional organisations, most of whom send a large percentage of their earnings home to support their families. With the projected cessation of mining operation on Nauru near the turn of the century, most Tuvaluans can be expected to return either to Funafuti or their home islands, thus placing increased pressure on already strained resources and eliminating a source of both family and overseas income for the country.

### 3.8 SUMMARY OF DEMOGRAPHIC TRENDS AND IMPACT ON THE ENVIRONMENT

Given extremely high population densities, high fertility rates, declining mortality and resultant youthfulness of the population, coupled with a limited resource endowment and little or no opportunity for outmigration, the future for sustainable development in Tuvalu does not look good. Projections based on even medium assumptions indicate that current demographic trends will very soon lead to disastrous crude population densities on the generally marginal land of Tuvalu. The "nutritional densities" are certainly very significantly higher than these crude density figures given in Table 3.1. The continuation of current population growth rates will soon result in densities which are physically impossible to support, not only in urban areas, but also in many of the rural outer islands.

As Bakker (1990) argues, although the annual growth rates on all rural atolls are below the Tuvalu national average of 3.2% annually, it should be realised that this is mainly because of internal migration from these atolls to the urban areas. As suggested above, however, it can be expected that the future will see some return migration. As a consequence, population growth rates of many of the rural atolls will increase in the near future, even if fertility starts to decline. He stresses that these crude densities give a far too optimistic picture of the situation since crude density takes the entire land area of the atolls into account and not that part which is suitable for agriculture. Alternately he says that the density figures should probably also be adjusted for the fact that many households on the rural atolls get at least a part of their food from the sea. He stresses that not only will such increases put stress on the carrying capacities of these atolls in terms of food productive capacity, but also in terms of drinking water, toilet facilities and sources of energy for lighting and for cooking.

## **CHAPTER 4**

# **CONSTRAINTS TO THE SUSTAINABLE USE OF RESOURCES AND DEVELOPMENT**

### **4.1 INTRODUCTION**

To be successful, atoll development must take into consideration the constraints to sustainable development imposed by: 1) the existing environmental and social conditions within Tuvalu, and 2) external conditions or factors (e.g., the stability of the world economic system and the nature of the development models that are being used).

More specifically, this section focuses on constraints to sustainable atoll development related to: 1) the geography and natural environment of Tuvalu; 2) the nature of current development strategies and the signs of environmental and ecological breakdown globally and in the Pacific atolls caused by these models; and, 3) cultural factors or human-induced effects which make sustainable atoll development problematic.

### **4.2 ENVIRONMENTAL CONSTRAINTS TO SUSTAINABLE DEVELOPMENT**

One overriding constraint to atoll development is the well-known fragility of island ecosystems and the extreme vulnerability of their plant, animal, soil and water resources, and their cultures and traditional resource-use systems, to outside human disturbance and pollution. Whereas the richer continental environments have shown considerable resilience to environmental degradation and external pressures, the limited resources and cultures of small islands have historically shown to be highly susceptible to irreversible degradation and extinction. There are countless examples of island plants, animals, AND peoples that have been irreversibly degraded or brought to extinction due to contact with foreign peoples, diseases and economic and military activities. There is an equally large literature on the failure of external economic initiatives promoted in the island environment.

Some of the more important physical or environmental constraints to conventional economic development in the atoll environment include: 1) isolation and inaccessibility from markets and sources of imported products; 2) geographical fragmentation; 3) small size and land scarcity; 4) mineral scarcity; 5) tropical cyclones and strong winds; 6) periodic drought, water scarcity or absence of surface water resources and high salinity; 7) extremely poor or deteriorating soils; and, 8) the poor or endangered indigenous biota (plants and animals) (Table 4.1). All of these must be considered when selecting development alternatives.

Table 4.1. Nature and degree of severity of physical or environmental challenges or constraints to sustainable development in Tuvalu (+++ = severe or of serious concern; ++ = warranting concern; + = of localised concern in some areas; - = non-existent or minimal concern).

Constraint	Severity of Concern
Isolation and Inaccessibility	+++
Geographical Fragmentation	+++
Small Size and Land Scarcity	+++
Mineral Scarcity*	+++
Tropical Cyclones/Strong Winds	+++
Drought	+++
Water Scarcity/No Surface Water	+++
High Salinity	+++
Poor or Deteriorating Soils	+++
Poor or Endangered Biota	+++

\* The phosphate resources of Banaba (Ocean Island), formerly part of the Gilbert and Ellice Islands Colony, were depleted in 1979.

#### 4.2.1 Isolation and Inaccessibility

Tuvalu suffers from isolation from important metropolitan centres, which are the markets for their export products and sources of consumer and capital goods. Tuvalu also has outer islands or rural areas, which are effectively isolated either from the social services and employment opportunities of urban centres within a group or from important overseas metropolitan centres. Similarly, outer islands suffer greatly in terms of the high cost and difficulty of government administration because of their highly dispersed nature. Tuvalu, for example, has no air links from Funafuti to any of its other eight islands, and shipping to outer islands is irregular and depends on a single ship, the *Nivanga*.

#### 4.2.2 Small Size and Land Scarcity

Small size and consequent land scarcity is a critical environmental issue in Tuvalu. As suggested above, the problem of land scarcity is particularly serious given the infertility of the soil and limited water availability on atolls which makes the "nutritional population densities" particularly high and the carrying capacities of atolls, at least in terms of terrestrial resources, extremely limited. This is particularly serious on urbanised Funafuti, where, population densities are extremely high and much of the land is currently undevelopable because of the excavation of the "borrow pits" on Fongafale islet for the construction of the airfield during World War II.



#### 4.2.3 Drought

Insufficient rainfall or drought is common in Tuvalu, especially in the northern islands closer to the equator, sometimes lasting several months. During such periods, drought plays havoc with agricultural systems which require a reliable water supply, with numerous reported cases of breadfruit dying off, coconut palms ceasing to produce nuts for consumption and copra production, and even indigenous plants dying off. Such conditions severely restrict the options for sustainable agricultural development on all atolls, particularly the drier northern atolls of Tuvalu.

#### 4.2.4 Tropical Cyclones and Flooding

Excessive flooding and hurricane-force winds caused by tropical cyclonic activity and tsunamis also cause widespread destruction to crops, housing, tourist facilities, infrastructure and natural features. Frequent high winds and rough seas seriously limit fishing efforts throughout the group.

Although Tuvalu was thought to lie outside the hurricane belt, it experienced widespread destruction from Tropical Cyclone Bebe which hit the island of Funafuti in October 1972. The cyclone killed six people, left 800 persons homeless, wrecked four ships, destroyed thousands of coconut trees and other subsistence crops, caused widespread coastal erosion, destroyed extensive areas of living coral, and formed a huge rubble rampart 18 kilometres long on Funafuti. There are also records of an even larger rampart formed by a more powerful tropical cyclone which hit the island in 1894. Most recently, Funafuti has been affected by less destructive Cyclones Ofa and Val in February 1990 and December 1991 respectively. The increased incidence of tropical cyclones and increased rainfall in recent years has been related to the occurrence of El Nino (Ninyo) conditions and associated increasing atmospheric instability due to cyclical warming of the eastern Pacific Ocean.

Associated with the high incidence of such natural disasters, is a widespread deterioration in the traditional capability to prepare for, respond to, and recover from natural disasters. This seems to be related to the increasing willingness of central governments and international agencies to rush in with relief supplies and material and manpower assistance, before the severity of a given disaster is adequately assessed, thus inducing dependence and possibly paving the way for greater suffering in the future, when aid funds may not be so forthcoming.

#### 4.2.5 Mineral Scarcity

Most of the smaller, geologically-recent islands on the Pacific Plate, such as Tuvalu have historically shown little potential for mineral development. Notable exceptions to this are, of course, the phosphate-rich upraised coral-limestone islands such as Banaba (Ocean Island) and the recently discovered, and potentially mineable phosphate deposits under the lagoon of Matahiva atoll in the Tuamotus of French Polynesia. There are deposits of sand, gravel, and limestone aggregates found on all of Tuvalu's islands.

Also of potential importance to Tuvalu, is what is probably the world's richest source of manganese nodules. These are widely scattered on the ocean floor at depths of up to six thousand metres inside a 30 million km<sup>2</sup> triangle extending to the southeast of Hawaii and including areas of the Exclusive Economic Zones (EEZs) of Kiribati, the Marshall Islands, the Cook Islands, and a number of other island states. Perhaps more important economically, are the recent deep-ocean discoveries of zinc-, copper-, and iron-rich polymetallic sulphide deposits, all of which seem to have been formed very recently along presently active mid-ocean rift zones. Also of future importance could be the occurrence of cobalt-rich manganese crust surrounding Pacific Plate seamounts, such as those which extend to the west of the active volcanic island of Hawaii (Malahoff, 1984:295). Unfortunately, the potential for finding economically exploitable deposits in Tuvalu's limited EEZ is very limited.

Even if valuable deposits did exist, Tuvalu does not possess the technical or financial resources to mine them, and by necessity would have to rely on large mining conglomerates from metropolitan countries. The seabed resources pose the further problem of ownership, and international mining interests are now negotiating for free access to these deep-sea riches, thus underlining the critical importance of the ongoing Law of the Sea negotiations and the need for a firm and united stand to be taken by Pacific states, with respect to sovereignty to the respective EEZs.

Other problems include depletion of mineral deposits and low world market prices, which can be the economic death knell for some countries and often lead to closure of mines or the non-exploitation of deposits. The phosphate deposits of Banaba are already exhausted, and the projected date for the exhaustion of Nauru's deposits is the turn of the century. Both have been major sources of overseas employment for Tuvalu, which will cease when the deposits are exhausted.

#### **4.2.6 Water Scarcity and Absence of Surface Water**

Most of Tuvalu's islands have no surface water sources, and, in the case of the smaller atoll islets, little or no freshwater lens (water table) development. Consequently, the potential for industrial, irrigated agricultural, or urban development is severely limited. Moreover, the groundwater on some islands is not potable by U.S. Department of Health standards, and even on the larger, wetter atolls, there is, serious periodic water scarcity.

#### **4.2.7 Earthquakes and Vulcanism**

Other specifically geological problems include earthquakes and active vulcanism, and associated seismic sea waves or tsunamis. Although Tuvalu is in a seismically stable area of the Pacific Plate, earthquakes and volcanic eruptions also cause seismic sea waves or tsunamis, which travel thousands of miles across the ocean and constitute serious hazards to atoll communities.

#### 4.2.8 Poor or Deteriorating Soils

As detailed above, the excessively well-drained calcareous soils of the low-lying coral-limestone islands of Tuvalu are among the poorest in the world. They are almost devoid of soil macronutrients and micronutrients apart from calcium, and have little or no organic matter. Even if nutrients are available, high pH and carbonate content make soil nutrients, such as iron, copper and zinc, unavailable to plants. Furthermore, the use of inorganic fertilisers is ineffective due to high pH and are easily leached into the fresh water lens, which constitutes a serious health problem in terms of contamination of limited domestic water supplies.

#### 4.2.9 Poor or Endangered Biota

As detailed above, the terrestrial floras and faunas are among the poorest and most highly degraded and endangered in the world. In terms of marine flora and fauna, Tuvalu is not as impoverished, although there is still an attenuation of species with distance from Papua New Guinea, where there are about 600 species of finfish, but probably only between 300 to 400 in Tuvalu. Tuvalu, however, is probably more impoverished than the larger atoll country of Kiribati, because of more limited habitat diversity, with important subsistence species such as the ark shell (Anadara maculosa) and the giant clam (Tridacna gigas), which are present in Kiribati, being absent from Tuvalu.

Such floristic and faunal poverty represents a major limiting factor to sustainable development in comparison to the rich resource endowments of the larger islands, especially those in the far western Pacific. There is scope, however, for the introduction of appropriate species which might be appropriate to the environmental and cultural conditions of Tuvalu. Examples include the trochus shell (Trochus niloticus), which has been successfully introduced into many atoll lagoons and has become a major economic resource in the Marshall Islands since its introduction there by the Japanese before World War II, and a number of giant clam species (Tridacna and Hippopus spp.) which are being cultured in Palau and Queensland.

### 4.3 CURRENT DEVELOPMENT TRENDS AND SIGNS OF ENVIRONMENTAL AND ECOLOGICAL BREAKDOWN GLOBALLY AND IN THE PACIFIC ATOLLS

#### 4.3.1 Nature of Current Development Models

Perhaps the major constraint to sustainable development is that current development models do not seem to be sustainable, even in the richer continental environments they were designed for, let alone in the fragile resource-poor atoll environment. Put very simply, the dominant development trend is based on the wishes of national governments and international donor agencies to have atoll societies, both rural and urban, use their environmental resources (oceans, islands, lands, forests, labour and

culture) to make money, to generate foreign exchange, to repay loans, to provide cash employment, to dispose of toxic waste from metropolitan countries, or for military activities.

Some of these "developments" pursued in the atoll environment include: 1) catching fish, crabs and lobsters or collecting shellfish to be either exported overseas or sold at local markets; 2) aquacultural production of fish for baitfish or export or seaweed for export; 3) clearing forest, fallow lands or food gardens in order to plant cash crops, such as coconuts, which are then processed for export overseas, instead of following traditional agroforestry land use systems where a diversity of tree crops, food crops, and other useful plants were planted or protected along with limited small animal production; 4) reclaiming coastal land for urban, transportation (wharfs, causeways, roads and airfields), tourism or industrial development; 5) increasing use of costly and dangerous pesticides, inorganic fertilisers, livestock antibiotics, and other chemicals to increase short-term production and cash returns; 6) the dumping or incineration of toxic or radioactive wastes on islands or in the shared oceanic environment; and, 7) land alienation for the testing of nuclear weapons, weapons disposal or other military activities.

All of these types of development, have a number of things in common: 1) they are usually capital-intensive (in terms of money capital) requiring large sums of money (often in the form of loans or aid), which force countries into indebtedness; 2) they depend on overseas or urban-trained experts, rather than on local knowledge and expertise; 3) they often depend on costly imported non-traditional technologies, which are not completely understood by the people of the community; and 4) they often have unfavourable or negative effects on the fragile atoll environment. This includes negative effects on both: a) **natural resources**, such as land, soils, water, trees, animals, lagoons and reefs; and b) **cultural resources**, such as land tenure systems, social organisation, traditional production systems, traditional education systems, and the productive roles of children, youth and women. Furthermore, such development initiatives often take little notice of, or are started with little knowledge of technologies and systems of resource use, which already exist within Tuvalu, and rarely take into consideration the possible effects that new developments or introduced technologies will have on these existing technologies, the people and the environment.

Unfortunately, because development planners, policy makers, and international aid agencies have only limited understanding of the nature of the atoll environment, and the importance of traditional environmental management systems to the stability and maintenance of Pacific atoll communities, the introduction of new, often western-inspired modern technology often replaces, destroys, or "underdevelops" the existing systems that have proved reasonably sustainable in the atoll environment for thousands of years. This underlines the urgent need to limit technological change to appropriate technology and to develop means or measures for assessing whether a given technology or development initiative is appropriate and sustainable in the atoll environment.

#### 4.3.2 Signs of Environmental and Ecological Breakdown in "Developed" Industrialised Countries

Perhaps the most frightening sign of environmental stress and breakdown, that the people of Tuvalu should take note of, is that imported "modern" development strategies **are not even working in the resource-rich ecosystems they were designed for.** Moreover, overconsumption in the industrialised nations, whose per-capita consumptions range from ten to one hundred times (!) that of the "developing" countries, leaves less of the "world cake" for developing countries. Even if there were enough resources to make it possible, universal industrialisation would impose intolerable stress on world ecosystems.

There are already clear signs of ecological and social breakdown in the urban-industrial nations. The world economic situation is the bleakest since the "Great Depression" of the 1930s. Unemployment, social and political breakdown, repressive governments, war and crime are more widespread than ever, and ecological breakdown has reached a truly crisis stage in the developed countries. Even in economic terms, the long-term costs of pollution, pesticide poisoning, and ecological breakdown may surpass the profits made in the short-run by using production-oriented strategies. The fact that this is happening is clearly signalled by the potentially negative impact of global warming and the increasing attempts of the industrialised countries to export to the atolls their wastes and pesticides or nuclear and non-nuclear weaponry which are considered too toxic or dangerous for their own environments and peoples.

If "ecological scarcity" were ever a concern, it would be in atoll countries, such as Tuvalu, where resources, particularly land-based resources, are so severely limited. Moreover, because of the fragility of the atoll environment, to let other larger, over-consuming countries dump their hazardous wastes and test their weapons in the atoll environment can only serve to add insult to injury in terms of further compromising the potential for healthy sustainable development in atoll countries. In short, Tuvalu's main concern is that because many "developed" countries are consuming and polluting far out of proportion to their needs, the countries of the developing world, including Tuvalu, are effectively not only denied the "right to develop", but also being forced to become the hazardous waste dumps for excessive wastes considered too dangerous for disposal in the developed countries. In this respect, Tuvalu strongly supports the "Polluter Pays Principle", regardless of whether this is interpreted in monetary or environmental terms.

#### 4.4 CULTURAL OR HUMAN-INDUCED CONSTRAINTS TO SUSTAINABLE DEVELOPMENT

Signs of human-induced environmental degradation and social and economic deterioration, and an absence of appropriate development, are increasingly visible in Tuvalu and constitute perhaps the most visible and serious constraints to sustainable development. These constraints to sustainability include: global warming/sea level rise, demographic problems/overpopulation, ecological blindness, malnutrition/poor health, agricultural/subsistence deterioration, inappropriate fisheries exploitation, nuclear pollution/presence, non-nuclear pollution, energy dependency, economic vulnerability/foreign domination of economy, landform destruction, deforestation,



agrodeforestation, species extinction/endangerment, soil destruction/deterioration, limited industrial potential, inadequate infrastructure, rapid urbanisation/centralisation, inappropriate education, landlessness, inappropriate technology, social disintegration, military/defence activities, epidemic pest infestations, overgrazing, inequality of women, mining-induced damage, tourism-induced disruption and indiscriminate pesticide use (Table 4.2).

Table 4.2. Nature and degree of severity of cultural or culturally-induced constraints to sustainable development in Tuvalu (+++ = severe or of serious concern; ++ = warranting concern; + = of localised or minor concern in some areas; - = non-existent or minimal concern).

Constraint	Severity of Concern
Global Warming/Sea Level Rise	+++
Demographic Problems/Overpopulation	+++
Ecological Blindness	+++
Malnutrition/Poor Health	+++
Agricultural/Subsistence Deterioration	+++
Inappropriate Fisheries Exploitation	+++
Landform Destruction	+++
Nuclear Pollution/Presence	+++
Non-Nuclear Pollution	+++
Energy Dependency	+++
Economic Vulnerability/Foreign Domination	+++
Deforestation	+++
Agrodeforestation	+++
Species Extinction/Endangerment	+++
Soil Destruction/Deterioration	+++
Limited Industrial Potential	+++
Inadequate Infrastructure	+++
Rapid Urbanisation/Centralisation	+++
Inappropriate Education	+++
Landlessness	+++
Inappropriate Technology	+++
Social Disintegration	++
Inequality of Women	++
Pest Infestations	++
Overgrazing	++
Mining-Induced Damage	++
Tourism-Induced Disruption	+

Many of these are interrelated and there are no doubt more that could be added to the list. These are all, however, signs of present or future ecological stress and breakdown resulting from a breakdown of the natural and cultural ecosystems of atoll societies caused by inappropriate development models. Together, they must be seen as the major constraints to sustainable use of resources and development in Tuvalu and other atoll societies. Although some of these constraints are clearly social, economic or political in nature, they must be considered as constraints to sustainable environmental development given the fact that atoll societies are, and have always been, part of, and not separate from their environment.

#### **4.4.1 Global Warming and Eustatic (Worldwide) Sea Level Rise**

It has been widely predicted that during the next century, there will be a eustatic (worldwide) rise in sea level ranging from a moderate 44 cm to an extreme of 258 cm by the year 2075 due to global warming. Although there have been rises and falls in sea level due to natural global warming and cooling in the past, the rise this time would be faster and due mainly to human activities, the main factor being the "accumulation of so-called greenhouse gases (carbon dioxide, nitrous oxide, methane, chlorofluorocarbons, and others) that alter the outgoing radiation and thus affect ocean volume and glacial melting.

If such a scenario should eventuate, the implications for the small-island states and coastal areas are serious. Some of the potential effects of rising sea levels on low-lying islands and coastal areas include: 1) increased frequency of tropical cyclones and storminess; 2) increased flooding and inundation of wetlands, coastal agricultural areas and other low-lying areas; 3) increased saltwater incursion and storm overwash into coastal aquifers, freshwater lenses, and agricultural areas; 4) increased destructiveness of unpredictable natural hazards such as tropical cyclones, storm surge, and tsunamis, especially if they coincide with exceptionally high tides; 5) increasingly destructive wave activity and decreased protection from submerged offshore reefs; 6) increased coastal erosion; 7) loss of mangrove forests; 8) loss of agricultural areas and fuelwood resources; 9) loss of seagrass beds; 10) declining fisheries productivity; 11) increased coral mortality; 12) changes in oceanic currents and upwelling; 13) breakdown in natural community (ecological) interrelationships; 14) loss of property and structures; and, 15) the total disappearance of some atoll nations. Most of these potential effects would have serious implications for the survival of Tuvalu as a nation.

Although we don't know for sure what the extent of sea level rise will be, there are some inexpensive, and locally implementable development strategies, such as coastal forest protection and reforestation using indigenous species, and appropriate land reclamation, which, if done now, could address many of the projected negative impacts of global warming, while at the same time addressing many of the other more immediate stated development goals and constraints to sustainable development.

#### 4.4.2 Demographic Problems

The constraint to sustainable development posed by increasing population, including rural to urban migration, which puts excessive stress on natural and cultural resources, undermines any hope of sustainability in areas such as urbanised Funafuti. None of the problems associated with acute land shortage, land fragmentation, the poverty of terrestrial resources, the fragility of marine resources, or those related to overexploitation and the threat posed by pollution and waste disposal can be addressed unless something is done to control our high rates of population growth and rural to urban migration.

As argued in the section on "Demographic Trends", demographic constraints, such as high population growth rates, increasingly unfavourable age structures, and increasing urbanisation on islands with limited land availability are quite clear and will ultimately limit atoll development alternatives. On the other side of the coin, depopulation, especially in terms of "brain drain", is also an obstacle to most kinds of development, especially on outer rural atolls.

Increasing urbanisation is another indicator of increasing population pressure. An increasing proportion of Tuvalu's people now live in urbanised Funafuti, where land scarcity, unemployment, and housing shortages have led to social breakdown, increasing consumption of nutritionally-inferior imported foods and alcohol, and squatterisation, all of which place increasing pressure on existing resources, water supplies and food systems. Although some atoll countries such as Tokelau and the Cook Islands have declining or stabilised populations, because of free migration to New Zealand, there is very limited potential for this in Tuvalu.

#### 4.4.3 Environmental Blindness

Increasing environmental blindness and neglect of traditional environmental and resource-use knowledge may be the overriding constraint to sustainable atoll development. A rapidly increasing number of the urban-born or urbanised, and some urban- or overseas-educated leaders have lost the knowledge of and respect for the environment that their ancestors had. Their modern education "teaches" them economics, accounting, administration, politics, history and even modern agriculture and fishing . . . the tools of western development and modernisation, but little about their traditional resource-use systems. Such an orientation will continue to induce widespread environmental blindness which will foster an adherence to existing, environmentally-disruptive development alternatives.

The answer is to integrate environmental education, particularly aspects of traditional sustainable atoll resource-use systems into both the formal and non-formal education systems.

#### 4.4.4 Malnutrition and Poor Health

The state of health and nutrition in a country is one of the most important indicators of societal wellbeing and development. Although the people of Tuvalu are generally well-nourished and healthy, there are some increasingly serious nutritional problems and health disorders, which are related to changes in resource use systems, increasing population densities, and urbanisation.

Recent studies throughout the Pacific also show that correlations seem to exist between increasing consumption of imported refined foods and increases in non-communicable diseases such as diabetes, hypertension, cardio-vascular disease, hyperuricaemia, and certain forms of cancer. Studies of the Micronesian people of the highly-urbanised phosphate-rich equatorial island of Nauru, have recorded among the highest prevalence of diabetes in the world, as well as very high prevalences of obesity, hypertension (high blood pressure), hyperuricaemia (often manifested as acute or chronic arthritis) and gout, diseases of the digestive system, cirrhosis of the liver, and cancer. All ranked high in, or were contributory to the major causes of death in Nauru. A Study by Zimmet *et al.* (1981) showed that similar trends are prevalent in Tuvalu, and are closely related to an abandonment of traditional foodstuffs and an increasingly urbanised lifestyle. Dental disease is also increasingly widespread in urban Tuvalu.

In terms of other health problems and causes of mortality, diarrhoeal diseases, influenza, perinatal complications, skin and eye diseases, and a number of other infectious diseases remain among the major health problems in Tuvalu, and, in many cases, are related to poor management of scarce water resources, poor nutrition, overcrowding and poor environmental hygiene, and the lack of ability to provide both primary and secondary health services to isolated rural areas.

Influenza, historically responsible for devastating epidemics throughout the Pacific, is still the most common infectious disease. Influenza, at times, becomes almost epidemic on small islands with very high population densities, such as Tuvalu and Kiribati, where almost one-half and one-quarter of the respective populations reportedly suffered from influenza in 1983, with 991 people dying in Kiribati (SPEHIS, 1983).

There are high rates of infantile diarrhoea in Tuvalu, and adult diarrhoea and other gastrointestinal problems, constitute serious health hazards in some areas. In the Marshall Islands to the north, diarrhoeal disease is the number one cause of death (WHO, 1984). In Ebeye Lagoon, in the Marshall Islands, where pollution levels have been tested and found to be 25,000 times (!) higher than the safe level set by the WHO, regular epidemics of gastroenteritis are almost impossible to control and constitute a biological time bomb (Keju and Johnson, 1982). Although the situation has not reached such a serious stage in Tuvalu, increasing populations in urban Funafuti could face similar situations in the future.

One of the most frightening health problems is the almost epidemic outbreak of venereal or sexually-transmitted diseases (STD's) in some areas of the Pacific. The situation is particularly serious in urbanised areas of Papua New Guinea, New Caledonia,

Fiji, French Polynesia, the Federated States of Micronesia, Palau, the Marshall Islands and Nauru. Particularly concerning is the increase in penicillin-resistant strains of gonorrhoea. Also of concern are other sexually-transmitted diseases, such as the incurable and ultimately fatal acquired immune deficiency syndrome (AIDS), which is reportedly now present in the Pacific, with an increasing number of cases having been reported from Saipan, American Samoa, French Polynesia, Fiji and Papua New Guinea, respectively, with Kiribati having just recently confirmed its first case.

The situation is not bad in Tuvalu, although there are signs of increasing incidences of STDs and some potential for an outbreak of STDs in urban Funafuti which would constitute a serious constraint to sustainable development.

Bacterial and viral forms of conjunctivitis, trachoma, and other eye diseases are particularly common in Tuvalu. Conjunctivitis is very contagious, as was evidenced by the epidemics of viral conjunctivitis which sweep the islands periodically. Trachoma, a separate, but more serious eye disease, is reportedly also very common in pockets throughout the Pacific, such as Papua New Guinea, and the atoll countries. In Kiribati, for example, an Australian team recently found over half of children tested to be suffering from either trachoma or night blindness (due to vitamin A deficiency) or both. Although conjunctivitis and trachoma are the most common eye diseases, the most serious blinding disease is cataracts, which is associated with the aging process, and which occurs earlier in atoll countries than in developed countries, between the ages of 30 and 50 (Sniffen, 1985).

Fish poisoning is particularly common in Tuvalu and other areas where fish is the main local protein source and where a great variety of fish have shown to be toxic. According to figures reported to the South Pacific Commission, the highest annual rates of morbidity per 10,000 population from ciguatera poisoning (the most common form of fish poisoning) range from 51.8 to 98.6 for French Polynesia, Tuvalu, Tokelau, and Kiribati. The true rates are undoubtedly higher due to under-reporting and non-diagnosis, but with increasing information on ciguatera, and through improved education and screening of fish species, it should be possible to minimise the number of serious cases.

Skin diseases, such as scabies, tinea, and ringworm are very common, and underreported throughout the Pacific in the areas where personal hygiene is poor or fresh water supplies inadequate. They are, especially common in Tuvalu.

Mosquito-borne haemorrhagic dengue is also a problem in Tuvalu, with a number of recent deaths being attributed to the disease.

#### **4.4.5 Deterioration of Traditional Agricultural and Subsistence Systems**

One of the most serious constraints to sustainable development in Tuvalu is the deterioration of the traditional agricultural and subsistence production systems. Intensive excavated-pit cultivation (particularly, *Cyrtosperma* taro and bananas) has declined drastically on some islands. A particularly important role of the traditional agricultural system, in addition to food and export production, is the production of a wide range of



other useful products such as medicines, beverages, animal feed, fuelwood, fertiliser, tools, fishing equipment, handicrafts, construction materials, canoes, fencing, fibre and cordage, dyes, oils, perfumes, body ornamentation and toys, the value of which, when added to the value of subsistence fishing, is estimated to constitute between 20 to 80 per cent of the real incomes of Tuvalu's rural, outer island communities. The protection of this time-tested subsistence production system is seen as a priority for sustainable development because of the limited opportunities for cash income in Tuvalu and because the replacement of these products with imported substitutes would either be impossible or extremely expensive and subject to the same deterioration in terms of trade and inflationary pressures affecting all imports.

#### 4.4.6 Inappropriate Fisheries Exploitation

Inappropriate use and overfishing of reef, lagoon, reef-slope and pelagic (open ocean) fisheries resources is a major constraint to development. For atoll societies, the fisheries resource has tremendous long- and short-term potential for development. Unfortunately, little information exists concerning the carrying capacity and the extent of over exploitation of fisheries resources in highly urbanised areas such as Funafuti Lagoon.

The pelagic (free-swimming, often migratory species) or deep ocean fishery is almost universally underexploited, despite years of exploitation by American and east-Asian distant-fishing powers. At present, however, with the exception of Fiji, which has developed its own tuna fleet which employs 350 persons, no other countries have successfully developed their own distant-fishing capability, although Tuvalu owns one boat and has attempted, unsuccessfully (because of lack of baitfish, rough seas and seasonality of the resource) to develop the industry. In most cases, foreign- or jointly-owned plants either can or freeze the fish caught by foreign vessels, for export. Such policies, although probably necessary in the short-run, limit economic benefits to individual countries, in terms of gross returns, employment and value added.

Rights to exploit the resources within Tuvalu's Exclusive Economic Zone (EEZs) are sold or leased (on a licence basis) to distant-fishing powers, and constitute an increasingly important source of foreign exchange. This arrangement, apart from increased artisanal fishing for local consumption, seems to be the only economically and technically viable means of exploiting this underutilised resource.

Other areas of potential development include the increased local artisanal commercial fishing for pelagic flying fish, which are a traditionally important food species in Tuvalu. Another underexploited resource is the reef-slope or island platform fishery (extending from depths of six to 1,000 metres) with its rich resources of prawns, deep-water snapper and other demersal (bottom dwelling, non-free-swimming territorial species), which were rarely if ever traditionally exploited. Most of the species from this fishery, in fact, have no local names. Neighbouring Kiribati is currently exploiting this rich resource, having recently established a lucrative airfreight export market in Hawaii for deep-water snapper and tuna, for the sashimi (raw tuna) market. Such developments, however, depend on dependable air transport unavailable at present to Tuvalu. However, the long-term potential for this type of fisheries development in Tuvalu is limited due to

the limited area of ocean bottom, between depths of 100 and 200 m, in comparison with the larger islands, such as Tonga and Fiji, with extensive areas of offshore banks and reef platforms.

The lack of regulation of the use of the traditional reef, lagoon and inshore or freshwater fisheries, and of the EEZ and international waters is of particular concern. Localised exploitation of crustaceans (lobster, crab, prawns, etc.) and other marine foods in these zones, for rapidly expanding local urban markets and growing rural populations, has led to the depletion of these resources. Of particular concern is the commercial overexploitation of lagoonal fisheries which could undermine the sustainability of important subsistence and local artisanal fisheries. The abandonment of traditional taboos, marine tenure systems, and fishing regulations, which have been responsible for relatively sustained-yield production over thousands of years, coupled with widespread use of dynamite, pesticides, other fish poisons and stupeficients, and small-mesh gillnets are also rapidly degrading important fisheries resources.

Species of particular nutritional and cultural importance which already show evidence of overexploitation include a range of groupers and snappers (Cephalopholis, Epinephelus and Lutjanus spp.), emperors (Lethrinus spp.) and rabbitfish (Siganus spp.) and giant clams (Tridacna spp. and the spider conch or kalea (Lambis truncata).

An associated problem, in terms of fisheries development, is the high incidence of small fishing vessels in distress or lost at sea (12 to 15 in 1989-90). This seems to have resulted from the increasing use of outboard-powered craft instead of traditional paddling or sailing canoes, and has involved considerable expense, in terms of search and rescue, and loss of life. The main causes are poor engine maintenance and engine failure, overloading, running out of fuel after chasing tuna schools, and rain squalls that obscure islands (McCoy, 1991).

#### 4.4.7 Landform Destruction

Unique landforms such as swamps, reefs, lagoons and individual islands are found in Tuvalu and constitute important cultural and economic resources, especially in terms of the aesthetic, scientific, spiritual, recreational, ecological, touristic and agricultural importance. The destruction of these landforms, must be seen as a major environmental issue.

Perhaps one of the most obvious examples is the destruction of much of Fongafale islet on Funafuti to construct the airstrip during world War II. In addition to the runway taking up a major portion of the island, the acquisition of fill to build the runway during World War II has left one-third of the main islet of Fongafale riddled with useless excavated "borrow pits" which remain unsuitable for either settlement or agriculture.

Reef and island destruction due to dynamiting and sedimentation and the construction of causeways and boat channels are also widespread, but not as obvious.

#### 4.4.8 Nuclear Pollution

The Pacific, and in particular the ecologically fragile atolls, has one of the longest continuous histories of nuclear pollution in the world. There has been widespread testing of nuclear weapons, the continued presence of nuclear vessels and arms, and the past and proposed disposal of nuclear wastes. These must be seen as one of the most serious obstacles to sustainable development, both globally and for Tuvalu.

The U.S. has tested nuclear weapons on Bikini and Enewetak in the Marshalls, the British and U.S. on Kiritimati (Christmas) and Johnston Islands (a U.S. possession) in the neighbouring Line Islands. Most recently, the French have tested over 100 nuclear devices on Moruroa and Fangataufa atolls in the Tuamotus atolls of French Polynesia. There are also an estimated 8000 nuclear weapons stored and deployed by the U.S. and 40 Soviet nuclear submarines located in the Pacific. The Soviet Union, China and the U.S. also use the Pacific as an intercontinental ballistic missile range.

There have been joint U.S. and Japanese proposals for the "interim" storage of 10,000 tons of spent nuclear fuel from Japan, South Korea and the Philippines and two Japanese proposals to dump containers of high- and low-level nuclear waste in the Pacific. More recently, the U.S. has begun, as part of a "huge war dump burn-off" to burn millions of litres of toxic nerve gas and dispose of other dangerous weapons at a \$US150 million "chemical warfare base" on Johnston Island, despite strong objections by Tuvalu, the nearby Marshall Islands and Federated States of Micronesia, Kiribati and the other independent states of the Pacific Ocean. In spite of the opposition, the US military has already begun operations.

All of these activities have potentially very negative impacts on the shared oceanic and atmospheric environments and the health of the people of Tuvalu. The proven danger of such activities to the oceanic and island environments and the fatal somatic (to generations directly affected) and genetic (to future generations of affected individuals) damage induced in living organisms is widely documented. Evidence from the Marshall Islands indicates that the negative impact of radioactivity, in terms of the increased long-term incidence of a number of cancers and other health problems, extends far beyond the islands immediately affected and has possibly already had a negative long-term impact on the health of the people of Tuvalu.

#### 4.4.9 Non-nuclear Pollution

Non-nuclear pollution, including solid waste disposal, soil pollution, water pollution, and air pollution, is also a major concern in Tuvalu. As stressed by Greenpeace, although the total volumes of waste produced may not be large compared to other countries, the effects of the disposal of increasing amounts of waste on fragile small islands environments are likely to be extreme and constitute a very serious constraint to sustainable development. This is particularly true for atolls with limited fresh water supplies and inshore marine ecosystems that are easily contaminated (Stone, 1990).

Solid-waste disposal, e.g., the disposal of dilapidated motor vehicles, plastics, beer cans, unused domestic pesticides and pesticide containers (agricultural pesticides are currently not used in Tuvalu), waste oil, sewage sludge, and toxic wastes such as spent dry-cell and car batteries) is a major problem. Discarded motor vehicles, machinery and other solid waste can be seen along roads, the airstrip and beaches and in backyards and the borrow pits, creating hazards for children, serving as mosquito breeding sites, and restricting land use. Waste is normally disposed of by the Island Councils and the Health Department, although some individuals indiscriminately dump wastes because they do not want to pay fees for rubbish collection. Non-toxic waste has also been used for land reclamation in some cases. There are no sewage treatment plants with sewage sludge being dumped at sea off Funafuti using two sludge tankers.

There are no hazardous waste dumps for the safe disposal of batteries, polychlorinated biphenyls (PCB's), pesticide containers, out-dated pesticides, etc., the extreme health hazards of which may not be realised for years. Of serious concern have been the recent attempts by companies of dubious credibility to dispose of, in the atoll and oceanic environment, extremely hazardous wastes, the disposal of which is banned in the USA, as well as in most other countries where their disposal has been attempted.

Water pollution from domestic waste, leaching of agricultural chemicals (e.g. fertilisers), and increasing sedimentation are also on the increase. Oil pollution is increasingly common in Pacific harbours, and coliform bacteria (associated with faecal matter) concentrations are dangerously high near densely-settled atoll communities, such as in Funafuti. Although little documentation exists, the leaching of inorganic fertilisers into groundwater, and the concentration of these substances in food chains is undoubtedly also a problem.

Industrial air pollution is at present not a serious problem in Tuvalu, although smoke from wood burning stoves and open fires constitutes a significant health hazard, as excessive exposure to smoke has been linked with eye disease and lung cancer, especially among women, with studies in India indicating that women suffer extreme exposure to smoke pollution equivalent to smoking 20 packs of 20 cigarettes a day! (Smith, 1985).

#### **4.4.10 Energy Dependency**

The absence of proven fossil-fuel reserves in Tuvalu, makes increasing dependence on non-renewable fossil fuels one of the most critical constraints to sustainable atoll development. Petroleum imports, as a percent of domestic exports, have exceeded the value of exports over the past decade. This means, for example, that essentially more than every single dollar received from exports is used to pay for fuel. Such near absolute dependency on imported fuel for energy also leaves Tuvalu economically vulnerable because increases in oil prices are, in many ways, much more critical in the Pacific than they are in the U.S. or Japan. High fuels costs, for example, are currently one of the main obstacles to the economic viability of commercial fisheries in Tuvalu.

Further underlining the critical nature of increasing dependence on fossil fuels, is the rapid depletion of fuelwood. Fuelwood scarcity is particularly a problem for the urban

poor who cannot afford costly fossil fuel substitutes, such as kerosene. Firewood scarcity is the "real energy crisis" of the poor, and can only lead to further depletion of remaining fuelwood resources, associated environmental deterioration, and further fossil-fuel dependency.

On Vaitupu in Tuvalu, all households use fuelwood, including coconut and other biomass residues, with 80% using fuelwood for all cooking. On urbanised Funafuti, although 93% of all households used fuelwood, only 12.5 % used it exclusively, with 73.2% using both fuelwood and kerosene. Most cooking with fuelwood is done over open fires. Unfortunately, the efficiency of cooking over an open fire is very low: about 5 to 10% of biomass energy being converted to useful cooking energy.

Fuelwood, particularly, high quality fuelwood, is in short supply for urban households in the densely populated area of Funafuti, where because of increasing demands on scarce resources, partly due to the increasing cost of kerosene, it has been estimated that the biomass resource may be exhausted by 1990 (PEDP, 1990). Moreover, as stressed above, cooking over an open fire poses serious health risks from chronic smoke inhalation. There is, thus, a need for the development of more efficient and less-smoky stoves or means of cooking.

#### **4.4.11 Economic Vulnerability/Foreign Domination**

Tuvalu's economy is extremely vulnerable and dependent, with the high degree of foreign domination, either direct or indirect, which limits its autonomy to follow its own strategies to promote sustainable development. Five key constraints contribute significantly to this situation: poor fiscal integrity, over-reliance on foreign aid, limited range of exports, heavy dependence on imported food, and the previously discussed fossil-fuel dependency.

In terms of fiscal (financial) integrity, Tuvalu's limited financial resources severely limits its ability to initiate new and innovative programmes, and necessitate heavy reliance on borrowing or aid to finance even recurrent expenditures. This makes Tuvalu very vulnerable to political and economic changes in the donor countries and multilateral aid agencies, (e.g., regional or U.N agencies). Tuvalu, however, has shown in its negotiations related to licensing of fishing rights in its EEZ and the channelling of aid funding into a capital Trust Fund, that freedom to negotiate economic agreements is a major consideration in the sustainable development of a country's resources.

Tuvalu depends on a very narrow range of exports. Copra, fish and postage stamps constitute the only significant exports, with Tuvalu's only fishing vessel now fishing, as part of an South Pacific Commission research programme, in Solomon Islands and Papua New Guinea waters, because, as discussed above, fishing has been economically non-viable in Tuvalu's EEZ.

The economic implications of increasing food dependency are also serious, with the value of imported foods far exceeding the total value of domestic exports, a situation which augers poorly for the future given the limited productivity of atoll soils. Tuvalu's



population may have, in fact, outgrown its resource base, with its existing population unable to feed itself from available land and sea resources. Should the supply of imported food be cut off, some people could literally starve.

Other, often related economic problems, which auger poorly for sustainable development, include increasing income disparity within Tuvalu, rapid inflation and increasing unemployment, particularly in Funafuti.

#### 4.4.12 Deforestation

Few stands of economically and ecologically precious inland forest remain in Tuvalu, except on some uninhabited islands. Small areas of mangrove or ubiquitous coastal strand forest have been preserved in some areas, but deforestation is proceeding at a frightening rate. These few remaining coastal forests continue to be transformed into degraded vegetation, housing, government buildings, roads, airports or monocultural coconut plantations. The removal of coastal strand species and mangroves for fuelwood occurs in many areas, especially in Funafuti, and has led to accelerated coastal erosion, increased susceptibility to cyclone damage, and, in the case of mangroves, to a loss in one of the main sustainable sources of pig feed.

Although Tuvalu has some conservation legislation to protect bird and marine life, it does not have effective legislation to protect valuable tree resources against the onslaught of modernisation and population increase.

#### 4.4.13 Agrodeforestation

Although deforestation (the elimination of forests) has received most attention from the international community, probably of equal importance is "agrodeforestation" (Thaman, 1989), in the forms of both declining tree planting and the elimination of trees from agricultural and urban areas. The situation is particularly serious on atolls with little or no remaining native forest, where the main agricultural and food crops are trees, and where agricultural areas and houseyard gardens serve as the few remaining reserves where endangered plant varieties can be protected.

Most of the trees that provide food, timber, firewood, medicines and have served other important cultural and ecological functions in Tuvalu today have been planted or protected in the past, but are not being replaced or protected by the present generation. Opening a tin of imported rice or peaches for a feast, going to the local dispensary or pharmacy for medicines, or purchasing imported plastic flowers, perfumes and deodorants are increasingly replacing the products that depend on the planting or protection of trees! Only recently, for example, has the Tuvalu government begun to acknowledge that some 20 years of institutionalised coconut replanting and rehabilitation have led to serious "agrodeforestation" and the gradual elimination of a wide range of ecologically and culturally important tree species, all traditionally components of the sustainable Tuvaluan integrated agricultural system.

Although, as mentioned above, some countries have increasingly effective systems of forestry reserves, conservation areas, or national parks, few, if any, have legislation or programmes prohibiting the cutting, or promoting the replanting of important or endangered tree species as part of agricultural or other modern-sector development. Thus, agrodeforestation continues, with little or no official recognition or resistance to it.

#### 4.4.14 Species Extinction and Endangerment

Given the extremely poor floras and faunas and limited land area of atolls, habitat disruption and overexploitation have either brought to extinction or endangered many atoll plant and animal species. Once-common native trees favoured for woodcarving, such as Calophyllum inophyllum (fetau), Cordia subcordata (kanava), Lumnitzera littorea (sangale) and Thespesia populnea (milo), and a wide range of plants used to scent coconut oil, and for natural ornamentation and medicinal purposes are now exceedingly rare in many areas of Tuvalu. Even formerly abundant species such as Pemphis acidula (ngie) and Pisonia grandis (pukavai) are rare in many areas. As these trees become endangered so do the sea birds and other animals that depend on them for food, habitat or roosting. The elimination of groves of Pisonia grandis, the favoured nesting species for sea birds, for example, has led to a decrease in bird populations and the associated problem faced by fishermen of increased difficulty in locating tuna schools by the presence of sea birds.

There is also increasing scarcity of certain marine organisms, such as sea turtles, large reef cods (Serranidae) and giant clams (Tridacna spp.) and the spider conch or kalea (Lambis trochata). Smaller catches and decreasing average size of species individuals, indicate that atolls have been overfished in the past. There is also evidence of declining yields of flying fish, possibly due to local overfishing, and in yellowfin tuna, attributed to overfishing by long-liners and purse-seiners. Of great concern, is that increasing commercialisation of many of these species, such as tuna, baitfish, giant clams, and a wide range of other finfish and crustaceans, has put increasing pressure on these resources, thus underlining the need for protective legislation and sustainable production strategies.

#### 4.4.15 Soil Deterioration

Deforestation, the widespread practice of burning organic debris and the decline in traditional intensive mulching systems have led to soil deterioration in some areas of Tuvalu. In some areas the abandonment of giant swamp taro (pulaka) pits is due to waterlogging or excessive salinity of soils. Inorganic fertiliser use, which although greatly increasing immediate crop yields, and perceived, by some, as particularly needed in the atoll environments, seems to impoverish the soil of organic matter and destroy the natural nitrogen-fixing ability of the soil. Moreover, in the high pH soils of atolls the use of inorganic fertilisers is less effective and can lead to dangerous pollution of scarce groundwater resources.

#### **4.4.16 Limited Industrial Potential**

For Tuvalu, there is very limited potential for industrial development. This is due to limited mineral, water and land resources, coupled with isolation from generally protected overseas markets for manufactured goods and source areas of raw materials, and the high cost of imported fuel, technology and expertise, which limit the multiplier effect of industrial development.

#### **4.4.17 Inadequate Infrastructure**

Tuvalu has poor infrastructural development for the provision of government and non-government services to, and marketing of local products from rural areas. The pattern established during the colonial period, that of development of infrastructure to support export and military activities, tourism, etc., has in most countries been perpetuated in the post-colonial period. Marketing networks exist for copra, but few similar developments exist for the distribution of food crops to rapidly expanding urban areas. For example, one of the main constraints of providing more fresh food to urban Funafuti is lack of air transport (Funafuti is the only island with an airfield) and unreliability of sea transport. Similarly, as stressed above, diesel generated electricity is available only in urban Funafuti, with outer islands having very limited access to most social services.

#### **4.4.18 Rapid Urbanisation and Increasing Centralisation**

Rapid urbanisation, rural-to-urban migration and increasing centralisation of employment opportunities, social services, infrastructure and administration are major problems in Tuvalu, with most employment opportunities occurring in urban Funafuti, and to a lesser extent on Vaitupu, where the Government Secondary School is located.

These trends and urbanisation in general seem to be related to perceived better opportunities for personal or family advancement through cash employment and education or, more generally, to the incorporation of Tuvalu into the global cash economy, and, in some cases, to the very limited resource bases for further development in outer island rural areas. The result of course is unequal pressure on both natural and cultural resources of a country, and in most cases increasing emphasis on unsustainable development of scarce resources, including increasing population density, shanty-town development, social dislocation, and environmental degradation. These phenomena place undue stress on limited land and financial resources, while at the same time siphoning some of the most able persons from rural areas where they can contribute to more sustainable and equitable development.

#### **4.4.19 Inappropriate Education**

Although seen as the most important means for developing human capital, formal education in Tuvalu may be inappropriate in terms of its predominantly western, urban-industrial bias. Formal education generally prepares students for "white-collar" urban

and/or government jobs, and alienates the young from the traditional resource-use systems and wisdom of the past, only to replace it with imported, often ecologically and culturally-insensitive, overseas educational models.

Few of the younger generation know the names of native trees, the life cycles of marine organisms, planting technologies or traditional handicraft and food preparation technologies which have supported Tuvalu's people for generations. Inappropriate education must be seen as one of the major obstacles to capitalising on time-tested, ecologically-conservative social and scientific technologies of the past as bases for sustainable development. As suggested above, focussing on the appropriateness of ecologically-conservative social and scientific technologies (including traditional environmental education strategies) and their importance as foundations for sustainable development must, therefore, be seen as a priority in the formulation of appropriate development strategies.

This is not to suggest that emphasis should not to be placed on preparing our young people to play a productive role in the global cash economy, both at home and overseas. Rather, it is suggested that a better balance is struck between Western educational models and the promotion of traditional knowledge of relevance to sustainable development in the modern world.

#### **4.4.20 Landlessness and Land Alienation**

Land shortage, landlessness and land alienation are among the main constraints to sustainable development, whether economic, social or environmental, with land being sacred and integral to the very survival of Tuvalu's people and, along with marine resources, the only resource which will protect them from increasing vulnerability to a very unstable world economy, deterioration in terms of trade, inflation and other factors beyond the control of people at the village and community levels.

Landlessness, although related to population pressure, is a major problem in Tuvalu. This occurs in a number of situations: 1) where traditional lands have been alienated or leased by government (this is equivalent to about 59 ha or one-quarter of the land area of Funafuti); 2) where land has been fragmented through inheritance; 3) where immigrant groups from outer islands have limited access to land; 4) where there is simply a physical land shortage and correspondingly high population densities; or 5) where there is maldistribution of land (e.g., some families have relatively small land entitlements)(Pasefika, 1988).

#### **4.4.21 Introduction of Inappropriate Technology**

The "tropicalisation" or "atollisation" of mid-latitude, continental technologies is often inappropriate. Examples, such as mechanisation, the use of inorganic fertilisers, pesticides, herbicides, dynamite and small-gauge gillnets for fishing, imported animal breeds and crop varieties, and some imported foods and medicines have already been shown to be inappropriate in terms of increasing dependence on costly, imported

resources, the stress they put on the environment and human health, and their displacement of labour, etc.

There are countless other examples of inappropriate technologies that have been introduced into the atolls, sometimes with good intentions, such as goats, snack-food manufacturing using imported products, outdated drugs, etc., but the biggest problem in the short-run is probably the lack of trained local scientists and technicians who can assess new technologies before they replace existing, more appropriate technologies. Even when local scientists are trained, most end up working for production-oriented industries, with little involvement in research and development of appropriate technologies adapted to atoll conditions. As a result, most atoll countries are becoming increasingly dependent on expensive, often aid-tied, inappropriate imported technology.

Before the proliferation of international technical aid, atoll peoples were able to, on their own terms and at their own speed, observe, evaluate, and selectively adopt new technologies such as new crops, metal axes and hoes, outboard engines, spearguns, fish hooks, etc. which they saw as appropriate. Today, with aid-tied technological assistance, well-warranted reluctance is often seen as backwardness, and widespread technological change is often implemented before the long-term environmental and social implications are fully understood. Such considerations are critical in the fragile atoll environment, with its scarce groundwater and soil resources and fragile ecosystems.

#### **4.4.22 Social Disintegration**

Although not widespread, signs of social disintegration are increasingly common in Tuvalu, especially in urban areas. The extended family system and wider kin-based, traditional "social security" systems are weakening, with nuclear, often broken families, becoming increasingly common. Theft, forgery, assault and minor crimes of violence are increasingly widespread in Funafuti. Much of this has been associated with increasing use of alcohol and drunkenness. Increasing consumption of alcohol and alcoholism, as both a major social problem and a health problem, have caused concern in urban Funafuti. Excessive alcohol consumption has negative effects on work attendance and performance, as well as on the proportion of incomes which reach families in the form of nutritious foodstuffs. As an energy-rich substance alcohol is a major cause of obesity, and has been shown to lead to higher rates of heart disease, cancer, and is the major cause of cirrhosis of the liver. It is also highly correlated with increasing rates of homicide, fatal traffic accidents, and crimes of violence in the Pacific.

"White-collar" crimes, such as embezzlement, bribery of officials, unethical business practices, tax evasion, illicit remission of large sums of money overseas, abuse of public office, and various other forms of corruption, increasingly widespread in the Pacific, are so far virtually nonexistent in Tuvalu, but are something which must be guarded against.



#### 4.4.23 Inequality of Women

Women have traditionally played a critical, often dominant role in Tuvalu society. They are cultivators, livestock husbanders, fishers (primarily reef gleaners), producers of handicrafts and material goods, and have primary responsibility for food processing, preservation, and preparation and child-rearing. In the modern development process, however, women's status seems to have deteriorated. Although not as serious as in Melanesia, modern development in Tuvalu has not involved women at the higher levels in both the planning and participation phases commensurate with their roles and contribution to "traditional development". In 1990, there were no women represented in the four highest grades of Government employment (Grades 1-4)(Booth, 1991).

Commercial agriculture, capital-intensive livestock schemes, commercial fishing development, access to new technologies, credit, upper-level government employment and cash employment in general are predominantly male-centred, although it is planned to involve women in commercial fish processing and marketing. With increased cash cropping, deforestation and commercial fishing near villages, women must go further afield to obtain food and firewood to prepare the family meal. The increased use of imported household goods (e.g., mattresses, pillows, blankets, plastic bags, etc.), imported foods and medicines and the increasing dependence on breastmilk substitutes, has affected women's role in family and community development, although women's handicraft production has, with the decline in copra production, emerged as an important village-based cash-earning activity.

Male domination in the leadership of administrative areas of government, political parties, religious bodies and planning agencies is the predominant trend in Tuvalu, although a woman is currently the Minister for Health, Education and Community Services, and in 1990 a woman was appointed to the Public Service Commission. Such discrimination, especially where women are the sole repositories of a great body of priceless traditional ecological, social, medicinal and nutritional wisdom, can only compromise the prospects for sustainable development . . . for both men and women!

#### 4.4.24 Pest Infestations

Pest infestations have considerable negative impact on sustainable atoll development, especially where monocropping or large-scale livestock operations, and indiscriminate use of pesticides by humans are concerned. As such, they are seen as cultural issues, although they in fact may be at least partly related to natural phenomena.

Fortunately, Tuvalu, because of its isolation, is relatively free from major agricultural pests, such as the Papuana taro beetle which has seriously affected the production of giant swamp (Cyrtosperma) taro and bananas, both important staples in Tuvalu.

Other destructive pests include rats (which are a major pest of sweet potatoes), unpenned domesticated animals, particularly pigs and goats, which cause considerable

damage to both commercial and subsistence crops and vegetation. There have also been periodic outbreaks of coccidiosis and a number of other poultry and swine diseases on large-scale poultry and pig farms elsewhere in the Pacific. Such outbreaks have considerable negative impact on commercial livestock production, as well as necessitating the increasingly widespread prophylactic (preventive or protective, rather than curative) use of drugs in large-scale livestock operations. The development of such practices, for economic reasons, has shown to lead to the development and accumulation, in animals, of resistant bacteria strains, which are then passed on through the food chain to humans.

Although currently restricted to many of the larger islands at present, without a strengthening of agricultural quarantine procedures, many of these crop and animal pests could become serious obstacles to sustainable development in Tuvalu.

#### **4.4.25 Overgrazing**

Overgrazing, although most common on the larger islands of the western Pacific, where it has led to severe soil erosion, uncontrolled foraging by pigs and devegetation by aid-funded introductions of goats in Tuvalu has led to a loss of scarce plant resources.

#### **4.4.26 Mining-Induced Damage**

Environmental damage associated with mining, as suggested above, is a major concern in Tuvalu, only in terms of the removal of limestone rock, coral and sand for construction and reclamation purposes. The proposed dredging of fill for the reclamation of the Borrow Pits on Funafuti could also be of concern, although the potential impact on the lagoon ecosystem will be closely monitored under the SOPAC-run pilot project to reclaim a limited area of the Borrow Pits.

#### **4.4.27 Tourism-Induced Disruption**

Tourism has some potential for developing underutilised resources and diversifying Tuvalu's economy. It is an increasingly important source of foreign exchange in Fiji, Tonga, and the Cook Islands, and is a major industry in Guam and French Polynesia.

There are, however, aspects of tourism which may be detrimental to sustainable development in Tuvalu. The pre-emption of land and the inflationary impact that hotel development has had on land values are of major concern. Others include the limited involvement of locals in upper-level jobs and management, and its role in cultural erosion in terms of its effect on the significance of traditional art, artefacts and ritual ceremonies, which are "produced" for the tourist. It has been reputed that tourism has "killed agriculture dead" in areas such as the Caribbean, leads to violence between locals and tourists, and, in general, carries significant social costs. There are also ecological consequences of the pre-emption of land, foreshore, scarce fresh-water supplies, and the capacity of the environment for waste disposal in Tuvalu.

Problems relating to tourist-local interaction, such as tourism-related pornographic and sex-related developments, criminal acts against tourists, tourism arrests for drug offences, and land disputes are only some of the signs of the "fading smiles of tourism" elsewhere in the Pacific. Finally, all of the above aspects of tourism, plus its almost total dependence on the health of the "leisure revolutions" in source countries and on the uncertainty of international air transport in Tuvalu makes tourism development exceedingly vulnerable to the vagaries of the world economy.

The potential for disruption is real, but so are the benefits, given the limited development options of atoll nations. In Tuvalu, there has been some benefit from sale of local handicrafts, a large percentage of which are to transit passengers passing through Funafuti on flights between Fiji and Kiribati and the Republic of the Marshall Islands.

#### **4.5 A PLEA FOR CULTURALLY AND ECOLOGICALLY APPROPRIATE ACTION TO PROMOTE SUSTAINABLE DEVELOPMENT**

Perhaps the real overriding constraint to the promotion of sustainable development, not only in Tuvalu, but throughout the world is inaction in the face of clear evidence that current models of development are not sustainable in ecological and cultural terms. In short, it is not enough to focus solely on problems or constraints to atoll development, and to malign the "development community", including our own "managerial elite", for our continued degradation of atoll resources and cultural traditions. We must be prepared to be innovative and actively search out strategies which achieve a balance between traditional and modern ways of production.

The image of the fragmented, isolated, overpopulated and land- and resource-poor atoll state of Tuvalu, beset with problems of frequent natural disasters, species extinction, widespread deforestation and agrodeforestation, soil impoverishment, breakdown of ecologically conservative traditional land and marine use systems, major nutritional and health problems, nuclear and non-nuclear pollution, inappropriate education, and signs of social breakdown, is grim to say the least. At first sight, these many and varied environmental and cultural constraints to development in Tuvalu seem almost unsurmountable. Fortunately, there may be "a way forward", because the situation in Tuvalu does NOT seem to have reached the critical, perhaps irreversible stage, that it has in other regions. Although many traditional cultures and their strategies have disappeared from the earth, Tuvaluans have maintained a high degree of cultural integrity because several of their ways of life (particularly their traditional agricultural and marine resource-use systems) have assets which seem especially valuable as a basis for sustainable development. Despite the great challenges and environmental and cultural constraints to such development, there is an endless array of strategies that have either been time-tested in the atoll environment, or which have proven successful elsewhere. There are also yet unproven technologies and strategies which could benefit Tuvalu. These could very well solve some of the problems of capital-poverty faced by most atoll states, thus allowing them to participate more fully in the benefits of the global cash economy.

The question which must be asked, however, is whether it will be possible to learn from the mistakes made in other countries and return to a more sustainable standard of

living which can provide everyone in Tuvalu with at least a reasonable level of "subsistence affluence". The waters, soils, animals, plants, oceans and minerals were traditionally allies keeping Tuvaluans in this state of affluence as long as their relationship with the natural environment remained symbiotic and sustainable. Scarce atoll resources were treated not as income to be spent, but as capital to be cared for, and preserved as the basis for future generations' subsistence affluence. It was a system where humans, their physical and spiritual needs, and their culture were very integral parts of the atoll ecosystem. To remain an effective and stabilising force in the system, it was critical that humans understood its internal makeup and functioning, and most importantly, the impact that their quest for basic needs and "luxuries" had on it.

Unfortunately, or more appropriately, tragically, most cultures are steadily losing their traditional understanding of human ecological principles, particularly the concept of ecological scarcity. Modern development and the "commercial imperative" have changed our resource perception. It has taken us from traditional, in-the-community, in-the-field education and put us into schools where we are taught less and less about our place in, and effect on the environment, and more and more about how we can exploit its resources to further "development". What is happening, is that almost two thousand years of human and experimentation in the atoll environment ... empirical education... is being cast aside for imperfect, untested models developed during the relatively short span of only two hundred years since the industrial revolution and the expansion of the European cultural realm over the earth's surface.

The signs of social and ecological breakdown are clearly before us. Today's development agendas seem to be taking the atolls further adrift towards increasing dependency, social breakdown, and ecological ruin. The critical constraint is whether the rapidly emerging Pacific atoll "managerial elite" (politicians, policy makers, community leaders, educators and agricultural and marine scientists), at the national and regional levels, will selectively foster the conservation, modification and adoption of those traditional or existing strategies which seem to have relevance today, along with appropriate introduced or locally-developed new strategies, which could provide the appropriate foundation for sustainable atoll development and a better modern life for our people.

## **SECTION II**

### **RESPONSES AND PRIORITIES FOR PROMOTING SUSTAINABLE DEVELOPMENT**

Whereas Section I provided an overall picture of the potential for and constraints to sustainable development in Tuvalu, Section II includes chapters on 1) responses by the Tuvalu Government to address the constraints to, and to promote sustainable atoll development, and 2) a prioritisation of the constraints and opportunities for future action.



## CHAPTER 5

### RESPONSES TO ENVIRONMENT/DEVELOPMENT ISSUES

#### 5.1 ENVIRONMENTAL ISSUES IN PERSPECTIVE

Because Tuvalu is comprised, almost entirely, of extremely small low-lying atolls rising only a few metres above sea level, and because of the fragility of its ecosystems, the scarcity of its terrestrial resources and the vulnerability of the country's atoll environment and its subsistence economy to the forces of external development beyond its control, environmental planning, management, protection and the promotion of sustainable development are of utmost importance.

Consequently, despite the absence of a comprehensive environmental protection plan, the Government of Tuvalu has accorded environmental protection and management a very high priority. In his May 1991 "Speech from the Throne" (a tradition within the Commonwealth whereby the Head of State addresses Parliament), the Governor General of Tuvalu, Sir Toaripi Lauti, highlighted the main thrust of the Government's efforts in addressing environmental issues:

. . . given the vulnerability of Tuvalu to the hazards of environmental degradation especially with regard to global warming and the sea level rise and interference in the natural ecology of life in the sea, my government has now placed this sector as one of its priorities. Accordingly, my government has adopted a two-tier strategy, firstly to use all international fora to publicise its views on the dangers of environmental degradation and to seek the assistance of its development partners . . . in monitoring domestic activities and minimising the adverse effects of growth and development on the environment. At the domestic level the activities in this area will be in two areas. The first is the monitoring of climatic change especially with regard to sea level rise and frequency of cyclones and dry spells. Secondly, measures are being considered for the monitoring of industrial and household pollution with a view to control and elimination. In pursuit of these objectives, my government has decided that, whenever appropriate, environmental impact assessment will be undertaken as an integral component of any development project. The vital requirement to safeguard the natural environment while improving the economic

productivity of the nation's resources implies that environmental considerations should be more effectively integrated into the development and planning process.

The chapter on "Land Management, Environment and Conservation" in National Development Plan IV similarly sets out the aims of the Government of Tuvalu as "to bring about improved land management and environmental control through better utilisation of the country's very scarce land and environmental resources". Specifically, the government aims to:

1. Maximise the development potential of the land and its resources, while recognising the rights of customary ownership of the land.
2. Control coastal erosion and protect the land area against encroachment by the sea.
3. Reclaim land where possible and where it will not cause greater environmental damage.
4. Protect the environment from pollution and from unnecessary exploitation beyond the immediate needs of the people.

Tuvalu has, already in place, or is party to, some national legislation, international initiatives and sectoral policies addressing specific environmental concerns.

## **5.2 NATIONAL LEGISLATION**

Existing national legislation relevant to specific environmental concerns, such as: 1) land or resource use and management and access to terrestrial and marine resources, 2) coastal management and protection, 3) conservation of strategic or endangered marine and terrestrial resources, 4) water, sanitation and environmental health, and 5) control of specific potentially polluting, dangerous or environmentally disruptive substances and materials, include:

### **Land or Resource Use and Land Management**

1. Native Lands Act, relating to native lands and registration of the titles thereof.
2. Neglected Lands Act, to provide for the purchase of neglected land and to regulate the sale thereof to indigent natives.
3. Closed Districts Act, to provide for the declaration of closed districts.

4. Prohibited Areas Act, to provide for certain islands and their territorial waters to be declared prohibited areas.
5. Mineral Development Licensing Act, to regulate the granting of licences to search for and win minerals.
6. Marine Zones (Declarations) Act (1983) to make provisions in respect of the internal waters, archipelagic waters, the territorial sea, the exclusive economic zone (EEZ) and the contiguous zone of Tuvalu.

#### **Coastal Management and Protection**

7. Foreshore and Land Reclamation Act, to declare the ownership of the foreshore and regulate certain reclamation projects.

#### **Conservation of Strategic or Endangered Marine and Terrestrial Resources**

8. Plants Act, to provide for the protection of endangered or culturally important plants species within Tuvalu.
9. Wildlife Conservation Act, to provide for the conservation of wildlife, in particular birdlife.
10. Fisheries Act, to regulate fishing and fisheries industries and to provide for the protection of specified fish species in Tuvalu and within its EEZ.

#### **Water, Sanitation and Environmental Health**

11. Public Health Act, to maintain adequate standards of public health.
12. Water Supply Act, to provide for the protection of water supplies.
13. Quarantine Act, to regulate the importation of agricultural and other products which may harbour pathogens of danger to sustainable development.
14. Importation of Animals Act, to regulate the importation of animals.

#### **Control of Specific Potentially Polluting, Dangerous or Environmentally Disruptive Substances and Materials**

15. Wrecks and Salvage Act, to provide for rights to wrecks and salvage.

16. Merchant Shipping (Oil Pollution)(Tuvalu) Order (1975), to apply provisions of the U.K. Merchant Shipping (Oil Pollution) Act of 1971.
17. Nuclear Installations (Gilbert and Ellice Islands) Order (1972), to apply provisions of the U.K. Nuclear Installations Act of 1965.

Although there is undoubtedly a need for further legislation to address specific environmental issues, there is considerable scope under the existing legislation for initiatives which can further the interests of conservation of natural and cultural resources and sustainable atoll development. In addition, there may be the need to update existing laws through marginal amendments so that they become more effective tools for environmental protection and management.

There is, in particular, the need, as the 1988 ESCAP Mission on the Environment recommended, for Tuvalu to enact an organic framework legislation of the "national environment protection policy law" type to complement existing legislation. The purpose of this framework legislation would be to establish overall integrated policy, implementation procedures (environmental impact assessment) and co-ordination among ministries charged with environmental protection for policy development, monitoring and feedback. In this vein, the recent preparation of a draft Marine Pollution Bill as the domestic instrument for the implementation of Tuvalu's obligations under the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP Convention) has afforded Tuvalu the opportunity to review its environment-related legislation. The review has pointed to the need for more comprehensive legislation, of the type envisaged by the ESCAP mission.

In addition, the Local Government Ordinance which provides for the establishment of local government through a system of Island Councils, includes, among the Councils' wide-ranging functions, several functions which relate to environmental management and protection in areas such as agriculture, livestock and fisheries, building/town/village planning, forestry and trees, land management/protection (including the prevention and control of land erosion by the sea or other causes) and public health. Pursuant to the provisions of the Local Government Ordinance, several councils have bye-laws prohibiting certain fishing methods (e.g, the use of pressure lamps and fishing nets to catch flying fish and prohibiting the use of motorised boats for trolling) with the view of either conserving existing stocks or ensuring more equitable benefit from the resource to all members of the community.

### 5.3 INTERNATIONAL CONVENTIONS

Because of the small size and limited political leverage of Tuvalu and other Pacific Island states, regional and international conventions and initiatives have shown to be among the most effective ways of addressing global, international and some national issues.

Tuvalu is a signatory, or has acceded to the following environment-related conventions:

1. South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty)
2. Nuclear Non-Proliferation Treaty
3. Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific (Tarawa Convention)
4. Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (SPREP Convention).

In relation to the above conventions, the Government of Tuvalu has concluded a Nuclear Safeguards Agreement with the International Atomic Energy Agency in implementing its obligations under the South Pacific Nuclear Free Zone and Nuclear Non-Proliferation Treaties.

By December 1991 the Fisheries Act will have been amended sufficiently to enable the ratification of the Driftnet Convention.

A Marine Pollution Bill has been drafted to implement the SPREP Convention obligations, and should be introduced to Parliament in late 1991.

#### **5.4 CO-ORDINATION OF ENVIRONMENTAL PLANNING**

Environmental protection/management is not the concern of a single ministry, with each ministry being actively involved with specific environmental concerns which fall directly within its area of responsibility. Only recently, following the election of the present government, have attempts been made to co-ordinate national environmental protection and management efforts through the Office of the Prime Minister.

The Prime Minister, The Honourable Bikenibeu Paeniu, who has a very strong interest in, and commitment to environmental matters and sustainable development, has participated in, and addressed, many international meetings on the environmental problems of Tuvalu and the Pacific Islands. The Cabinet, as the executive body in which inter-sectoral policies are discussed and formulated, also contributes to the co-ordination of environmental protection and management in Tuvalu.

However, the Secretary to Government and the Assistant Secretary General, who presently handle environmental matters, also have other responsibilities, and are, thus, unable to give environmental issues the full attention they deserve. Thus, consideration is being given to the strengthening of the role of the Office of the Prime Minister in environmental management through the establishment of an Environmental Planning Unit. This unit will be responsible for formulating and implementing a multisectoral programme of environmental planning and management. In the long term, the co-ordinating role of



this unit will be strengthened with the establishment of an inter-sectoral Advisory Committee comprising representative of all ministries. Rather than establishing an entirely new committee, the present National Development Strategy Committee (which is also the National Task Force in the preparation of this report), chaired by the Prime Minister and comprising all Secretaries, could become the Advisory Committee on environmental planning and management and double as an "Environmental Planning Unit".

## **5.5 LAND USE MANAGEMENT**

The Lands and Survey Department of the Ministry of Natural Resources and Local Government is responsible for land management. The main issues in land management, according to the National Development Plan IV, are:

1. Inefficiencies of land use resulting from customary land tenure.
2. The out-of-date land ownership register, which makes disputes over land more complicated and the transfer of land to new owners at times difficult.
3. Inadequate information on land resources, which restricts planning, particularly for agricultural development.

In responding to these problems, Government has proposed to introduce a new and comprehensive land register designed to more accurately inform all landowners of land titles. In addition, the University of Auckland, with funding from the United Nations has undertaken a Land Resources Survey of Tuvalu. The survey which involves the gathering/interpretation of data on present land use, land forms and soil analysis and investigation of the nature and quality of ground water, has provided adequate information for planning future land use, with particular emphasis on agricultural development.

The capital island, Funafuti, has a Land Use Planning Committee which implements some guidelines for urban development and oversees the physical development of the island. Acquisition and disposition of land throughout Tuvalu are governed by a number of laws, including the Crown Acquisition of Lands Act, the Native Lands Act and the Tuvalu Lands Code.

## **5.6 AGRICULTURE**

The aim of agricultural development in Tuvalu, according to National Development Plan IV, is to improve the standard of living of those who are involved in agriculture for subsistence living and cash income. Specific aims are to:

1. Increase the productivity of subsistence farming and, thereby, help to meet the increasing demand for food arising from the increase in population.
2. Develop commercial agricultural production, primarily for the growing local market on Funafuti.

3. Increase the amount and variety of locally produced foods to reduce dependence on imported foods.
4. Develop alternative farming opportunities which may provide reasonable cash returns to farmers consistent with fair consumer prices.
5. Develop and improve the capacity of the Agricultural Division to support agricultural development equitably on all islands.

Agriculture is, next to government employment, the second major commercial economic activity and the major source of subsistence income in Tuvalu. As such, the agricultural environment and the atoll agricultural system must be considered, perhaps, the most important basis for sustainable habitation of Tuvalu. The principal crops, which have sustained the people of Tuvalu for over a thousand years, include coconut, giant swamp taro or pulaka (Cyrtosperma chamissonis), taro (Colocasia esculenta), pandanus (Pandanus tectorius) and bananas (Musa cultivars), with coconut being the major export cash crop. Poultry and pigs are raised for local consumption.

The emphasis of the Government's agricultural policy has been on maximising self-sufficiency in livestock production, improving the productivity of coconuts for export of copra and the introduction of new and improved food crop and fruit tree varieties.

In implementing agricultural projects, the overall aim of Government has been to ensure that projects can be sustained without heavy cash or short-term high technology input. Further, staff levels and ability have to be matched to the level of agricultural development that can be sustained by the extremely fragile ecosystem. Simple but sustainable farming systems must be used and modified, according to the proven ability and experience of farmers, as well as being linked to the community.

There are at present three major agricultural programmes, namely 1) Food and Crop Production, 2) Livestock Production, and, 3) Agricultural Support Services.

#### 5.6.1 Food and Crop Production

Through the Food and Crop Production Programme, the Government's major objective is to increase the output levels and productivity of food production to meet the consumption needs of a growing population. It will do this by introducing new and improved varieties of food crops. A major strategy will be the introduction of tissue-cultured, virus-tested, new varieties (cultivars) of crops already grown, and familiar to farmers and consumers, in Tuvalu, to improve productivity, whilst not infringing quarantine requirements. Also, under this programme the output level and quality of copra will hopefully be improved. The component projects under this programme include:

1. Coconut Improvement, under which small demonstration seed nut gardens have been established on all outer islands, using hybrid seed nuts produced

at Vaitupu, to demonstrate to farmers the benefits and better yields obtainable from improved hybrid varieties.

2. Horticultural Promotion, which include the investigation of simple systems for atoll agricultural production, e.g hydroponics and other soil-less systems, improved mulching systems, etc. One objective would be to reduce the effect of nematode infection, particularly in taro and bananas.
3. Sweet Potato (Kumala) Production, in which the main emphasis will be on stimulating the production of the staple crop, sweet potato, on other islands besides Vaitupu, and to increase the availability and sale of kumala on Funafuti. The Agricultural Division will provide incentives to farmers in the form of subsidised supplies of wire fencing, fertiliser, mechanical inputs and tools. Initial targets for this crop are a total area of 6 hectares and a yield of 190 tonnes per annum, when full production is attained.
4. Bee-keeping, where the main emphases will be on making bee-keeping socially acceptable and the promotion of export markets, taking into consideration the uniqueness of Tuvalu honey as bees feed exclusively on coconut flowers and that it is produced in a totally disease- and pollution-free environment.
5. Fruit and Nut Tree Introduction, in which new species and varieties of fruit and nut trees, that have promise in the atoll environment, have been introduced in the past and will continue to be promoted under a regional project. 25 different varieties of fruit and nut trees, including a wide range of citrus cultivars have been tested on Vaitupu and some other islands. Work is also being conducted on improved banana varieties.

### 5.6.2 Livestock Production

Under the Livestock Production programme, the Agricultural Division will continue to support both backyard and commercial farmers in order to increase the level of livestock production and to meet the current local shortfall in the demand for meat and eggs. The main objectives will be to improve productivity levels through better husbandry techniques and breed improvement, and to encourage a more commercial attitude among farmers. The main components of this programme are the Pig and Poultry and Egg Production projects, with particular emphasis on the development and use of local food sources, including coconut, domestic waste, new cassava varieties and tilapia (*Oreochromis niloticus*) which is abundant in the mangrove areas of Funafuti.

### 5.6.3 Agricultural Support Services

The main aim of the Agricultural Support Services programme is to ensure that trained agricultural staff are capable of providing an improved level of extension service to

all islands. In addition, planning and management systems will be introduced to enable better informed decisions to be made on research and development, as well as reducing the administrative and research costs.

The Agricultural Support Services will support and encourage farmers, through a range of complementary services, to adopt new methods of farming and new varieties and breeds of crops and livestock. Through this programme, farmers will also be involved in decisionmaking relating to agricultural developments.

The main projects under the Agricultural Support Services are: 1) Information and Data Base, 2) Extension Services, 3) Research, 4) Quarantine, 5) Pest Control, 6) Rat Control, 7) Agricultural Revolving Fund, 8) Staff Support, 9) Staff Training, and, 10) Farmer Education.

## 5.7 FISHERIES

Marine resources are Tuvalu's major asset in terms of unexploited resource development potential. Subsistence fishing is the most prevalent form of fisheries development, with fish constituting the main source of dietary protein in Tuvalu. Non-motorised boats and small-scale gear are the predominant technologies employed and the outrigger canoe is an important capital asset. There is, thus considerable potential for sustainable development and modernisation of fisheries resources, which could provide the essential foundation for economic and social advancement by the country's largely subsistence population. The specific aims for the Fisheries sector, according to the National Development Plan IV, are:

1. Development of a commercial fishing industry based on the sustainable exploitation of all the country's marine resources, involving artisanal, small-scale commercial and industrial fisheries.
2. Maximisation of the export-earning potential of fisheries while continuing to meet local demand for fish and fish products.
3. Encouragement of participation in this development by fishermen on all islands in the country.
4. Promotion of fisheries-related activities, such as processing.
5. Promotion of the development of aquaculture and other miscellaneous marine resources as the basis of a small-scale fisheries industry.
6. Maximisation of returns available from foreign vessels fishing in Tuvaluan territorial waters.

To achieve these aims, Government policy has been to upgrade subsistence fisheries to an artisanal level in an endeavour to satisfy demand for fish on the domestic

market. In terms of more commercial or modern development of the fisheries sector, the thrust of Government's efforts is in four main areas: 1) Commercial Fisheries, 2) Foreign Fisheries Licensing, 3) Development of Aquaculture and Miscellaneous Species, and 4) Institutional Development.

#### **5.7.1 Commercial Fisheries**

The Commercial Fisheries programme which incorporates elements of both small-scale commercial artisanal and industrial fisheries, involves ten component projects: 1) Commercial Fisheries Management, 2) Fish Marketing and Processing (on Funafuti), 3) Jetty Improvement and Slipway Development (for fisheries vessels), 4) Community Fishing Centre Development (on each of the outer islands to provide a focus for the development of artisanal and commercial fisheries), 5) Provision of an Extension/Collection/Research Vessel, 6) Provision of Commercial Fishing Vessels, 7) an Artisanal Fishing Loan Scheme (a fund to be established within the National Bank of Tuvalu through which fishermen will be enabled to purchase boats and equipment), 8) Extension Services, 9) Channel Improvement (on Vaitupu), and 10) Survey of Ciguatoxic Fish Poisoning. Also an important component of commercial fisheries development is the deployment and maintenance of fish aggregation devices (FADs) in an attempt to increase catches and to reduce effort and distances travelled per unit catch (i.e., make fishing more economic).

#### **5.7.2 Foreign Fisheries Licensing**

Under its Fisheries Licensing Programme, the Government of Tuvalu will continue to negotiate/renew agreements with foreign fishing nations, both through bilateral and multilateral arrangements. The Government will also finalise work on the delineation of the country's 200-mile Exclusive Economic Zone (EEZ) and continue to look into cost-effective means of surveillance of the EEZ.

#### **5.7.3 Development of Aquaculture and Miscellaneous Species**

The Development of Aquaculture and Miscellaneous Species Programme will concentrate on: 1) Trochus Development, where transplantation of seeds will be carried out to the lagoons of Nukulaelae, Nukufetau, Funafuti and Nanumea; 2) Giant Clam (*Tridacna*) Culture, with seed clams imported from Palau; 3) Investigation of the viability of milkfish farming for baitfish and local subsistence requirements; 4) Cultivation of Eucheuma Seaweed, as a potential export commodity, in Funafuti lagoon, with plans for extension to other islands; and 5) Beche-de-Mer Development, where the objective is to encourage an entrepreneur to develop a private beche-de-mer export trading company in involving a foreign partner with international links to the Asian, or other appropriate markets.



In terms of programme implementation: 1) trochus have already been successfully introduced into the lagoons of Funafuti, Nukulaelae, Nukufetau, Nanumea and Nui, with legislation in place to protect them from predation for human food until production reaches a sustainable level; 2) a thousand baby giant clams (*Tridacna derasa*) from Palau were introduced into a protected area of Funafuti lagoon on an experimental basis in 1988, although only about 100 seem to have survived a recent tropical cyclone; and 3) a recent *Eucheuma* seaweed trial on Nui was very successful, although trials on Funafuti were unsuccessful due to destruction by big waves.

#### 5.7.4 Institutional Development

The Institutional Development programme has the objective of ensuring that the Fisheries Division is adequately staffed and resourced to carry out its various functions. Specific projects under this programme include: 1) Structuring of the Fisheries Division, with provisions for both an expansion and upgrading of staff, 2) Training, which involves basic training of staff at Diploma and Certificate levels in various aspects of fisheries, fish handling and marine engineering, as well as courses for upgrading existing staff, and 3) Resource Assessment, involving the collection of data on catches by domestic fishermen, analysis of catch, evaluation of deep bottom finfish and pelagic resources, and monitoring of baitfish resources. The latter project will provide essential data for the planning of both commercial and industrial fisheries development and conservation purposes.

### 5.8 COASTAL EROSION

Coastal erosion is a continuing problem for all Tuvalu's islands. A report on the extent of coastal erosion released in 1982 indicated that all islands except Niutao have very real and urgent coastal erosion problems. It is very difficult to estimate the actual rate of erosion, although NDP IV and the 1988 ESCAP Mission Report have indicated that in some locations erosion is occurring at a very serious rate of ten metres every ten years (one metre per year).

The most common form of coastal protection used on most islands in the past has been the "Gabion basket" sea wall, which consists of local materials, such as coral limestone, enclosed in wire cages. These, have been found to be ineffective, so it has been recommended that erosion could be better controlled through the combined use of local and imported materials in the form of rubble mound protection using modified concrete blocks (cubes). The 1982 Report established the extent of protection work required to be 4,274 metres and involving six islands. Phase One of the Coastal Protection programme began during the period of the last Development Plan (NDP III) from 1984 to 1988 and covered the islands of Nanumaga, Nukulaelae, Nukufetau and Vaitupu. Funding was provided by the European Community (EEC). Phase Two of the programme began in late 1987 and covered Funafuti, Nui and Nanumea. The total length of coastal protection work to be covered by Phase One and Two would be 1,970 metres, less than 50 per cent of the total protection work required. Unfortunately, the programme has been thus far unsuccessful because the 300 cm x 300 cm modified concrete blocks have been displaced by waves as small as one metre in height. Inadequate supply of local fill materials, the

high cost of imported cement and other materials, and the lack of equipment needed to transport and emplace larger, more effective blocks are major constraints to programme success.

There is evidence that the development of reef passages or boat channels by blasting reef coral has accelerated coastal erosion in some areas. Subsequently, attempts have been made, and are continuing, to minimise the effects of reef passage and boat channel development on the foreshore (See section on Reef Passages below).

## **5.9 LAND RECLAMATION**

There is a considerable area of degraded land in Tuvalu caused either by encroachment by the sea or by human activities, such as the construction of the airfield on Funafuti during World War II. A priority is the reclamation of these lands.

The major reclamation project is the proposed infill of some 52 hectares of wartime "borrow pits" and swampland on Fogafale islet of Funafuti resulting from the construction of the airfield during World War II. The project proposes to dredge the Funafuti lagoon for sand and other lagoon bed materials which will then be used as infill for the "borrow pits". A pilot study by the South Pacific Applied Geoscience Commission (SOPAC) to reclaim 2500 to 5000 square metres of borrow pits using a specially designed dredge, is currently under way to assess the suitability of sand and sediments from the lagoon for reclamation and the impact of dredging operations on the lagoon. Baseline studies have already been conducted and the dredge has been completed in Suva, Fiji. Actual dredging could start in early 1992.

On Nukufetau and Vaitupu, some areas of degraded lands have been identified for reclamation possibly through the construction of seawalls.

## **5.10 PUBLIC WORKS**

Many of the Public Works Department's development projects and regular construction and civil works require the use of materials from the foreshore, particularly sand and limestone aggregate. Fully aware of the impact of the removal of these materials in terms of accelerated erosion, attempts have been made to minimise the removal of such materials from foreshore sites. To this end, the Funafuti Island Council has a bye-law which prohibits the removal of sand and aggregates from specified areas. In areas other than those specified in the bye-law, a licence is required. The licence is normally granted on the Council's satisfaction that the removal of the materials will not contribute to accelerated erosion.

Also as part of the attempts to minimise the removal of sand and aggregates from the foreshore, the Public Works Department currently use the huge 18 km-long rubble rampart ("coral dam") on the southeastern ocean side of the atoll which was formed by Tropical Cyclone Bebe in October 1972 as the main source of aggregate materials. The environmental impact of the removal of material from the rampart has not been monitored.

## 5.11 WATER AND SANITATION

The Water and Sanitation sector continues to be accorded a high priority in recognition of the fact that in order to be healthy and be able to lead a satisfactory life, the population requires:

1. An adequate supply of water for drinking, cooking and washing and other uses; and
2. Suitable methods of disposal of used water and wastes (including solid wastes) to prevent the spread of diseases through either direct contact with wastes or indirect contact through the use of polluted water or infection by flies or mosquitoes.

The main legal responsibility for ensuring that water supply and sanitation facilities are provided rests with the Island Councils (Chap. 19 Local Government Act). Since the Island Councils lack the resources and capability to fully implement this responsibility, the Central Government has taken a leading role in Water and Sanitation through:

1. The Medical Division of the Ministry of Health, Education and Community Affairs, which has been involved in projects for the provision of wells and pit latrines on the outer islands and health education.
2. The Integrated Island Development Office of the Ministry of Home Affairs, which has, and continues to be, instrumental in providing assistance to the Councils in carrying out projects.
3. The Public Works Division of the Ministry of Works and Communication, which provides technical advice and is the implementing agency for a major water supply project.
4. The Office of the Attorney-General, which provides legal advice on existing legislation and deals with proposals for revision.

Due to the limited nature of groundwater resources and the high population densities, especially on Funafuti, rain water constitutes the main water resource. Consequently, the emphasis of Government's water supply policy is the provision of storage facilities which feed directly from roof catchments. In 1986 the Government approved a comprehensive water storage policy which set a water consumption target of 50 litres per head per day. To meet this target, steps have been taken to ensure that all new developments (private or public buildings) include adequate catchment and storage capacities. In the case of private housing, this would vary between 2250 to 3000 litres of water storage capacity per head. Public buildings would be required to hold storage for 122 days for each person and, if needed for emergency storage, the volume would need to be related to a rainfall of 600 mm on total roof area (NDP IV, 1988:225).

There are currently a number of water supply projects, the most notable being the U.N. Water Project, through which individual households and communities are provided with adequate water storage (e.g., ferro-cement tanks), and existing cisterns and water catchments are rehabilitated and maintained. However, many public buildings still do not have adequate rain catchment capacities. While some of these buildings will have catchment capacities improved under the current Water Supply project, others may be improved if additional funding becomes available.

In the long term, there are also plans to increase storage capacity for emergency needs. Government controlled storage will need to be increased to 11 million litres and private household storage to 28 million litres.

Investigations of groundwater resources, which are used for human consumption only during long dry spells, are progressing with completion expected at the end of 1991. Groundwater also serves the needs of the trees, banana plantings and giant swamp taro (pulaka) pits, thus, underlining the need for its conservation and protection from pollution. Bacteriological testing equipment has been received, and regular testing of groundwater samples will commence sometime in 1991 following completion of the necessary staff training. Legislation relevant to Tuvalu's needs with regard to water supply and sanitation is expected to be drafted during 1991 for enactment in 1992.

Because of the susceptibility of groundwater resources to pollution and the limited land area, waste disposal continues to be a problem in Tuvalu. There is no centralised sewerage system on any of the islands in Tuvalu, with waterborne wastes, especially sullage and sewage, being generally disposed of in soakways, septic tanks or pit latrines, or dumped at sea using two sludge barges. Recent developments have attempted to address this problem. A 1987 socio-economic study by the Integrated Island Development Office showed that 71 percent of all households in Tuvalu had some adequate form of toilet facilities, and statistics for 1986 provided by the Health Division of the Ministry of Social Services showed that there had been a reduction in diarrhoeal diseases over the six-year period 1980 to 1986. It would appear that improved sanitary facilities have had a positive effect on the health standard of the community.

In terms of solid waste, with the increasing level of packaged imports, the disposal of refuse, particularly plastic, glass and other non-biodegradable packaging materials, is becoming increasingly problematic. The problem is most prevalent on Funafuti, where population density is highest and there is greater use of imported products. The Funafuti Town Council and the Government share responsibility for the collection and disposal of refuse on Funafuti. The Town Council uses a tractor and trailer to carry out regular collections throughout the village; the cost of this service is paid for by an annual fee charged to households. Garbage is dumped in the burrow pits or along the hurricane-built rampart ("coral dam") on the southeastern seaward coast of the atoll. There is a need, however, to determine the long-term environmental and health impacts of such actions and a need to investigate alternative sites and ways of reducing or recycling solid waste. There is currently a community "Can Care Project" where aluminium cans are collected, crushed and exported for recycling in Australia.

## 5.12 ENERGY

Imported petroleum products are the major source of commercial energy used in Tuvalu, and accounted for about 12.5 per cent of the total value of imports in 1985. Given current development trends in Tuvalu and world economic trends, increasing dependency on imported fossil fuels will continue to be a major obstacle to sustainable development.

The Government of Tuvalu's main strategies in relation to Energy development are to:

1. Continue to review energy options for the country in close cooperation with the UNDP Pacific Energy Development Programme (PEDP) and its successor, the Forum Secretariat Energy Division, and to strengthen its own capacity to plan and manage energy projects.
2. Centralise all operational activities related to electricity production and distribution on all islands in the Tuvalu Electricity Authority.
3. Continue testing new energy technologies and identify the most appropriate options for Tuvalu and to promote, as a priority, renewable forms of energy that require minimal costs to install, operate and maintain.
4. Ensure that electricity supply costs are equitably shared by all sections in the community.
5. Introduce measures to conserve and better manage energy resources by ensuring the more efficient use of energy by Government agencies, and by promoting energy conservation in the private sector.

While the country continues to be dependent on fossil fuel, the Government has begun to investigate other forms of cheaper, renewable and environmentally-friendlier energy sources. One such energy source is the use of solar-powered photovoltaics. Since 1979, solar energy has been used to provide power for the operation of inter-island telecommunications system. In 1982, it was shown that solar energy was a cheaper form of lighting than kerosene pressure lamps when measured over a number of years. Since then, Government has accelerated promotion of the use of solar photovoltaics as energy source. The first project funded by the EEC, involves provision of solar-powered refrigeration units for the storage of drugs at clinics in the outer islands. One refrigeration unit has also been provided for Motufoua Secondary School on Vaitupu with aid funds from France. Another project was the provision of solar lighting for maneapas (communal meeting houses) in the outer islands.

The promotion of photovoltaics for domestic use is promoted through the Tuvalu Solar Electric Co-operative Society Ltd. The Society was set up in 1984 by the Save the Children Federation with branches on each of the eight outer islands. The objectives of the Society are to provide household solar lighting and proper maintenance of equipment for its members. The Society purchases solar units at reduced rates through bulk orders. Funds

for the Society are provided through three main sources: contributions by Society members (including a \$100 deposit and a monthly fee of \$6.25), low-interest loans obtained by the Society, and from grants to the Society. Experience over the years has provided information on the most appropriate scale and type of equipment suited to the outer islands. The Ministry of Works and Communication also provides a technician to maintain equipment in clinics, maneapas and private houses.

### 5.13 REEF PASSAGES OR BOAT CHANNELS

Reef passages or boat channels, built by blasting of coral heads to clear passages to the open sea, is a common form of outer island infrastructural development in Tuvalu. The passages provide all-tide access by fishermen to the open sea as well as facilitating the transportation of cargo to and from ships. Most such passages, when first blasted, did not take into consideration the impact on fish stocks and marine resources, stability of the reef and islands and coastal erosion, particularly during storms, and on the incidence of ciguatera fish poisoning.

In 1988, the New Zealand Ministry of External Relations and Trade commissioned ecologists at the University of Auckland to carry out an Ecological Impact Assessment of the effects of boat channel construction by reef blasting in Tuvalu. The results showed that the building of channels:

. . . did not have a big effect on the numbers of the 229 animals (e.g., fish), algae and sediments. In about 9 per cent of cases, the number of animals declined, while in 7 per cent of cases they showed an increase. The general conclusion of the study was that provided certain limits were placed on how, where and when channels were built, they would not cause widespread damage to reef communities (Kaly and Jones, 1990).

The study recommended measures and guidelines to minimise negative impacts and to, perhaps, increase the number of fish in the channels. It was suggested that both old and new passages could be improved by:

1. Limiting the number of channels built on any island.
2. Building channels so that their walls and floors are complex (This means that they should have several different types of materials on their floors and holes and overhangs in their walls in order to attract and provide habitats for a wide variety of fish).
3. Minimising the size of channels and locating them away from beaches (By keeping their ends well away from beaches, at least 10 metres, will help ensuring they do not drain the sand from the beach).



4. Minimising blasting damage to fish (This can be done by either blasting only after 11 am on any day or by setting a small initial blast to frighten fish).
5. Avoiding building or enlarging channels which connect with lagoons (As tidal currents running through these types of channels can move large amounts of sand and can kill off animal and algae communities in the lagoon and on the outer reef at the channel mouth).
6. Never building a channel connecting a ponding lagoon with the ocean (as this will cause the level of water in the lagoon to drop during low tide, thus killing corals, fish and other lagoonal life).
7. Building channels on protected side of islands, avoiding points around the reef, or using areas which have already been damaged in other ways (This limits channels to areas of lower productivity, lower exposure to storms and minimises the total area of damaged reef on an island).
8. Not spreading spoil from the blasting over a wide area of the tidal rock platform (This practice unnecessarily disrupts the ecology of the tidal platform, which is an important source of food for some fish during high tides. It could also make the reef more likely to have an outbreak of ciguatera by disturbing established communities of algae).
9. Lining channels with boulders, though not required (A wall of boulders running either side of a channel provides shelter which increases the number of fish species. They may also reduce some of the water flow into channels from the rock platform).
10. Stabilising the upper beach near the channels (This can be done by angling the access road to the village away from the channel, and by planting both sides of the roadway and top of the beach with coconut palms and low bushes for 20 to 50 m on either side to stabilise areas where people use the beach the most).
11. Replanting coral seed stock (This is to encourage natural populations of corals, fish and algae. It could be done by collecting 5 cm fragments of living coral from the surrounding reef and scattering them over damaged area during long spells of calm weather. These fragments must be kept covered by seawater at all times. They may also help restabilise the blasted area and reduce the possibility of an outbreak of ciguatera).
12. Creating reef reserves (These are small sections of the reef set aside as permanent reserves to compensate for the loss of sections to channels).

#### **5.14 CLIMATE CHANGE AND RISING SEA LEVEL**

A major environmental concern of Tuvalu and all atoll states is the potentially disastrous impact that climate change or global warming and associated sea level rise could have on the habitability of low-lying atolls. Climatic data in Tuvalu is collected by the Meteorological Division of the Ministry of Communication and Works, which has its main headquarters on Funafuti, and by several observer stations on the outer islands. These stations make daily rainfall and climatological observations which include wind speed and direction, rainfall, temperature and, in some cases, barometric pressure.

As part of global efforts to monitor climatic change and sea level rise, the Tuvalu Meteorological Service is participating in the Tropical Oceanic Global Atmosphere (TOGA) programme, established by the World Meteorological Organisation and administered by the US National Oceanic and Atmospheric Administration (NOAA). The main emphasis of the programme is the study of the global atmosphere and the oceans, and the interface between both, in the area 20 degrees north and south of the Equator. The project observes and monitor tides, temperature, rainfall and upper wind velocity. The University of Hawaii has, for ten years, operated a tide gauge based at the old wharf in Funafuti which transmits data direct to Hawaii.

The 1989 South Pacific Forum in Tarawa agreed to establish a series of monitoring stations in the region, including Tuvalu. The project is yet to be implemented, although, in May 1991, a Scientific Officer was appointed in the Meteorological Division with the responsibility of monitoring the sea level rise.

#### **5.15 TRAINING, EDUCATION AND PUBLIC AWARENESS**

Without improved environmental awareness and a firm environmental educational basis (in terms of both formal and non-formal education), improved environmental management and sustainable atoll development will be problematic. Accordingly, considerable effort must be placed on improving formal environmental education in primary and secondary schools, providing training in environment-related areas and in improving public awareness of environmental issues and the need for sustainable development.

At the primary school level, as a component of the "Education for Life" Programme, nature study and focus on people and the environment attempts to create interest in the environment. One of the main objectives is to get students to focus on the larger national environment in the context of development, rather than just on their single island ecosystems. There is, consequently, a need for wider coverage and for materials and content on environmental change and human impacts on the environment to be introduced into the present Primary schools curriculum. This should include the concept of the climatic change and sea level rise and other issues/problems such as land degradation, loss of biodiversity, pollution and loss of traditional agricultural, fishing and environmental knowledge.

There is currently no formal Environmental Studies at the secondary level, although environmental issues are addressed in different subject areas like Geography, Chemistry and Biology. There is, however, possible scope for environmental studies to be taught as a separate multi-disciplinary subject examinable at the National Form Four Examination.

In terms of training, there are currently no major plans for specialised training in environmental management, although a number of Tuvaluan graduates have Geography or Science (Environmental-related) first degrees which may qualify them for postgraduate environmental studies. There are also a Bachelor of Science degree in Environmental Studies and a Diploma in Environmental Education offered by The University of the South Pacific which are increasingly in demand from other regional countries, but which have not yet been utilised by Tuvalu.

In terms of public awareness, while there is a considerable degree of existing awareness of environmental issues, largely from personal experience, there has been, however, very little systematic effort to heighten this awareness through radio programmes or other forms of public education. There has been a regular programme on Radio Tuvalu on the Greenhouse Effect and sea-level rise, which has since been discontinued. This should be reactivated and broadened to cover general environmental awareness and education.

Tuvalu has also participated in periodic sessions of the SPACHEE ENVIRANET series conducted over the USP Peacesat network at the USP Extension Centre in Funafuti. These sessions, which have focused on issues such as global warming, food and the environment, sea turtles as an endangered resource, deforestation, reef and lagoon management and oceanic driftnet fishing, have been well attended by government and non-government participants, with the session on global warming being conducted from the USP Centre in Tuvalu.

## **5.16 NON-GOVERNMENTAL INITIATIVES**

There are a number of non-government and regional initiatives which have addressed some of the major environmental issues and promoted sustainable development. At the national level, these include women's organisations which have been active in promoting sustainable development among women; and youth associations which are instrumental in mobilising youth effort directed towards activities contributing to sustainable development. On individual islands, traditional political structures have also been instrumental in identifying development needs. As repositories of local knowledge and experience, their advice and participation should be sought in the protection/management of the environment and in the promotion of sustainable development.

As pointed out above, the Tuvalu Solar Electric Cooperative Society Ltd. has been active in the promotion of the use of this sustainable and environmental-friendly energy source. Government plans to further strengthen its role.

Almost all national non-governmental organisations (NGOs) are part of, or affiliated to, a wider network of regional or international networks of NGOs. Government should therefore facilitate the establishment of a national NGO umbrella arrangement which could be coordinated with and strengthened by national and regional/international efforts in relation to the promotion of sustainable development, including the channelling and identification of national environmental management needs, funding sources and appropriate support organisations or agencies for appropriate NGO initiatives.

Several international agencies which have programmes supporting local NGO's initiatives in the areas of environmental management and education and the promotion of sustainable development, some of which have already benefited Tuvalu, include: 1) the UNDP Integrated Atoll Development Programme, 2) the UNICEF and Foundation for the Peoples of the South Pacific (FSP)'s programmes promoting home food production and the strengthening of mixed food gardening, 3) the South Pacific Commission, which has active programmes in the areas of agriculture, fisheries, population, food and nutrition and health development, 4) Save the Children Fund which has established the "Can Care Project" to collect aluminium cans for compaction and shipment to Australia for recycling, 5) the South Pacific Action Committee on Human Ecology and the Environment (SPACHEE), 6) Greenpeace, and 7) the South Pacific Regional Environment Programme (SPREP). Efforts should be intensified to further strengthen links with these and other appropriate organisations to enhance the ability of both NGOs and government agencies to address major environmental issues.

## **CHAPTER 6**

### **PRIORITIES FOR FURTHER ACTION**

#### **6.1 ENVIRONMENTALLY SUSTAINABLE DEVELOPMENT AS A PRIORITY**

The Tuvalu Government places highest priority on the identification and promotion of environmentally and culturally sustainable development, both in Tuvalu and globally. It is stressed, however, that although Tuvaluans have lived a relatively sustainable way of life for generations in the atoll environment, this was at a relatively low level of material wellbeing, a level which is no longer considered adequate. Our people desire some of the more appropriate modern technologies and social services that will make their life easier, safer and more enjoyable in today's world. This requires increased cash incomes and foreign exchange and changes in lifestyles which, if NOT pursued in the right manner, could undermine the cultural and traditional resource-use systems which have promoted sustainability in the past. This is the dilemma of development which faces the people and Government of Tuvalu.

Sustainable development in Tuvalu must be seen as development which on one hand attempts to gain for our people the more appropriate technological and social benefits of modern urban industrial societies, while at the same time protecting, to the best of our ability, the social systems, technologies, knowledge and the terrestrial and marine resources that have allowed us to sustain atoll life in the past.

#### **6.2 CONSTRAINTS AND PRIORITIES**

There are, unfortunately, a number of constraints to sustainable development in Tuvalu which need to be addressed and prioritised. These are related to: 1) the scarcity of land and terrestrial resources; 2) the predominant importance of marine resources in the context of modern development; 3) the dominant role of subsistence production as the main component of real income for most of our people; 4) the extremely limited range of sources of cash income and foreign exchange, and their variability and susceptibility to economic and political pressures beyond our control; 5) the susceptibility of atoll ecosystems and cultures to disturbance and degradation; and 6) the range of more specific environmental and culturally-based areas of concern or constraints to sustainable development described above. This section attempts to prioritise: 1) the constraints to, and 2) opportunities for environmentally sustainable development, from the perspective of planning for and the promotion of such development in Tuvalu.

It must be stressed, however, that because most of these issues or constraints are interrelated, the prioritisation in no way suggests that Tuvalu will address these issues in isolation one at a time. Rather, the Government is committed to addressing these issues, simultaneously, in a cross-sectoral effort to promote sustainable ecodevelopment for the benefit of future generations.

It must also be made clear that Tuvalu has a firm commitment to addressing both global environmental issues, through its support of international initiatives, as well as addressing local concerns at the national and community levels. For simplicity's sake the issues will be broken down into: 1) broader, sometimes global, cross-sectoral issues of concern or constraints which affect all sectors and all environments or resources, and 2) those which pertain to specific sectors or resources. These are listed in Tables 6.1 and 6.2. Appendix VI lists the issues, constraints and opportunities for sustainable development in detail.

Table 6.1. Main issues of concern or constraints which affect all sectors and all environments or resources in relation to the promotion of sustainable development in Tuvalu.

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1. CLIMATE CHANGE AND SEA LEVEL RISE (land loss, flooding, salt water incursion, property damage)
  2. POPULATION PRESSURE (rapid growth, urbanisation and pressure on limited resource base)
  3. BREAKDOWN OF THE TRADITIONAL FOOD SYSTEM AND OF THE SUBSISTENCE PRODUCTION SYSTEMS, INCREASING DEPENDENCE ON AN UNSTABLE GLOBAL CASH ECONOMY AND ASSOCIATED INCREASING VULNERABILITY AND LOSS OF SELF-RELIANCE (declining consumption of local foods and increasing vitamin and mineral deficiency, obesity, diabetes and cardiovascular disease, declining availability of local medicines, fuel, fibre and other locally produced products, increasing monetisation, aid dependency and associated loss of self-reliance and environmental degradation)
  4. ENVIRONMENTAL BLINDNESS AND LOSS OF TRADITIONAL KNOWLEDGE OF RELEVANCE TO SUSTAINABLE DEVELOPMENT/NEED FOR ENVIRONMENTAL EDUCATION (current lack of traditional and modern emphasis on environmental education and sustainable development in the formal education system, deterioration in the Tuvaluan language, ignorance of traditional fishing, agricultural, medicinal, navigational and other survival skills among the young)
  5. CONSERVATION OF BIOLOGICAL DIVERSITY (terrestrial and marine animal and plant diversity of both wild and domesticated species as a basis for human survival)
  6. NUCLEAR POLLUTION, WEAPONS TESTING AND HAZARDOUS WASTE DISPOSAL (residual and current impact of nuclear weapons testing and pollution, and of the disposal of hazardous waste and weapons on neighbouring islands and in the shared oceanic environment)



7. INADEQUACY OF DATA ON RESOURCES AND SUSTAINABILITY OF STRATEGIC ECOSYSTEMS (need for data on fish stocks and recruitment, lagoonal processes and ecosystems, etc.)
  8. NEED FOR ENVIRONMENTAL PROTECTION INFRASTRUCTURE (laws, agencies, training/expertise, funding, conservation area development, etc.)
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Highest on the list is the threat posed by climatic change or global warming and associated sea level rise which could make the habitation of low-lying island and coastal areas problematic. This has caused serious concern at all levels in the community, and threatens the very existence of Tuvalu as a nation. Although there is uncertainty as to the amount and rate of potential sea level rise, it remains a major consideration in planning for sustainable development.

Of almost equal concern is the constraint to sustainable development posed by increasing population, including rural to urban migration, which puts excessive stress on natural and cultural resources and undermines any hope of sustainability, particularly in urbanised Funafuti. None of the problems associated with acute land shortage, land fragmentation, the poverty of terrestrial resources, the fragility of marine resources to overexploitation and the threat posed by pollution and waste disposal can be addressed unless we do something about controlling our high rates of population growth and rural to urban migration.

Because of the critical importance of good nutrition and health as the basis for a healthy society, and because of the critical role that subsistence production plays as a component in the real incomes of our people, the breakdown of our subsistence production systems, perhaps most importantly the deterioration of our traditional food system, is seen as a major constraint to sustainable development. With the declining consumption of local foods, medicines, fuel and other subsistence products that have long provided the basis for the health of Tuvaluan society, there have been serious increases in the incidence of vitamin and mineral deficiency, obesity, diabetes, stroke and cardiovascular disease and increasing and costly dependence on other imported products which can be produced locally in a sustainable manner. Humans and their subsistence production systems, as integral and dominant components of the atolls ecosystem, **must** be protected along with the natural environment to ensure sustainability.

Because of the susceptibility of our natural resources to degradation and their role as the basis for almost all subsistence (non-cash) and cash income, high priority is placed on the conservation, protection and enhancement of freshwater resources, soils, terrestrial plants and animals, and reef, lagoon and ocean marine resources. In the same context, the conservation of biological diversity, of both wild and domesticated species, as a basis to support continuing human habitation of the atolls is a priority. Of particular importance is the enhancement of rainwater catchment capacity and the protection of existing groundwater resources and coastal waters from pollution.

Other areas of major concern which, in concert with all other ecological problems, undermine sustainability of atoll living include: coastal erosion; waste management and disposal; and increasing dependence on a non-renewable energy source in the form of imported fossil fuel for transportation, cooking, lighting and other developmental purposes, a trend that is not sustainable in the long term (see Table 6.2).

Of particular concern is the long term impact of nuclear weapons testing and nuclear pollution on the peoples of Tuvalu, our island neighbours, and on the shared oceanic environment. As shown by experiences in the Marshall Islands, even very low levels of nuclear radioactivity resulting from past and present nuclear testing constitute a severe long-term health hazard and obstacle to habitation of our islands, even in island groups at great distances from the actual nuclear test sites. There is similar concern over the negative impacts of the disposal of hazardous and military wastes in neighbouring island groups and in the oceanic environment, and the inability of Tuvalu to control such actions.

Table 6.2. Main issues of concern or constraints which pertain to specific sectors or resources in relation to the promotion of sustainable development in Tuvalu.

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1.	PROTECTION OF MARINE RESOURCES (reef, lagoon, ocean and maricultural)
2.	CONSERVATION/PROTECTION OF FRESHWATER RESOURCES (groundwater and water catchment systems)
3.	PROTECTION OF TERRESTRIAL RESOURCES (combating deforestation, loss of soil fertility, declining food production, declining bird populations)
4.	LAND SCARCITY, COASTAL EROSION AND LAND RECLAMATION (combating coastal erosion resulting from both natural causes and modern coastal development)
5.	WASTE MANAGEMENT AND DISPOSAL (foreign toxic and hazardous waste, local solid waste, sewage and industrial waste)
6.	ENERGY DEPENDENCY (increasing dependence on imported fossil fuels for transportation, cooking, lighting and other purposes and fuelwood shortage)
7.	REHABILITATION OF DEGRADED LANDS (rehabilitation of the Borrow Pits on Funafuti, seawall construction and coastal protection)

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Also of concern is the rehabilitation of the degraded lands or "borrow pits" on Funafuti which are due to the excavation of fill from 30% of the area of Fogafale islet to

build the airstrip during World War II. Problems associated with this include land tenure arrangements, identification of sources, quantity and quality of fill (sand and aggregate) for reclamation and the development of technologies to acquire fill and to reclaim degraded lands.

Finally, three major areas of concern which will affect the ability of Tuvalu to address all issues or areas of concern, and which thus must be considered of high priority are: 1) the need for environmental education, including both traditional and modern environmental education, to eliminate "environmental blindness" and to stress, in both the formal and nonformal education systems, the constraints to and opportunities for sustainable development in Tuvalu; 2) the inadequacy of data and the need for research on resources and sustainability of strategic ecosystems as a basis for informed national and local planning and development; and 3) the need for environmental protection infrastructure in the form of strengthened legislation, agencies, research, training and conservation area development.

Without a firm basis of traditional and modern environmental education, particularly public environmental education, and environmental infrastructural development, the promotion of sustainable development in Tuvalu will be problematic. Because of the overemphasis on modern education along western lines, mainly to prepare the young for a role in the modern cash economy or monetised sector, and almost exclusively in English at the more advanced levels, there is increasing ignorance of the natural environment. This includes ignorance of traditional resource-use systems and of the Tuvaluan language relating to such issues. With many of the younger generation having little knowledge of the Tuvaluan names for plants, fish and other natural phenomena, it is no wonder that knowledge of traditional sustainable subsistence production systems is being lost.

### **6.3 CONSTRAINTS TO ADDRESSING MAJOR ENVIRONMENTAL ISSUES**

The more specific constraints to addressing these major environmental concerns in Tuvalu are interrelated and consist of a wide range of geographical, ecological, technological, social and economic constraints which are common to most isolated small island states. Some of the more important constraints referred to in Chapter 4 and in Tables 6.1 and 6.2, and summarised in Table 6.3 include: 1) an extremely limited resource base to cater for both subsistence and increased commercial export production; 2) inadequate knowledge of the status of existing resources and environment and the impact of modern development on them; 3) the extremely fragmented and dispersed nature of the islands and Tuvalu's EEZ which makes resource management, the provision of social services and programme implementation difficult; 4) increasing economic, technological and nutritional dependency on foreign industrialised countries and external forces beyond the control of the Tuvalu government and its people; 5) increasing propensity of industrialised countries to export their inferior, often non-biodegradable, products and industrial and military wastes to oceanic islands and their surrounding seas in an attempt to enhance or protect their own economies and environments; 6) inappropriate or unbalanced planning and aid, which overemphasises commercial/export and monetised development at the expense of subsistence resources and production systems as a basis for

the sustainable development of non-industrialised societies like Tuvalu, in which culture, traditional production systems and the environment cannot be separated; 7) continuing dependence on often inappropriate education systems, strategies and curricula, usually in the English language, at the expense of traditional knowledge and wisdom; 8) the difficulty in establishing conservation areas or enforcing environmental legislation due to the economic costs involved, lack of information on the status of resources, the dispersed nature of the islands, and traditional land and marine tenure systems; and 9) inappropriate and unsustainable consumption patterns (overconsumption and associated pollution) in industrialised countries which severely affect sustainability both globally and in non-industrialised countries.

Table 6.3 Geographical, ecological, social, technological and economic constraints to addressing major environmental issues in Tuvalu.

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#### GEOGRAPHICAL

1. Extremely limited land area available for habitation, landfill sites or other forms of development relative to population size and density.
2. The extremely fragmented and dispersed nature of the islands and EEZs which makes programme implementation, provision of social services and resource management difficult;
3. Extreme difficulty of policing extensive coastal areas and EEZs.
4. Extremely poor and endangered terrestrial biota.
5. Extremely poor and limited soil resources.
6. Extremely limited water resources and periodic drought.
7. Highly mobile nature of some animal populations (e.g., migratory birds, turtles and pelagic fish species).

#### ECOLOGICAL/RESEARCH

1. Uncertainty about time frame and local impacts of developments on the environment and ecological processes, in particular, the uncertain impacts of climate change and sea-level rise.
2. Inadequate knowledge of the current status of resources (species, size, distribution, reproductive/recruitment characteristics, degree of current exploitation, endangerment status, impact of pollution and ecosystem/habitat status).

3. Inadequate information on/examples of the impact of development on the atoll environment and strategic plant and animal species.
4. Inadequate information on the effects of loss of biodiversity on ecological balance and the subsistence economy.
5. Competing demands on limited freshwater resources.
6. Lack of information on the nature and origin of waste and its long-term impact on the environment.
7. Increasing scarcity of fuelwood, particularly in urban areas.

#### TECHNOLOGICAL

1. Loss of traditional knowledge of resource management strategies, traditional agricultural and fishing technologies, and food preparation and preservation technologies.
2. Increasing dependence on costly and polluting imported technologies.
3. Increasing importation of and dependence on non-biodegradable products and packaging.
4. Increasing interest by metropolitan powers in disposing of their hazardous and military wastes in the atoll and oceanic environments.
5. Increasing dependence on fossil fuels, e.g., use of kerosene for cooking and dependence on outboard motors and air travel between islands.
6. Lack of an energy conservation policy.

#### SOCIAL/TECHNOLOGICAL/PHILOSOPHICAL

1. Inappropriate and unsustainable consumption patterns (overconsumption and associated pollution) in industrial countries which severely affect sustainability both globally and in non-industrialised countries.
2. Extreme dependence on actions taken by and support/aid from industrialised countries to promote sustainable development.
3. Lack of international and local appreciation of the ecological and economic importance of biodiversity to ecosystem and cultural stability.

4. Lack of legislation controlling waste at its source or restricting the use of non-biodegradable waste.
5. Inability to restrict neighbouring islands from being used as waste disposal/reduction sites (e.g. incineration of toxic military wastes and munitions at Johnston Island).
6. Lack of proper land use planning.
7. Traditional attitudes towards marine resources as being bountiful and inexhaustible.
8. Land and marine tenure systems, limited and fragmented land area and the subsistence importance of the environment which makes western-style conservation area development and resource protection problematic.
9. Little or no emphasis on environment, agriculture and food and nutrition in the formal education system (environmental and nutritional ignorance/blindness).
10. Overemphasis on Western educational models and education for urban sector/white collar jobs.
11. Narrowness of Western environmental education and conservation strategies which place little emphasis on people as part of nature and dependent on it for subsistence.
12. Dependence on foreign curriculum experts and the English language in formal education.
13. Limited opportunity for external migration and overseas employment.

#### ECONOMIC

1. Narrow economic base and limited financial and technological capabilities of the country.
2. Commonly held view that environmental protection is an obstacle to, rather than a foundation for development.
3. Overemphasis on short-term, aid-funded economic development, often with no provision for environmental impact assessment (tight timetables and budgets set by donor agencies).
4. Multidisciplinary and cross-sectoral nature of environmental management which makes its integration into narrow sector-based national planning problematic.
5. Limited recognition or understanding of the economic importance of subsistence production to sustainable development, on the part of planners and international



organisations.

6. Overemphasis on commercial and export production at the expense of environmentally sustainable traditional production systems.
  7. Increasing monetisation and the increasing promotion of and dependence on imported food and other consumer and capital goods.
  8. Increasing cost of imported fuel, relative to export earnings and per capita incomes, and vulnerability of fossil fuel source areas and pricing to conflict (e.g., the Gulf War) and price fluctuation.
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#### **6.4 OPPORTUNITIES AND REMEDIAL STRATEGIES TO ENCOURAGE SUSTAINABLE DEVELOPMENT**

Appendix 6.1 lists some of the specific strategies or "opportunities" that could be employed to address some of the major environmental issues and to overcome some of the internal and external constraints to sustainable development. These include both local and international initiatives, some which can be implemented at the community level with little or no external financial or technical assistance, whereas others require major funding and international cooperation.

##### **6.4.1 Local Initiatives**

Some of the local initiatives that could foster sustainable development include:

1. Make the strengthening of environmental management infrastructure a priority.
2. Establishment of an autonomous, cross-sectoral environmental ministry, unit, or board and an associated environmental impact assessment capability.
3. Incorporation of environmental impact assessment procedures in all development strategies/initiatives as an integral component of the planning process.
4. Draft and strengthen appropriate environmental legislation and enforcement procedures.
5. Strengthening of both formal and public environmental education, including the increase of local input and traditional knowledge, as a basis for sustainable development.

6. Strengthening of the national research capability to assess the national resource base/environment and the impact of development on it, and to compile information on traditional resource-use systems and environmental knowledge.
7. Make training in environmental management a priority in manpower planning.
8. Establish/strengthen a system of appropriate terrestrial and marine parks, wildlife reserves and conservation areas, which takes into account both the nature of the resources and their subsistence importance.
9. Land reclamation, seawall construction/stabilisation and coastal reforestation schemes (including the reclamation of the Borrow Pits as a priority).
10. Strengthening of family planning and population control programmes.
11. Strengthening of the traditional subsistence production system, particularly the terrestrial and marine food production systems, in concert with, rather than in conflict with export-oriented development.
12. Establish germ plasm collections of, or nurseries for endangered or economically and culturally important wild and domesticated plant species.
13. Shift commercial fisheries emphasis to underexploited species and ecosystems (e.g., pelagic and reef-slope areas), maricultural production or to appropriate introduced species (e.g., trochus, giant clams, pearl oysters, eucheuma seaweed, etc).
14. Make decentralisation a priority, including the strengthening of social services and infrastructure in rural outer island areas.
15. Encouragement of appropriate water conservation policies and water collection and desalinisation technologies.
16. Promotion of soil improvement technologies, including traditional mulching and fertilisation practices.
17. Promotion of renewable energy alternatives, such as solar power, in an effort to reduce increasing dependence on imported fossil fuels.
18. Adopt appropriate strategies for waste disposal including the reduction of dependence on non-biodegradable or hazardous products and the adoption of appropriate disposal or recycling strategies.

As stressed above, many of these initiatives, some of which have already been implemented, will require government and/or international funding, whereas many can be

implemented immediately at the national and community or island level given the political will to do so.

#### **6.4.2 International Initiatives**

Initiatives requiring international action and solidarity which are seen as a priority by the Tuvalu Government include:

1. Action by industrialised countries to reduce emission of greenhouse gases.
2. Action to reduce deforestation and encourage reforestation.
3. Research to identify means of preparing for/addressing global warming.
4. Establishment of a Global Fund to help developing countries respond to climate change and sea level rise.
5. Guarantees of the 'Right to Development' and continuance of aid to low-lying developing countries, despite potential negative impacts of global warming on aid-funded development initiatives.
6. Accession to international treaties prohibiting the use of destructive fishing technologies and exploitation of endangered/restricted species (e.g., bans on oceanic driftnetting, CITIES, etc.).
7. Accession to international agreements and programmes to conserve biodiversity and endangered ecosystems.
8. Accession to accords/treaties restricting the movement and disposal of toxic and hazardous waste in the island/oceanic environment.
9. Accession to accords/treaties prohibiting: a) the testing of nuclear weapons, disposal of nuclear wastes, b) supporting initiatives to conduct and release the results of unbiased research on the impacts of nuclear weapons testing on the habitability of islands and the health of peoples affected by nuclear testing, and c) supporting proposals to decontaminate islands or compensate peoples/countries affected by nuclear testing/pollution.
10. Continued collaboration with international institutions such as SPREP, Forum Secretariat, USP, FFA, UNDP/FAO, SPC, ICOD, ICLARM, USAID, AIDAB and other bilateral aid programmes to strengthen national and regional environmental management infrastructure and research capabilities.
11. Support of all international initiatives, in particular UNCED, which could bring about a change in the world economic order so that it increasingly leads to economic and trade relationships, and consumption and pollution levels which foster sustainable lifestyles in countries, like Tuvalu, where

export and subsistence production will probably remain the basis for economic and cultural wellbeing.

## **CHAPTER 7**

### **PROCEDURAL MATTERS RELATED TO THE PREPARATION AND ENDORSEMENT OF THE REPORT**

This chapter describes: 1) the process used in the preparation of the Tuvalu National Report for the United Nations Conference on Environment and Development (UNCED); 2) the composition of the Tuvalu National UNCED Task Force; and 3) the level of government endorsement of the report and commitment to the principles of UNCED.

#### **7.1 PREPARATION OF THE NATIONAL REPORT**

The preparation of the national report was carried out over a ten-month period by SPREP Consultants, Uentabo Neemia and Professor Randolph R. Thaman, in close consultation with the Office of the Prime Minister, the National UNCED Task Force and other relevant ministries, agencies and persons in Tuvalu and the region (see Appendix VII). A wide range of published and unpublished reports and other relevant materials were also consulted. The chronology of the report preparation process was as follows:

1. Commencement of preparation of Draft Report (May 1991)
2. Visit by U. Neemia to Tuvalu to: 1) discuss the preparation of the Tuvalu National Report to UNCED and to collect required data from relevant Ministries, Departments and other agencies or persons and 2) to consult with the National Task Force (8 to 15 May 1991).
3. Completion of first draft of main chapters of Report for submission to Government and SPREP for consideration the SPREP Workshop on South Pacific Preparations for UNCED which was held in Nadi from 4 to 6 June 1991 (June 1991) to prepare 1) a Regional Ministerial Declaration, 2) a list of Regional Priorities and Objectives, both for consideration by the SPREP Ministerial-level Intergovernmental meeting to be held in Noumea in July 1991 and the Third UNCED Preparation Committee Meetings (PrepCom) which was held in Geneva in August 1991, and 3) a framework for the Regional UNCED Summary Report (June 1991).
4. Attendance by Misalaima Nelesone (Tuvalu Government Representative) and U. Neemia and R. Thaman (SPREP Consultants) at the SPREP Workshop on South Pacific Preparations for UNCED held in Nadi (4 to 6 June 1991).

5. Completion of Draft Report for submission to government for consideration in preparation for second visit of consultants (Neemia and Thaman) and as a basis for; 1) Tuvalu's representation at the Third Intergovernmental Meeting of the South Pacific Regional Environment Programme (SPREP) held in Noumea from 24 to 28 September 1990; 2) Tuvalu's representation at the Third PrepCom held in Geneva in August 1991 (August 1991); and, 3) preparation of a Draft Regional Synthesis Report to UNCED to be prepared by SPREP.
8. Visit by Neemia and Thaman to Tuvalu to: 1) discuss the Draft National Report with the National UNCED Task Force and other relevant Ministries, Departments and persons (6 to 11 September 1991).
9. Attendance by Misalaima Nelesone and R. Thaman at Workshop on the South Pacific Preparations for UNCED held in Port Vila, Vanuatu to: 1) finalise the Draft Regional Synthesis Report to UNCED; 2) finalise the summary National Reports as appendices of the Regional Synthesis Report; 3) to identify common areas of concern in the Region; 4) to identify major constraints to sustainable development and strategies needed to address these constraints; 5) to identify the human, financial and human inputs needed to implement such strategies; and 6) to relate these to key cross-sectoral issues in terms of sustainable development (21 to 23 October 1991).
10. Completion of amended/strengthened versions of Tuvalu National Summary Report for inclusion in the Regional Synthesis Report and for approval by National Task Force (November 1991).
11. Incorporation of changes to the National Summary Report and notification of changes to SPREP (December 1991).
12. Completion of National UNCED Report for final endorsement by the Tuvalu UNCED Task Team and the Government of the Tuvalu for forwarding to SPREP and the UNCED Secretariat (February 1991).

## **7.2 ROLE AND COMPOSITION OF THE TUVALU NATIONAL UNCED TASK FORCE**

The role the Tuvalu National UNCED Task Force was to represent relevant ministries and coordinate efforts in: 1) the completion and endorsement of both the Tuvalu National Report to UNCED and the Tuvalu National Summary Report which will serve as an appendix to the Regional Synthesis Report to UNCED; 2) coordinate the attendance and input of Tuvalu to UNCED and all regional and international preparatory meetings or fora leading up to UNCED; and 3) liaise with, coordinate and facilitate the in-country visits of the SPPREP Consultants and respond to the Drafts of both the National Reports and National Summary Reports to UNCED.

The members of the Tuvalu National UNCED Task Force are as follows (see Appendix VII for a complete list of those persons consulted in Tuvalu and elsewhere):

Hon. Bikenibeu PAENIU	(Chairman) Prime Minister of Tuvalu
Mr David BALLANTYNE	Attorney-General
Mr David COTTINGHAM	Secretary for Health, Education and Community Affairs
Mr Amasone KILEI	Deputy Secretary to Government
Mr Kelese KOLONE	Secretary for Works and Communications
Mr Simeti LOPATI	Acting Secretary for Home Affairs
Mr Panapasi NELESONE	Secretary for Finance and Commerce
Mr Seve PAENIU	Economic Planning Officer
Ms Vinnetta ROBINSON	Economic Planning Advisor
Mr Enele SOPOAGA	Secretary for Foreign Affairs
Mr Tauaasa TAAFAKI	Secretary to Government
Mr Pokia TIHALA	Secretary for Natural Resources

Near the end of both visits of the Consultants, meetings with the National Task Force were held to discuss the current status of the National Report, with particular emphasis on major issues which were seen as a priority to the Government and people of Tuvalu. At these meeting suggested changes in emphasis, wording or major amendments to the Report were identified and noted by the Consultants.

### **7.3 GOVERNMENT ENDORSEMENT OF THE NATIONAL REPORT AND SUPPORT OF THE PRINCIPLES OF UNCED**

The Government of Tuvalu very strongly endorses the National Report to the United Nations Conference on Environment and Development (UNCED) for submission to the UNCED Secretariat. We also see the document as an important source of information and a guideline which can be used by Government and non-government organisations to promote sustainable development in Tuvalu.



The report is based on a review of the available literature and documents and consultations with governmental officials, public servants, aid agencies, NGO representatives, community leaders and other persons with relevant knowledge. Particular thanks are given to SPREP, ADB and UNDP for their support in producing the report, those persons who contributed their time and expertise, the National Task Force for its work in reviewing and strengthening the report, and in particular the SPREP Consultants, Uentabo Neemia and Professor Randy Thaman of the Institute of Pacific Studies and the Geography Department of the School of Social and Economic Development of The University of the South Pacific, respectively, for their assistance in producing the Report. Because of the breadth and multidisciplinary nature of information required to adequately assess constraints and opportunities for sustainable development in the atoll environment, the report is necessarily general in its coverage, although detailed information in Appendices and a Bibliography of relevant sources are provided. It is hoped that the report accurately expresses the diverse concerns of the Government in relation to its stated commitment to environmentally and culturally sustainable development in the atoll environment.

The emphasis on good environmental management placed by the Governor General of Tuvalu, Sir Toaripi Lauti, in his May 1991 "Speech from the Throne"; the strong international stand taken by our Prime Minister, The Honourable Bikenibeu Paeniu, over a number of environmental issues, particularly over the potential dangers of global warming-related sea-level rise; and the Government's continual support of regional and international initiatives to protect the shared resources and environments of both the Pacific Ocean and the Planet Earth clearly reflect the strong commitment of the Government and the people of Tuvalu to the promotion of environmentally sustainable development and the principles of the United Nations Conference on Environment and Development (UNCED).

Although the constraints to sustainable development in Tuvalu are many and formidable, the opportunities to foster more environmentally and culturally sustainable forms of atoll development are many. As stressed in this document, a main guiding principle of future development, at all levels, must be the maintenance of intergenerational, inter-regional and international equity. In other words, there is a need for all international agencies, nations, large companies, communities and individuals to promote development which, in their own self-interest, does not compromise the ability of future generations, other countries or businesses, and less advantaged communities and individuals to live out of the same global natural resource endowment. Overuse and overpollution by some groups of countries or individuals within countries, is thus seen as the major overriding constraint to sustainable development both globally and locally.

The Government of Tuvalu is, thus, totally committed to development and restructuring of the world economy which will improve international and local equity in terms of the right to environmentally, economically and culturally sustainable development. In this context, it is stressed that, although Tuvaluans have lived a relatively sustainable way of life for thousands of years in the atoll environment, this was at a relatively low level of material wellbeing, a level which is no longer considered adequate. Our people desire some of the more appropriate modern technologies and social services that will make their life easier, safer and more enjoyable in today's world. This requires increased cash incomes and foreign exchange and changes in lifestyles which, if NOT

pursued in the right manner, could undermine the cultural and traditional resource-use systems which have promoted sustainability in the past. As such, we must promote ecologically sustainable "ecodevelopment": development which on one hand attempts to gain for our people the more appropriate technological and social benefits of modern urban industrial societies, while at the same time protecting, to the best of our ability, the social systems, technologies, knowledge and the terrestrial and marine resources that have allowed us to sustain atoll life in Tuvalu in the past. This is the dilemma of development which faces the people and Government of Tuvalu.

It is the hope of the Government and people of Tuvalu, that the United Nations Conference on Environment and Development (UNCED), the "Earth Summit", to be held in Rio de Janeiro, Brazil in June 1992, will achieve its objectives in promoting environmentally sustainable development for the countries and people of Planet Earth. Tuvalu is proud to participate in this undertaking, and, through this National Report, the Government and people of the Tuvalu express their strongest support for the principles and objectives of the United Nations Conference on Environment and Development (UNCED) and the promotion of environmentally and culturally sustainable development, globally, regionally and in Tuvalu.

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Appendix I. Frequency of the usage for specified purposes of 140 widespread Pacific Island atoll and coastal plant species.

Purpose/Use	Ferns x/10	Herbs x/17	Grasses /Sedges x/11	Vines/ Lianas x/14	Shrubs x/26	Trees x/62	Total x/140
Medicinal/Health	6	15	7	11	23	51	113
General Construction	-	-	-	-	6	54	60
Body Ornamentation	6	8	3	7	12	26	62
Firewood/Fuel	-	-	-	-	8	43	51
Ceremony/Ritual	3	4	-	5	6	23	41
Cultivated/Ornamental	4	3	-	2	10	20	39
Tools/Toolmaking	-	-	-	-	4	33	37
Emergency/Famine Foods	4	5	2	2	4	18	35
Boat/Canoe Building	-	-	1	-	3	30	34
Dyes/Pigments	-	-	-	2	4	24	30
Magic/Sorcery	1	6	1	1	6	14	29
Fishing Equipment	-	1	2	-	8	17	28
Cordage/Fibre	2	2	2	6	3	10	25
Games/Toys	-	-	1	4	4	16	25
Supplementary Foods	2	2	-	2	3	14	23
Scenting Oil/Perfumery	1	1	1	1	6	11	21
Fertiliser/Mulching	1	2	2	1	4	11	21
Weapons/Traps	-	-	-	-	6	14	20
Woodcarving	-	-	-	-	1	18	19
Food Parcelisation	3	1	-	3	1	11	19
Animal Feed	1	4	-	3	2	9	19
Legends/Mythology	-	-	-	-	3	15	18
Handicrafts	1	1	3	2	1	9	17
Clothing	-	1	3	-	1	9	14
Musical Instruments	-	-	-	-	1	13	14
Cooking Equipment	-	-	-	-	1	12	13
Fish Poisons	-	-	-	3	4	4	11
Export/Local Sale	-	1	-	-	2	8	11
Adhesive/Caulking	-	1	-	1	-	9	11
Fire by Friction	-	-	-	-	1	8	9
Soap/Shampoo	-	1	-	3	3	2	9
Containers	-	-	-	-	1	7	8
Repellents/Fumigants	-	-	-	-	2	6	8
Wild Animal Foods	-	-	-	-	3	5	8
Tannin/Preservatives	-	-	-	-	1	6	7
Antitoxins	-	1	-	1	1	4	7
Living Fences/Hedges	-	1	-	-	1	5	7

Staple Foods	-	1	-	-	-	5	6
Drinks/Beverage	-	1	-	2	1	1	5
Strainers/Filters	-	-	2	-	-	3	5
Toilet Paper	-	-	-	-	1	4	5
Land Reclamation	-	-	-	-	-	5	5
Calendars/Clocks	-	-	-	-	-	5	5
Contraceptives/Abortifacients	-	-	-	-	3	2	5
Thatching/Roofing	-	-	-	-	1	3	4
Illumination	-	-	-	-	-	4	4
Combs	-	-	-	-	-	4	4
Animal Cages/Roosts	-	-	-	-	-	4	4
Oils/Lubricants	-	-	-	-	-	3	3
Brushes	-	-	-	-	-	3	3
Fans	-	-	-	-	-	3	3
Corks	-	-	-	-	-	3	3
Fishing bait	-	-	-	-	-	3	3
Other Uses*	-	-	2	-	5	27	34
<hr/>							
TOTAL	35	63	32	62	161	671	1024
<hr/>							
NO USES	-	1	1	-	-	-	2
<hr/>							

\* Other uses include stimulants/teas, flavouring/spices, ear cleaners, splints, aphrodisiacs, hair remover, masticants/chewing gum, abrasives, tooth brushes, cigarette wrappers, coconut climbing bandages or harnesses, measuring tapes, fireworks, windbreaks, sand screens, ladders, walking sticks, tethering posts, punishment/torture, communication/language, and computation or counting.

Source: Thaman, 1990.

Appendix II. Atoll and coastal plant species found in Tuvalu which are of particular cultural utility in Melanesia, Polynesia and Micronesia, based on an analysis of different uses listed in the Appendix I (Note: not including a wide range of ecological functions or uses).

Latin Name (Tuvaluan Name)	Uses
<i>Cocos nucifera</i> (niu)	125
<i>Hibiscus tiliaceus</i> (fau, fau tuu)	57
<i>Pandanus tectorius</i> (fala)	53
<i>Calophyllum inophyllum</i> (fetau)	43
<i>Cordia subcordata</i> (kanava)	40
<i>Guettarda speciosa</i> (pua)	36
<i>Scaevola sericea</i> (ngasu, ngahu)	32
<i>Pemphis acidula</i> (ngie)	30
<i>Thespesia populnea</i> (milo)	26
<i>Rhizophora</i> spp. (tongo)	25
<i>Tournefortia argentea</i> (tausunu, tauhunu)	23
<i>Casuarina equisetifolia</i> (toa)	22
<i>Premna serratifolia</i> (aloalo)	22
<i>Morinda citrifolia</i> (nonu)	22
<i>Pipturus argenteus</i> (fau vau, fau)	21
<i>Terminalia catappa</i> (talie)	21
<i>Ficus tinctoria</i> (felo)	21
<i>Hernandia nymphaeaeifolia</i> (puka, puka vaka)	18
<i>Lumnitzera littorea</i> (sangale)	17
<i>Pisonia grandis</i> (puka, puka vai)	17
<i>Barringtonia asiatica</i> (futu, kafutu)	14
<i>Gardenia taitensis</i> (tiale)	12
<i>Triumfetta procumbens</i> (tolotolo)	11
<i>Clerodendrum inerme</i> (inato)	10
<i>Cassytha filiformis</i> (fetai)	10
<i>Crinum asiaticum</i> (talotalo)	9
<i>Polypodium scolopendria</i> (maile)	8
<i>Ipomoea pes-caprae</i> (fue)	7

Source: Adapted from Thaman, 1990.



Appendix III. Marine finfish of major and minor strategic dietary or economic importance in Tuvalu due to their nutritional value and subsistence and/or commercial economic importance. Notes: 1) Under "Importance", S and s = major or minor subsistence dietary importance, C and c = major and minor local commercial importance; E and e = major and minor or potential importance as an overseas export product; and B and b = major and minor important to the tuna export industry as live baitfish for pole-an-line skipjack fishing.

Latin Name	Common Names	Tuvaluan	Importance
<b>MAJOR DIETARY IMPORTANCE, SOLD COMMERCIALY OR EXPORTED</b>			
<u>Acanthocybium solandri</u>	wahoo	paala	s,c,e
<u>Acanthurus triostegus</u>	convict surgeonfish, tang	manina	s,c
<u>Acanthurus xanthopterus</u>	yellowfin surgeon- fish, tang	palagi?	s,c
<u>Adioryx spinifer</u>	scarlet squirrelfish	taa	s,c
<u>Amphotistius kuhlii</u>	blue-spotted ray	fai?	s,c
<u>Aphareus rutilans</u>	red jobfish	palupalu sega loa	s,c,e
<u>Apogon exostigma</u>	one-lined cardinalfish	palumaliau	s,b
<u>Aprion virescens</u>	green jobfish	utu	s,c,e
<u>Archamia lineolata</u>	bronze-streaked cardinalfish	matapa	s,b
<u>Arothron stellatus</u>	boxfish, puffer- fish	?	s
Atherinidae spp.	hardyheads, silver- sides	salii	s,b
<u>Bolbometopon muricatus</u>	humphead parrotfish	taona	S,C
<u>Bothus pantherinus</u>	leopard flounder	ali	s,c

<u>Bregmaceros</u> sp.	?	?	b
<u>Caesio caerulaureus</u>	blue-and-gold fusilier	ulia	b
<u>Carangoides ortho- grammus</u>	gold-spot trevally	?	s,c
<u>Caranx ignobilis</u>	great trevally	tinulua	S,C
<u>Caranx lugubris</u>	black trevally	tafauli	s,c
<u>Caranx melampygus</u>	bluefin trevally	ulua	s,c
<u>Carcharhinus albimar- ginatus</u>	silvertip shark	?	s
<u>Carcharhinus longimanus</u>	oceanic whitetip shark	mago	s,c
<u>Carcharhinus melano- pterus</u>	blacktip reef shark	?	s,c
<u>Cephalopholis argus</u>	peacock rockcod	loi	s,c
<u>Chanos chanos</u>	milkfish	paneava	s,c
<u>Cheilinus undulatus</u>	hump-headed Maori wrasse	tagafa	S,C
<u>Cheilodipterus quinque- lineata</u>	five-lined cardinalfish	kalisi	b
<u>Cheilopogon</u> spp.	flying fish	isave	S,c
<u>Chromis</u> sp.	chromis	moimoi	b
<u>Coryphaena hippurus</u>	dolphin fish, mahimahi	masimasi	s,c,e
<u>Cypselurus</u> spp.	flying fish	isave	S,c
<u>Decapterus macrosoma</u>	scad	?	s,b
<u>Diodon hystrix</u>	porcupine fish, pufferfish	sokisoki?	s,c
<u>Elagatis bipinnulatus</u>	rainbow runner	kamai	s,c,e

<u>Epinephelus merra</u>	honeycomb rock cod	gatala, liki	S,c
<u>Epinephelus microdon</u>	marbled cod	fapuku	S,C
<u>Epinephelus morrhua</u>	snakeskin cod	?	s,c
<u>Etelis carbunculus</u>	red snapper	palu malaupuku	s,c,e
<u>Etelis coruscans</u>	longtail snapper, onaga	palu malau	s,c,e
<u>Etelis oculatus</u>	queen snapper	palu loa	s,c
<u>Euthynnus affinis</u>	mackerel tuna	atualo	s,c
<u>Galeocerdo cuvieri</u>	tiger shark	mago?	s
<u>Gazza minuta</u>	toothed ponyfish	?	s,c
<u>Gerres</u> sp.	silver biddy	matu	S,C
<u>Gnathanodon speciosus</u>	golden trevally	?	s,c
<u>Grammorcynus bicarinatus</u>	scad mackerel	?	s,b
<u>Gymnosarda unicolor</u>	dogtooth tuna	valu	s,c,e
<u>Gymnothorax fimbriatus</u>	moray eel	pusi	S,C
<u>Halichoeres</u> sp.	wrasse	?	s,b
<u>Holocentrus</u> spp.	squirrelfish	malau (gen.)	s,c
<u>Hyporhamphus dussumieri</u>	garfish	tute	S,C
<u>Istiophorus platypterus</u>	sailfish	?	s,c
<u>Katsuwonus pelamis</u>	skipjack	atu	S,C,E
<u>Khyphosus cinerascens</u> ( <u>Khyphosus</u> spp.)	topsail drummer	nanue	S,c
<u>Leiognathus equulus</u> ( <u>L. fasciatus</u> )	ponyfish	?	s,c
<u>Lethrinus chrysostomus</u>	sweetlip enperor	?	s,c

<u>Lethrinus elongatus</u>	long-nosed emperor	filoa	S,C
<u>Lethrinus harak</u>	thumbprint emperor	tanutanu	S,C
<u>Lethrinus mahsena</u>	yellow-tailed emperor	?	S,C
<u>Lethrinus nebulosus</u>	spangled emperor	?	s,c
<u>Liza vaigiensis</u>	diamond-scale mullet	kanase	S,C
<u>Lutjanus bohar</u>	red bass	fagamea	S,c
<u>Lutjanus fulvus</u>	redtail snapper	tagau	s,c
<u>Lutjanus gibbus</u>	paddletail	taea	s,c
<u>Lutjanus kasmira</u>	blue-striped snapper	savane	s,c
<u>Lutjanus monostigma</u>	one-spot snapper	taiva	s,c
<u>Makaira indica</u>	black marlin	ulau	s,c
<u>Makaira mazura</u>	blue marlin	sakula	s,c
<u>Monotaxis grandoculis</u>	large-eye bream	kailo	s,c
<u>Mugil cephalus</u>	sea mullet	kanase	S,c
<u>Mulloidichthys vanicolensis</u>	goatfish	kaivete	S,C
<u>Myripristis violaceus</u> ( <u>M. spp.</u> )	squirrelfish, soldierfish	malau	S,c
<u>Naso unicornis</u>	unicornfish, leatherjacket	ume	S,C
<u>Neoniphon spp.</u>	squirrelfish	malau (gen.)	s,c
<u>Parapriacnathus sp.</u>	sweeperfish	?	b
<u>Plectropomus sp.</u>	big-spot coral trout	tonu	S,C
<u>Pomocanthus spp.</u>	damselfish, angelfish	?	s,c,e

<u>Pranesus pinguis</u> ( <u>Atherinomorus lacunosa</u> )	broad-banded hardyhead	salii	s,b
<u>Pristipomoides flavipinnis</u>	yellow-finned opakapaka	palu sina	s,c,e
<u>Pristipomoides filamentosus</u>	red-finned opakapaka	palu matu	s,c,e
<u>Pristipomoides multidens</u>	purple cheek, striped jobfish	?	s,c,e
<u>Pristipomoides zonatus</u> ( <u>Tropidinius zonatus</u> )	flower snapper	palu savane	s,c,e
<u>Prometichthys prometheus</u>	snake mackerel	?	s
<u>Pseudamia polystigma</u>	cardinalfish	?	b
<u>Pseudobalistes flavimarginatus</u>	green triggerfish	sumu	s,c
<u>Pterocaesio diagramma</u>	yellow lateral-line fusilier	ulia	b
<u>Ruvettus pretiosus</u>	oilfish, escolar	palu talatala	s,c
<u>Scarus ghobban</u>	five-banded parrotfish	ulafi	S,C
<u>Scomberoides lysan</u>	queenfish	lai	s,c,b
<u>Selar crumenophthalmus</u>	bigeye scad	atule, salala	S,C,b
<u>Seriola rivoliana</u>	amberjack	palu matu	s,c,e
<u>Siganus punctatus</u>	spinefoot, rabbitfish	maiava	s,c
<u>Siganus vermiculatus</u> ( <u>S. chrysopilos</u> , <u>S. doliatus</u> )	rabbitfish, spinefoot	maiava	S,C
<u>Sphyraena barracuda</u>	great barracuda	ono	S,C
<u>Sphyraena forsteri</u>	seapike	?	s,c

<u>Spratelloides delicatulus</u>	blue sprat	kavaliki	s,B
<u>Stenatherina panatela</u>	?	?	b
<u>Thunnus albacares</u>	yellowfin tuna	takua, kasi	S,C,E
<u>Upeneus</u> sp.	goatfish	?	s,c
<u>Valamulgil seheli</u> ( <u>V. buchanani</u> )	bluetail mullet	kanase	S,C
<u>Variola albomarginata</u>	lunar-tailed cod	pula	s,c
<u>Xiphias gladius</u>	swordfish	?	s

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Sources: Lewis, c.1985, c.1986, c.1987b; Fisheries Division, 1990; Burgess et al., 1988; Wheeler, 1975; Fowler, 1959; Eginton and Mead, 1978; Taumaia, P and Gentle, M, 1982; Elway et al., 1983; Gillet, 1985; UNDP/FAO Regional Fishery Support Programme, Pers. Com., 1991.

Table IV. Marine non-fish food species of major and minor strategic dietary or economic importance in Tuvalu due to their nutritional value and subsistence and/or commercial economic importance (Notes: 1) Under "Importance", S and s = major or minor subsistence dietary importance, C and c = major and minor local commercial importance; T and t = major and minor importance for the local tourism industry or restaurant business; and E and e = major and minor importance as an overseas export product.

Latin Name	Common Names	Tuvaluan	Importance
<b>REPTILES</b>			
<u>Eretmochelys imbricata</u>	hawksbill turtle	fonu	s,c,e
<u>Chelonia mydas</u>	green turtle	fonu	s,c
<b>CRUSTACEANS</b>			
<u>Birgus latro</u>	coconut crab	uu	s
<u>Cardisoma carnifex?</u>	land crab	kaipea, pakea	S,c
<u>Lysiosquilla maculata</u>	mantis shrimp, banded prawn- killer	valo	s
<u>Panularius</u> spp.	rock lobster	ula	S,c,e
<u>Penaeus</u> sp.?	saltwater prawn		s
<b>SHELLFISH (Bivalves and Gastropods)</b>			
<u>Asaphis violascens</u>	sanguin clam	kosi?	S
<u>Balcis</u> sp.			
<u>Bulla</u> sp.	bubble shell		
<u>Cerithium asper</u>	cerith		
<u>Cerithium</u> sp.	cerith		



<u>Codakia tigerina</u>	Pacific tiger lucine		
<u>Donax faba?</u>	donax		
<u>Epitomium</u> sp.	wentletraps		
<u>Fragum</u> sp.	cockle		
<u>Gafarium pectinatum</u>	venus shell		S
<u>Gari</u> sp.	sanguine clam		
<u>Lambis truncata</u>	spider conch, spider shell	kalea	S,c
<u>Lioconcha castrensis</u>	venus clam		
<u>Mesodesma</u> sp.			
<u>Natica</u> sp.	moon snail		
<u>Nerita</u> sp.	posini		
<u>Oliva oliva</u>	olive shell		
<u>Pitar</u> sp.			
<u>Pyramidella terebellum</u>			
<u>Spirula spirula</u>	ram's-horn shell		S
<u>Rhinoclavis</u> sp.	cerith		
<u>Spondylus</u> sp.	spondylus		s
<u>Strombus luhuanus</u>	bloodmouth conch, red-lipped stromb	paneia	S
<u>Tapes literata</u>	littleneck clam, lettered venus clam	nikatona	S
<u>Tellina rugosa</u>	rugose tellin		
<u>Tellina virgata</u>	virgate tellin		
<u>Thais (Purpura) aculeata</u>	rock shell		

<u>Tridacna maxima</u>	rugose giantclam	fasua nao	S,C,e
<u>Tridacna squamosa</u>	fluted giant clam	fasua taka	S,C,e
<u>Trochus niloticus</u>	trochus shell	muli kao	c,e
<u>Turbo</u> spp.	turban shells	alili	s

## HOLOTHURIANS

<u>Actinopyga miliaris</u>	blackfish	
<u>Actinopyga echinites</u>	deepwater red fish	
<u>Bohadschia marmorata</u>	chalky sandfish	
<u>Bohadschia vitiensis</u>	Brown sandfish	
<u>Bohadschia argus</u>	eyed sandfish	
<u>Bohadschia</u> spp.	sandfish	
<u>Halodeima atra</u> ( <u>Holothuria atra</u> )	lollyfish	
<u>Halodeima edulis</u> ( <u>Holothuria edulis</u> )		
<u>Mertensiothuria lecospilota</u>		
<u>Metriatyla scabra</u> ( <u>Holothuria scabra</u> )	sandfish	
<u>Microthele fuscogilva</u> ( <u>Holothuria fuscogilva</u> )	white teatfish	
<u>Microthele nobilis</u> ( <u>Holothuria nobilis</u> )	black teatfish	
<u>Stichopus chloronotus</u>	sea cucumber	
<u>Thelonata ananas</u>	prickly redfish	

MISCELLANEOUS

jellyfish		?	s
<u>Octopus</u> sp.	octopus	feke	S,C,t
<u>Sepioteuthis</u> sp.	squid	gufeke	s
<u>Siphonosoma</u> <u>australe</u>	peanut worm	ipo?	s

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Sources: Lewis, c.1987a; Fisheries Division, 1990; Merrick, 1989b; 1978; Dance, 1974; Taniera, 1988; Munro, 1988; Langi, 1990; Eys and Philipson, 1989; McElroy, 1990; Parkinson, 1984ab.

Appendix V. Main issues/constraints and opportunities/remedial strategies in relation to the promotion of sustainable development in Tuvalu.

ISSUES	CONSTRAINTS	OPPORTUNITIES
1. Climate change and sea level rise	<p>Uncertainty about time frame and impacts;</p> <p>Feeling of helplessness with:</p> <ul style="list-style-type: none"> <li>- dependence on industrialised countries;</li> <li>- most protection measures beyond Tuvalu's financial and technological capabilities;</li> </ul> <p>Low-lying nature, and susceptibility of all islands to inundation;</p> <p>Extensive area of coastline relative to total land area;</p> <p>Disincentive to investment and development initiatives.</p>	<p>Local programmes of seawall construction, land reclamation, and coastal reforestation;</p> <p>Support regional and international action to:</p> <ul style="list-style-type: none"> <li>- reduce emission of greenhouse gases;</li> <li>- reduce deforestation and encourage reforestation;</li> <li>- identify means of preparing for global warming;</li> </ul> <p>Establish Global Fund to help DCs respond to sea level rise;</p> <p>International guarantee of 'Right to Development' and continuing aid to low-lying DCs.</p>
2. Population growth and distribution	<p>Extremely limited land area;</p> <p>Concentration of population on Funafuti;</p> <p>High natural population growth rates;</p> <p>Limited opportunity for external migration and overseas employment;</p> <p>Extremely high population density relative to land productivity.</p>	<p>Implement strong family planning;</p> <p>Promote further decentralisation;</p> <p>Improve social services to outer islands;</p> <p>Intensify local food production and promote urban food gardening;</p> <p>Educate for gainful employment in rural areas or overseas.</p>

<p><b>3. Deterioration of traditional food and subsistence production systems; and associated increasing incidence of nutritional disorders and nutrition-related diseases and dependence on an unstable global cash economy</b></p>	<p>Loss of knowledge of traditional agriculture and food systems;</p> <p>Limited recognition of economic importance of subsistence production;</p> <p>Overemphasis on coconut monoculture;</p> <p>Overexploitation of marine food resources;</p> <p>Increasing acceptance of and ability to buy imported foods and beverages;</p> <p>Inadequate nutrition education.</p>	<p>Public education on nutrition-related health problems;</p> <p>Promote subsistence food production and tree planting;</p> <p>Establish national food and nutrition policy and committee;</p> <p>EIA to include impact on subsistence production system;</p> <p>Restrict harvesting of inshore marine food resources for local consumption.</p> <p>Strengthen plant and animal quarantine programmes to protect existing resources against disease infestations;</p>
<p><b>4. Environmental education and public awareness</b></p>	<p>Ignorance of major environmental issues and the need for environmental protection;</p> <p>Lack of data on impact of development on the atoll environment;</p> <p>Inappropriate western education models and dependence on foreign curriculum experts;</p> <p>Loss of knowledge of traditional resource-use systems.</p>	<p>Increase local content and use of traditional environmental knowledge in curricula and public education;</p> <p>Make environmental studies an examinable subject at all levels;</p> <p>Increase emphasis on training in environment-related fields;</p> <p>Train local people in curriculum development;</p> <p>Compile knowledge of traditional environmental management.</p>

<p><b>5. Need for environmental protection infrastructure</b></p>	<p>Cross-sectoral nature of environmental management;</p> <p>Lack of integrated legislation for environmental management and protection;</p> <p>Lack of trained manpower in environmental planning, law, conservation and EIA;</p> <p>Lack of funds for protection infrastructure and conservation area establishment;</p> <p>Tenure system and limited land area make western style conservation area development inappropriate;</p> <p>Inadequate data base on resources or development impacts.</p>	<p>Acquire funding for management infrastructure development;</p> <p>Establish autonomous cross-sectoral environmental administrative unit with EIA capability;</p> <p>Incorporate EIA procedures in all development planning;</p> <p>Draft umbrella environmental legislation and enforcement regulations;</p> <p>Make training in environmental planning, law, conservation and EIA a priority.</p> <p>Establish system of protected areas of ecological and subsistence importance.</p>
<p><b>6. Land Reclamation including reclamation of Funafuti "Borrow Pits" excavated during World War II and coastal reclamation and seawall construction on most islands to halt coastal erosion and prepare for the possible impacts of sea level rise due to global warming</b></p>	<p>High cost of reclamation and seawall construction works;</p> <p>Extensive nature of degradation on Funafuti;</p> <p>Land tenure arrangements among original land owners;</p> <p>Identification of sand and aggregate sources for reclamation;</p> <p>Need for feasibility studies of "Borrow Pit" reclamation and land rehabilitation;</p> <p>Unknown impacts of fill removal on lagoon ecosystem and of reclamation on terrestrial ecosystems.</p>	<p>Solicit funding and technical assistance for reclamation;</p> <p>Research on suitable methods for reclamation and revegetation of degraded lands;</p> <p>Establish nurseries of plants suitable for reclamation and coastal stabilisation;</p> <p>Development of technologies to recapture fill.</p>

<p><b>7. Conservation and protection of freshwater resources</b></p>	<p>No surface water and very limited groundwater;</p> <p>Low rainfall and periodic drought;</p> <p>High population densities in urban areas;</p> <p>Competing demands on limited water resources;</p> <p>Susceptibility of groundwater to contamination by salt water incursion and human and animal waste;</p> <p>Limited development of rainwater catchment potential.</p>	<p>Increased use and development of rainwater catchment systems;</p> <p>Soft loans for rainwater catchment and storage systems;</p> <p>Building code to require tank construction with all new structures;</p> <p>Promotion of water conservation;</p> <p>Feasibility studies of desalination;</p> <p>Public education on the importance of water conservation.</p>
<p><b>8. Protection of marine resources from overexploitation</b></p>	<p>Traditional attitude of inexhaustible marine resources;</p> <p>Inadequate data on resource status;</p> <p>Marine pollution;</p> <p>Disruption of lagoon circulation and coastal ecosystems by construction and reef passage construction;</p> <p>Overexploitation of reef and lagoon fisheries;</p> <p>Indiscriminate use of modern fishing techniques;</p> <p>Poaching by foreign vessels;</p> <p>Extreme difficulty of policing extensive coastal areas and EEZ.</p>	<p>Public awareness campaigns;</p> <p>Assessment and monitoring of resource status;</p> <p>Maricultural development and the introduction of appropriate species (e.g. <i>Trochus</i>, <i>Tridacna</i>, seaweeds);</p> <p>Shift emphasis to underexploited species (e.g., tuna);</p> <p>Catch regulations for given species;</p> <p>Accede to treaties on marine resource protection;</p> <p>International collaboration in policing EEZ.</p>

<p><b>9. Protection of terrestrial resources</b></p>	<p>Limited land area relative to population;</p> <p>High proportion of unusable degraded land on Funafuti;</p> <p>Susceptibility of islands to coastal erosion;</p> <p>Lack of data on nature and economic value of terrestrial atoll resources;</p> <p>Land tenure issues;</p> <p>Mining of sand, aggregates and coral construction;</p> <p>Coastal and mangrove deforestation;</p> <p>Overemphasis on coconut monocultures;</p> <p>Lack of proper land use planning and EIA procedures;</p> <p>Inadequate land use legislation and enforcement;</p>	<p>Develop a National Environmental Management Strategy (NEMS);</p> <p>Public education and awareness programmes;</p> <p>Research on terrestrial resource status and development impacts;</p> <p>More effective land use legislation and enforcement;</p> <p>Systematic coastal reforestation and agroforestry programmes.</p>
<p><b>10. Conservation of biological diversity</b></p>	<p>Lack of public understanding of importance of biodiversity;</p> <p>Lack of knowledge of species and endangerment status;</p> <p>Effects of diversity loss on ecological balance and subsistence economy not appreciated;</p> <p>Highly dispersed nature of Tuvalu;</p> <p>Highly mobile nature of some animal populations (e.g., migratory birds, turtles and pelagic fish).</p>	<p>Public education and awareness programmes about biodiversity;</p> <p>Accede to international agreements promoting biodiversity protection;</p> <p>Institute resource inventories and research on the ecological and cultural importance of biodiversity;</p> <p>Establish a system of protected areas;</p> <p>Promote biodiversity conservation at the community and landowner levels;</p> <p>Establish nurseries of important wild and domesticated plant species.</p>



<b>11. Waste management and disposal</b>	<p>Susceptibility of groundwater and marine resources to pollution;</p> <p>Increasing pressure from metropolitan powers to dispose of hazardous waste in atoll and oceanic environments;</p> <p>Extremely limited land available for landfill sites;</p> <p>Lack of disposal facilities for hazardous waste;</p> <p>Increasing dependence on imported non-biodegradable products and packaging;</p> <p>Lack of information on the nature and origin of waste and its environmental impacts;</p> <p>Lack of legislation controlling toxic and non-biodegradable waste;</p> <p>Inability to stop use of neighbouring islands as waste disposal/reduction sites (e.g. Johnston Is. for JICADS).</p>	<p>Implement recycling programmes;</p> <p>Isolate toxic waste disposal from groundwater and marine resources;</p> <p>Sewage outfalls and waste treatment development with no impact on groundwater and lagoon ecosystems;</p> <p>Public education on waste disposal;</p> <p>Use non-hazardous waste for land reclamation and sea wall construction;</p> <p>Reduce importation of non-biodegradable, non-recyclable and hazardous waste;</p> <p>Substitute biodegradable for non-biodegradable packaging;</p> <p>Research on appropriate waste management (e.g., Greenpeace Waste Trade Programme).</p> <p>Accede to accords/treaties on movement and disposal of toxic and hazardous waste.</p>
<b>12. Increased dependency on global cash economy/limited local monetary economic development potential/relative poverty in monetary terms</b>	<p>Overemphasis on short-term, aid-funded economic development;</p> <p>Overemphasis on commercial and export production at expense of environmentally sustainable traditional production systems;</p> <p>No developing planning assessment of the long-term impact of modern development and the cash economy on subsistence production systems and traditional resource management knowledge;</p> <p>Loss of traditional environmental knowledge and production systems;</p>	<p>Require aid donors to fund an EIA component, which includes impact on subsistence production, for all development projects;</p> <p>Greater commitment to maintenance of traditional subsistence production and resource management;</p> <p>Studies of the economic importance of traditional resource management systems;</p> <p>Public education on the importance of traditional resource-use systems.</p>

<p><b>13. Energy dependency on imported fuels</b></p>	<p>Lack of an energy conservation policy;</p> <p>Absence of fossil fuel resources;</p> <p>Increasing cost of imported fuel relative to export earnings;</p> <p>Increasing dependence on outboard motors and motor vessel transport;</p> <p>Deforestation and fuelwood scarcity in urban areas.</p>	<p>Promote energy conservation;</p> <p>Promote renewable energy (e.g., solar) alternatives;</p> <p>Public information programmes on energy dependency and conservation;</p> <p>Research on energy alternatives and conservation;</p> <p>Support negotiations for more equitable regional prices for fossil fuels.</p> <p>Promote sail power as an adjunct to engine driven craft;</p> <p>Expand fuelwood resources;</p> <p>Promote adoption of efficient wood burning stoves.</p>
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<p><b>14. Nuclear pollution and its irreversible long-term impact on human health and the habitability of islands</b></p>	<p>Past history of atmospheric and underground or under water nuclear testing in neighbouring island groups (e.g. Kiritimati Island in Kiribati and the Marshall Islands)</p> <p>Long-term and delayed (often for generations) somatic and genetic effects of radioactivity on human health</p> <p>Lack of data on the environmental and human health impacts of nuclear testing because of confidentiality or unwillingness of responsible parties to conduct such research</p> <p>Inability to destroy and danger of disposal of nuclear waste</p> <p>Fragility and mobility of the Pacific oceanic and atmospheric environments which spreads the potential risk of nuclear pollution throughout the Pacific</p> <p>Unwillingness of nuclear powers to accede to Pacific countries' demands to ban nuclear weapons testing and nuclear waste disposal</p>	<p>Accede to treaties and actions to halt nuclear weapons testing and the disposal of nuclear wastes in the Pacific islands and the surrounding oceanic environment</p> <p>Promote the formation of regional or international task forces to conduct unbiased scientific assessments of the impacts of nuclear weapons testing on the habitability of affected islands and the health of affected peoples</p> <p>Promote initiatives to rehabilitate islands and compensate communities affected by nuclear pollution/destruction</p>
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Appendix VI. Persons in Tuvalu and elsewhere consulted during the preparation of the Tuvalu National Report to UNCED.

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## **TUVALU**

### **Members of the National UNCED Task Force**

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Mr Amasone KILEI	Deputy Secretary to Government
Mr Kelese KOLONE	Secretary for Works and Communications
Mr Simeti LOPATI	Acting Secretary for Home Affairs
Mr Panapasi NELESONE	Secretary for Finance and Commerce
Mr Seve PAENIU	Economic Planning Officer
Ms Vinnetta ROBINSON	Economic Planning Advisor
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### **Others Consulted in Tuvalu**

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