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World Institute for Development
Economics Research

World Development Studies 1

Small Islands, Big Issues

Crucial Issues in the Sustainable Development of
Small Developing Islands



February 1995

UNU World Institute for
Development Economics Research
(UNU/WIDER)

World Development Studies

Small Islands, Big Issues

Crucial Issues in the Sustainable Development of Small
Developing Islands

Papers were prepared at the request of the United Nations Department for Policy
Coordination and Sustainable Development for presentation at the Global
Conference on the Sustainable Development of Small Island Developing States,
held in Barbados on 25 April - 6 May 1994.

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Printed at Forssa Printing House Ltd, 1995

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ISSN 1238-1896
ISBN 952-9520-22-0

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PREFACE

Most of the world's countries are small. The definition of 'smallness' is of course not quite exact. Small states, even small developing countries differ in many respects. Still, in the case of the small, developing island states – which total 33, making up about 17 per cent of the total membership of the UN – there are many structural similarities. They are, to a large extent, dependent on foreign trade due to their limited and often very poor resource endowment. Some of them are very seriously affected by the long distances not only from the main centres of world output, but also to their neighbouring countries.

They have in most cases limited access to human capital and their domestic savings are in general quite small, especially in relation to the necessary infrastructure of ports, airports, roads, educational and health services. The close to 25 million people living in those states are exposed, at the same time, to hurricanes, earthquakes and other forms of natural disasters. These problems comprise already important challenges to their development policies in general, and to their sustainability. In the later part of the 20th century, some new opportunities and concerns have been added to the traditional ones. These are related to the greater, easier and cheaper global movement of people including the fast expansion of international tourism, which helped to 'discover' the small island states. The old and new challenges require a comprehensive approach to the economic and ecological problems of those states in order to understand the nature of the dangers and formulate the required policies. The papers in this volume were written for a conference on Sustainable Development of Small Island Developing States, which took place in Barbados in 1994. The conference was organized by the United Nations Department for Policy Coordination and Sustainable Development.

The paper of Professor Bisnodat Persaud focuses on a centrally important issue: the alternative sources of energy for the small island states. The energy policy of those states is looked at in the setting of their specific characteristics and in the technological, economic and environmental aspects of the different sources of energy. The paper of Dr George Vassiliou, the former President of Cyprus, deals with tourism in the context of sustainable development. Tourism is, of course, a source of additional income opportunities, but at the same time the states' external dependence is increasing. New investments are needed for infrastructural development and for the protection of their fragile environment against environmental degradation, which is often the downside of heavy tourism. Professor G.O.P. Obasi examines an other important issue: the great variety of sources and implications of natural disasters, which is often more tragic and has more long-term implications in the small islands states due to their size and specific geographical locations. Coastal management in these states means, very often, the ecological management of the whole island. This is the conclusion of the study by Dr Vili Fuavao, who includes also the political, economic, cultural and legal

arrangements in analysing 'coastal management in small island developing states'. The collective paper of John Scott, C.E. Berridge and Jeremy Collymore is a case study dealing with the early warning capabilities of the Caribbean Meteorological Organization and the Caribbean Disaster Emergency Response Agency. Their conclusion is that timely warning can reduce many of the tragic consequences of natural disasters, but most of the small islands have just rudimentary facilities. A different, but equally important, issue is the subject of the paper by Elizabeth Dowdeswell: waste management with particular reference to water pollution in the small island states. The sources, the quantities and the consequences of waste, have many specificities; at the same time the great environmental hazards comprise a general and very difficult to cope with problem.

It is evident from the papers that most of the small island states need more expertise and technical assistance in their efforts to monitor, analyse, diagnose and manage their ecological problems in order to improve their capabilities.

We publish and present this interesting, and in many ways unique, contribution by some of the best global experts on the subject to the readers in cooperation with the UN Department for Policy Coordination and Sustainable Development. The issues discussed in the papers occupy an important place in the research programme of UNU/WIDER. The perspectives of the small island state open a new and not too well understood, and in a way hidden, dimension of sustainability. They serve also as important proof to the great diversity in endowments and in the measures needed.

Mihály Simai
Director, UNU/WIDER, Helsinki

FOREWORD

The six studies contained in this volume were prepared at the request of the United Nations Department for Policy Coordination and Sustainable Development for presentation at the Global Conference on the Sustainable Development of Small Island Developing States held in Barbados in April/May 1994. They have all been refined by their respective authors subsequent to the conference.

Three of the studies examine development opportunities and economic and environmental problems small islands face in the energy, tourism and the coastal zone sectors as well as policies and measures for the sustainable development of each sector. Two studies deal with issues relating to natural and man-made disasters in small islands. One of these is analytical, and looks into the extent and causes of natural disasters in small islands and discusses policies and measures to cope with them. The other is a technical assessment of the adequacy of existing early warning facilities in two institutions in the Caribbean. It also provides estimates of the additional resources necessary to upgrade the existing facilities and turn them into full-fledged early warning systems. Another study examines issues relating to waste management with particular reference to water pollution in small islands and discusses policies and measures for effective waste management and prevention of water pollution in the particular context of small islands.

While they were given the widest possible circulation at the conference, the United Nations has decided to publish all these studies together in one volume and make them available to interested readers worldwide as they deal with issues that are of central importance to the sustainable development of small islands on which there is a dearth of detailed, in-depth studies.

It is hoped that the studies will prove useful to policy makers in small islands as well as to those elsewhere concerned with the sustainable development of small islands, and to researchers on the sustainable development problems and prospects of small islands. Above all, it is hoped that they will encourage further in-depth research on specific themes pertinent to the sustainable development of small islands.

Nitin Desai
Under-Secretary-General
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September 16, 1994

CASE STUDY I

**ALTERNATIVE ENERGY SOURCES
FOR SMALL ISLAND DEVELOPING STATES**

*Bisnodat Persaud*¹

1. Challenges

1.1 Background

In discussions in recent years on sustainable development, energy has emerged as a major issue. The threat of global warming and the environmental shock it would cause have helped to concentrate minds. Fossil fuels, the largest source of energy, are responsible for a large proportion of the emissions of carbon dioxide (CO₂), a major greenhouse gas. They also cause a build-up of other forms of pollution.

Thus, energy featured substantially in discussions at the United Nations Conference on Environment and Development (UNCED). This debate has reinforced the case for alternatives to fossil fuels, which had subsided after the sharp fall in energy prices from the heady levels of the 1970s. This build-up of interest continues and in the agenda of the Preparatory Committee for the Global Conference on the Sustainable Development of Small Islands Developing States, energy resources featured as a priority area under a major item concerned with the management of resources and became the subject of chapter VII of the draft programme of action (A/CONF.167/L.1).

1.2 The study

This background explains the context of this study on alternatives to conventional sources of energy. It is concerned with exploring the scope for alternatives to fossil fuels for small island developing states in the pursuit of energy efficiency on a sustainable basis.

¹ The author is grateful for assistance provided by the following persons, in securing information for this paper: Dr. Kulsum Ahmed, Consultant, Environment Department, World Bank, Washington, DC; Mr. Donatus St. Aimee, Science and Technology Officer, Economic Commission for Latin America and the Caribbean, Trinidad and Tobago; Dr. Headley Brown, Financial Consultant, Headley Brown and Company, Jamaica; Dr. Trevor Carmichael, Nova Environmental Consultants, Barbados; Professor Oliver Headley, Department of Chemistry, University of the West Indies, Barbados; Ms. Brett Jacobs, Advisor, Energy Division, Forum Secretariat, Fiji.

1.3 Energy and small island developing states

Energy is an important subject for any major conference concerned with sustainable development. However, the question arises, in considering issues for the Global Conference on the Sustainable Development of Small Island Developing States, whether energy has any special significance for these states beyond its general importance in the context of sustainable economic development.

While small island developing states have special development problems posed by size, as well as particular structural transformation and environmental problems, they tend not to be unfavourably placed when average levels of per capita income are compared. They also tend to have more open economies by necessity. This encourages modernization. With this pattern of development, average per capita consumption of fuels would be high compared with developing countries generally and would be similar, where income levels are comparable, to the per capita consumption of middle-income countries. The tables contained in the present paper confirm this tendency. Where small island developing states are oil-importing countries, this would mean relatively high per capita fuel imports, although it does not necessarily mean that fuel imports would form a higher proportion of imports. This would depend on types of economic structure and since small island states, for comparable levels of per capita income, would tend to be more service-oriented than industrially oriented, there is no *a priori* reason why, from a structural standpoint, small states would have higher fuel-import burdens.

Does size then have any implications for the burden of energy imports? The evidence from Tables 1.1, 1.2 and 1.6 are not clear, although Table 1.6 indicates a higher level of per capita consumption of energy for small island developing states in comparison with continental states. The sample is small, however, and Tables 1.1 and 1.2 do not show a higher import burden for small island developing states. This calls for more detailed study. However, there are good reasons for believing that energy imports pose burdens for small island developing states beyond that implied by their relatively high levels of per capita consumption. Volumes of imports are low to small island developing states and this would mean not only high external transportation costs but also high prices. This external situation is aggravated by the fact that some small island developing states, e.g., many in the South Pacific, are situated far from fuel-exporting countries.

The levels of demand do not make long-term contractual arrangements with small island developing states attractive for fuel-exporting countries. However, some small island developing states have special relationships with such countries. A few Caribbean countries have been able to benefit from special credit arrangements from Venezuela and Mexico. Jamaica has also been able to obtain a special supply and credit arrangement from Nigeria.

The possibilities of bargaining from the strength of bulk buying are indicated by the fact that some South Pacific countries have been able to obtain 10 to 20 per cent reduction in wholesale or bulk supply prices as a result of firm negotiations. It indicates

also the possibilities for regional cooperation in marketing arrangements to secure discounts.

In relation to external transportation charges, it is well established that small states face high freight charges. One study showed that for the period 1987 to 1989, whereas transport and freight costs for exports from small island developing states was 39.7 per cent, it was 22.89 per cent for developing countries generally and 4.42 per cent for developed countries (Briguglio 1993).

Size also has an important bearing on internal factors, which tend to increase the energy supply burden. There are several issues:

- i) Small states are not able to reap significant scale economies from generating plants;
- ii) The tendency towards encouraging competition in electricity generation, transmission and distribution by unbundling and other means is not only difficult but in some aspects impossible to achieve;
- iii) High costs for electricity discourage governments from deregulation and charging economic prices, divestment is made less attractive to governments and potential purchasers and this postpones pursuit of efficiency; rural electrification and supply of electricity thus continue to be seen as a social service. Whatever the justification, this means high-cost energy supplies even to low-cost urban consumers;
- iv) Cost also increases because per capita costs of generating plants are high; this means that plants are not upgraded or renewed as often as they should be. This makes for further inefficiencies;
- v) A few small island developing states have established refineries which, being small, are high-cost and unless abandoned will continue to impose a burden on consumers, which is not compensated for by any significant employment generation.

The high cost of conventional electricity generation in small island developing states is indicated by the tariffs charged (see Table 1.8) and cost per kilowatt hour (kWh) is estimated at between 10 and 20 cents. This compares with 5 to 8 cents in industrial countries. The great variation in customer per employee (see Table 1.5) is also indicative of the scale economy possibilities associated with larger size. Electricity-generating plants in small island developing states are much smaller than those regarded in bigger countries as being of optimum size.

The high cost of electricity generation in small island developing states means that alternative energy sources could more quickly become competitive, especially since in many of the alternatives, scale economies are not paramount and the wide availability of the resources concerned – sun, wind etc. – encourages conversion in dispersed small units.

However, while alternative energy sources have greater possibilities in small island developing states and possibly in developing countries generally, they are not being given the appropriate encouragement. Very often research and development is inadequate and change has to await technological breakthroughs in the developed countries. Many other policies prevent a level playing field from developing between conventional and alternative energy sources.

The conclusion, then, must be that the size of states has a significant bearing on their energy possibilities and that, for small oil-importing countries, conventional energy supplies tend to be costly and to impose burdens on development. These burdens are significant because of the importance of energy as an input in development activities. This means that energy efficiency which reduces the import bill and production costs could make a significant impact on development.

The importance of this conclusion is also seen in the fact that, where countries are facing adjustment difficulties, fuel imports and debt service charges can be very constraining in enabling resources to be available for important social sector expenditures and human and other capital investment. With debt service in some countries exceeding 25 per cent of export earnings and with energy imposing similar burdens on foreign exchange, progress in adjustment becomes difficult to achieve. Quick progress in securing debt reduction and energy efficiency could therefore be very important in achieving sustained recovery.

A second conclusion is that energy policy plays an important role in securing environmental protection through the impact it can have on dangerous emissions and by reducing spillages in oil handling, oil refining, electricity generation and the transport sector. The tremendous overall importance of energy policy in achieving sustainable development must therefore be appreciated, especially in the context of fragile small island environments. It points to the need for greater attention to be paid to achieving energy efficiency as well as to examining the scope for alternatives.

A confirmation of the general importance of energy policy can be seen in the fact that it was high energy prices that led to great dislocation in the developing countries, from which many are finding it difficult to recover. Some of these are small island developing states.

2. Promoting sustainable development in small island developing states

Difficulties in procuring energy supply at reasonable prices in the forms in which it is required add to the many development constraints facing small island developing states. Small island developing states also face special resource management and environmental problems. Energy policy, which has an important bearing on the environment, must be seen against this background, which emphasizes the importance of endeavouring to ensure that energy policy at home and abroad does not aggravate the difficulties small island developing states face in achieving sustainable development.

Climate change and its ecological consequences, especially sea level rise, would be particularly severe for small island developing states, exposed as they are to the sea. Inundation would affect many of them and in some cases total evacuation might be required. This applies to a number of islands in the Caribbean, the Indian Ocean and the South Pacific. The great possibility of an increased incidence and ferocity of hurricanes and typhoons is a matter of special interest to small island developing states because of their exposure to such disasters. Since climate change has a special connection with energy policy, it gives small island developing states a special interest in this policy internationally and domestically.

In small island developing states, population pressure is usually more severe on forests, land, water and coastal areas where people tend to concentrate. Coastal zones are usually rich in resources but they usually pose demanding management requirements. The proportionately large exclusive economic zones which have come under their control add to these resource management problems. Biodiversity is also a special concern because of the many endemic species that continental isolation and the special ecology of small island developing states nurture. The limited range of resources available in small island developing states and the greater pressure acting on these resources give a special imperative to resource management. It is against this background that the strong implications that energy policy poses for the environment must be seen.

Any consideration of the merits of alternative sources of energy must take on board the issue of the relative importance of the pursuit of energy efficiency and the promotion of alternatives. In an important sense, they are not different issues. What is of paramount importance is the promotion of greater efficiency in general energy use, but this efficiency must be seen in the context of promoting development that is sustainable.

Energy efficiency therefore has to be viewed in this wider context, which means that in its cost/benefit calculations, environmental considerations must be taken fully into account and not neglected as in the past.

Fossil fuels are the largest source of energy in many small island developing states, as in other states. Very few small island developing states are well endowed with fossil fuels. This does not mean that these states do not have a sustainable development problem. Often exporting states underprice their domestic supplies and do not reflect their full social costs in terms of the requirement for good resource management, environmental damage and inter-generational equity. With prices not usually reflecting environmental costs, there is often excessive use and unnecessary damage from refining ventures, concentrated petrochemical activities, oil spillages, intensive vehicular use and large-scale processing ventures established to make use of cheap fuel. Nations well endowed with natural resources must use these resources to promote their development. However, they need to do so prudently.

Such countries must not allow the resources concerned to inhibit the development of other sectors through the economic phenomenon known as the Dutch

disease. Environmental considerations require them to go further. Where exploiting that resource has strong environmental implications, as is the case with energy, then extreme care is required. In other words, countries well endowed with fossil fuels may be spared a serious growth challenge but they are not spared a serious sustainable development problem. It is important to stress this energy policy issue, even though the particular concern of the present paper is the energy choice faced by countries which are deficient in fossil-fuel resources.

3. Energy developments

3.1 Small island developing states

As in all countries, a major reliance on fossil fuels for commercial energy has continued in small island developing states in spite of policies that have emphasized greater reliance on renewable energy sources. The steep oil price increases in the early and late 1970s led to policies to encourage energy efficiency and increased use of renewable energy. However, the subsequent fall in oil prices, especially after the mid-1980s (except for a small increase again during the Gulf crisis), has continued and interest in alternative sources of energy has only recently revived, following the rising awareness of environmental considerations. UNCED, and the detailed preparatory work for it, has contributed greatly to this change.

For small island developing states with reasonable levels of per capita income, reliance on fossil-fuel imports in total energy consumption is large. In the Caribbean, for example, petroleum imports are responsible for more than 75 per cent of primary energy and more than 50 per cent of final consumption in all small island states (Boopsingh and Byer 1993). Trinidad and Tobago, as a petroleum surplus country, is an exception. Bagasse and fuelwood are also significant contributors to final consumption in Jamaica and bagasse alone is significant in Barbados (Boopsingh and Byer 1993). Only in Dominica is hydropower a substantial and successful contributor to energy needs. There is also a significant contribution in Saint Vincent and a small one in Jamaica. Solar energy is used to some extent but the only area where its use has expanded and has become significant is in water-heating in Barbados. It is also used to some extent in crop drying. There is increasing interest in photovoltaic (PV) systems, with recent improvements in the technology and substantial cost reduction. Some use of windpower in the region is long-standing; there is also a current revival of interest because of technology improvement and cost reduction.

In the South Pacific, patterns of energy use are somewhat similar, except that lower levels of development in most islands as well as small and isolated populations have meant a continuing major reliance on biomass, especially fuelwood, sawmill waste and coconut shells and husks. According to information supplied by the Energy Division of the South Pacific Forum secretariat, biomass contributes about 48 per cent of final energy consumption. Greater use than in the Caribbean is also made of hydropower (7 per cent) and photovoltaics. Even in Fiji, with a development level

similar to some Caribbean states, the larger reliance on biomass persists. Thus, 55 per cent of final consumption comes from wood and bagasse.

3.2 *The world*

According to recent United Nations estimates, world consumption of fossil fuels is projected to increase from 6,894 million tons of oil equivalent (mtoe) in 1990 to 13,754 mtoe by 2020. This represents an annual growth rate of 2.23 per cent (see Table 1.11). However, the growth for developed market economy countries is projected at 1.04 per cent compared to 4.21 per cent for the developing countries. The consequence is that by 2020, developing countries will be responsible for 48 per cent of world consumption compared to 26 per cent currently.

The developed market economies have made great strides in reducing the intensity of energy use in relation to gross domestic product (GDP) (see Table 1.12). This increase in energy efficiency will continue and the intensity for these countries is expected to fall from 0.5 metric tons of coal equivalent per thousand dollars of GDP in 1988 to 0.29 by 2020. During this time, the newly industrializing countries are expected to make modest progress but other developing countries are expected to increase their intensity to 0.78 by 2000 and then reduce it to current levels of around 0.6 tons.

According to this projection, developing countries should move to just under a half of world consumption, while there should still remain a large gap in per capita consumption between them and the developed market economy countries. The rates of increase in consumption of different fuels between 1970 and 1991, which guide these projections, are shown in Table 1.10. The consequences for the emission of CO₂ and other pollutants are shown in Table 1.14. Developing countries, by that time, should be responsible for larger amounts of CO₂, sulphur oxide and nitrogen oxide emissions than the developed market economy countries, although only in terms of rates of emission at that time and not in any cumulative sense.

How have small island developing states fared in these consumption increases in the past two decades? In the Caribbean, high oil prices and poor growth performance have meant that fossil-fuel consumption has not been increasing significantly, at least not as in middle-income countries generally. Table 1.3 shows the pattern for the Caribbean. In the case of a few individual countries, especially the smaller ones, which have been able to maintain a good rate of growth, such as Saint Lucia, consumption has been increasing at about the same rate as that of the newly industrializing countries.

In the South Pacific islands, the growth rate in energy consumption in the 1980s, while not as high as in the newly industrializing countries, was nevertheless larger than in the Caribbean, presumably not only because of better economic growth performance but also because of existing lower levels of per capita consumption. In 1990, for instance, growth for the whole region was about 4.4 per cent (South Pacific Forum secretariat).

3.3 Energy policy in small island developing states

In the context of trends and developments, what should energy policy be in small island developing states? As in other areas of development policy, energy policy has not yet been widened to take into account environmental implications. The achievement of sustainable development will require paying substantial attention to mitigating environmental damage resulting from fossil-fuel use, and ensuring a level playing field between all energy investments by undertaking cost/benefit analyses that take into account all environmental costs and benefits. This means that all off-site costs – costs imposed on the community – must be internalized by creating appropriate taxes, incentives and regulations to eliminate them or bring them under manageable control. Investments undertaken will still have to produce the highest return, but such returns must be calculated on the basis of all costs – social and private.

The consequence on a national basis must be to ensure that total capital – incorporating both man-made and natural – increases over time. This would help to ensure inter-generational equity. However, enlarging capital cannot be viewed only on an aggregate basis, since some natural capital is vital for the future and damage to it can be irreversible. The infinite damage that can arise from climate change means that humankind cannot just be reactive to the consequences of greenhouse gas emissions. The precautionary principle must therefore be brought into play, and it must take into account not only the probability of damage but also its possible extent and its irreversibility.

Thus, although greenhouse gas emissions from small island developing states would have contributed very minimally to greenhouse gas build-up in the biosphere, small island developing states have an interest in the Framework Convention on Climate Change (A/AC.237/18 (Part II)/Add.1, annex I) and its effectiveness. Their interest in controls on CO₂ emissions will require that they cooperate with other developing countries in insisting on firmer commitments in accepting targets that fully reflect the precautionary principle, taking into account the extent of expected damage. But small island developing states will also have to cooperate with other developing countries in accepting targets that take into account these principles but also reflect their much smaller historical contribution to the accumulation of greenhouse gases. A particular requirement to encourage developing countries, especially small island developing states, to participate fully would be the recognition of their expanding energy needs for development, and their consequent strong interest in research and development and investment in alternative energy sources, where these offer feasible sustainable development prospects. An important instrument, in this connection, is the Global Environment Facility (GEF), which will need expanded resources and greatly improved access for small island states.

In connection with improvements in the operation of GEF, and its interest in energy-related environmental impacts, it is of interest to note that deforestation is one adverse contribution of a renewable energy source – fuelwood. In small island states, limited land in relation to population and a lack of sustainable alternative energy sources have encouraged much deforestation and the destruction of vital watersheds. Forests

also make a positive contribution to easing global warming by acting as a carbon sink. Increased protection for forests reinforces the case for much greater resources and a larger role for GEF. Greater recognition is needed of the rapid deforestation in small island developing states, which has not featured significantly in the global discussion on forest protection. It is very important nationally in the energy equation in small island developing states and requires greater international attention than it has been given so far. An international dimension of deforestation in small island developing states (a concern of the Convention on Biodiversity [UN Environment Programme 1992] and the Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation and Sustainable Development of All Types of Forests [Rio Conference 1992]) is the existence of many rare endemic biological species in small island developing states because of their isolated ecology. These need special protection, which could be provided by improved coastal zone management and the practice of sustainable agriculture and forestry.

4. Fossil fuels and the environment

The excessive use of fossil fuels entails much damage at the national level in all countries. Protection is far from adequate, taking into account associated national and global adversities. The national environmental consequences of excessive fossil-fuel use have been inadequately recognized. The impact is strong in small island developing states even where use intensity is not yet high because of the fragile coastal ecology, its economic importance and the special need to manage well the limited range of resources available. Tourism is an important economic activity in most small island developing states. The environment therefore becomes a great economic asset.

It should be remembered that oil products dispersed into the environment decompose slowly and frequent small spillages lead to a build-up of problems for nearby streams and the marine environment.

Oil is a significant environmental threat to streams and coastal areas because it forms a thin seal on the surface of the water, which prevents the free passage of oxygen and CO₂ between the water surface and the atmosphere above and could easily result in fish kills or fish catches which are unsuitable for human consumption (Baines 1991).

Oil spillage occurs from various sources: accidents, power plants, refineries, garages, the cleaning of storage tanks and tankers, leakage from deteriorating storage tanks, the oily wastes of ships and ships' bilge water dumped in in-shore waters. The cleaning of oil tankers in national waters is a special problem for small island developing states. Regulations under the International Maritime Organization (IMO) have attempted to curb this but surveillance by small island developing states of their exclusive economic zone (EEZ) has not been adequate.

Power plants pose a special problem for small island developing states. Cooling systems require high volumes of water. After use, this water is hot and contaminated and its dispersal into the sea alters the temperature of the nearby sea and its salinity, and

this, together with the dangerous chemicals such as chromium that water contains, destroys marine life, especially corals, which are particularly vulnerable to heated water. According to a recent report by the Energy Sector Management Assistance Programme in Jamaica, besides the emission of sulphur dioxide and nitrogen oxides, the second major environmental effect from power plants is the release of dirty water, oil, chemicals and boiler blow-down into the station drains and hence into the sea.

On land, fossil-fuel use, especially coal and oil, results not only in CO₂ emissions but also sulphur dioxide, nitrogen oxides, unburned hydrocarbons and carbon monoxide and also lead from leaded fuels. While industrial activity is not usually at an intensity in small island developing states to cause a dangerous build-up of these pollutants in the atmosphere, in a few of the larger cities, atmospheric pollution and industrial wastes are beginning to be a serious problem requiring controls. The adoption of taxes and incentives to encourage use of unleaded petrol is very slow, and lead poisoning from discarded batteries and industrial wastes is a problem in some areas.

An example of the complacent attitude to the situation is indicated by the fact that in some islands, unleaded petrol fetches a higher price than leaded one. Unleaded petrol is not also available in many small island developing states, especially in the South Pacific. The excessive use of motor vehicles, including ones that are not economical in the use of petrol, is a cause of atmosphere pollution in a number of cities, especially those in larger small island developing states. Taxes on vehicles and petrol should take into account their environmental costs.

Risks to small island developing states also arise from oil imports and exports and the international oil trade. The Caribbean, which has a large number of small island developing states, is particularly vulnerable, as its sea is an important cross-road for the world's oil trade. Each year over 2 billion barrels of crude oil pass through the region and at any one time about 100 tankers are in transit through it (Maharaj 1993). The Caribbean Sea therefore has a high risk potential for oil spills. Already the second largest tanker spill in the world occurred in the region in 1979, when two super tankers, the Atlantic Express and the Aegean Captain, collided off the coast of Trinidad, spilling some 900,000 barrels of oil.

It is clearly the case that energy policy, especially as it relates to fossil fuels, does not yet incorporate sustainable elements. Taxes, incentives and controls are not yet closely related to environmental consequences, and costs imposed on the community from oil spillage, marine pollution and a contaminated atmosphere are not yet internalized to produce relative costs and prices that reflect considerations of sustainable development. In some cases, activities causing pollution in their production, such as electricity generation, are subsidized rather than taxed to reflect the 'polluter pays' principle. Uneconomic pricing is still prevalent for electricity in many small island developing states. Even when environmental considerations are included, pricing systems prevent small plants generating electricity from a renewable resource from capturing all its advantages. For example, electricity pricing may protect power companies from the risks associated with sudden price hikes for oil by allowing increases in tariffs to fully reflect such price increases. Also, prices charged to

consumers are often based on average costs rather than marginal costs. Peak load pricing is scarcely used, and rural and isolated communities do not pay the high costs their generation and distribution incurs. Thus, renewables do not face a level playing field in competing in areas of supply in which they could be competitive, such as rural electrification. It should also be noted that renewable resources allow electricity generation capacity to be added by small increments, thus avoiding costly plant expansions and reducing the risk of adding too much at too little capacity. Generating equipment often faces lower import duties than equipment connected with the use of renewable resources.

Because of privatization and deregulation, there is a movement away from subsidized pricing, but it is still widely used, especially where power plants continue to be state owned. This is particularly the case in the South Pacific, where, because of small populations and isolated communities, electricity costs are high and rural electrification would not proceed far without subsidies. While there may be some justification for such subsidies for social reasons, they should be accompanied by equal encouragement for the use of renewable energy. Even where there are no subsidies to power utilities, prices may cover only private or on-site costs and not take into account costs imposed on the community through atmospheric pollution and oil spillages on land, streams and coastal waters.

Where, for social or political reasons, governments do not wish to impose such costs, they must be aware of the implication for the build-up of environmental damage and be prepared to offer equivalent subsidies to alternative and more benign energy sources, such as solar energy. In some respects, subsidies may be justified. In many small island developing states, kerosene prices are subsidized in order to prevent excess fuelwood use and deforestation. However, equivalent subsidies should be made available for benign alternatives, such as solar cookers and ovens.

One small island developing state in which solar energy has made good progress in the Caribbean is Barbados, in the area of domestic water-heating. Tax incentives were provided to encourage firms to produce, and householders to set up, solar water-heating systems, and this has led to considerable expansion in their use and significant energy saving.

The fact is that there has been considerable reduction in the cost of producing energy by renewable means, such as direct solar use for heating and drying, and producing electricity through solar thermal means or photovoltaics. On the basis of private costs alone and leaving out environmental considerations, some of these systems have become marginally competitive with fossil-fuel alternatives, depending on location. For example, while photovoltaics is not yet competitive with power generating plants, for isolated communities it has become competitive, as can be seen from the increasing adoption of PV systems for such locations.

What is interesting, however, is that environmental considerations are not internalized in such costing, for the reason that the polluting power plant is not required to pay for any community damage its electricity generation incurs. If such full costing

were to be taken into account, the alternatives would become competitive over a broader range and could become increasingly so, since the policy would encourage greater volume production of solar water-heaters and PV systems and more research into these alternatives, all of which would reduce the cost per unit of energy produced. Environmental changes are not easy to cost. The whole issue of estimating such costs is new. In the United States of America, for instance, analysts have estimated the additional cost for coal to take into account its impact on the environment as between 21 per cent and 1,025 per cent of its market price. Even the minimum of 21 per cent is, however, a significant addition.

One advantage of renewable energy as a source for electricity generation is that optimum capacity is usually smaller or that scale economies are not usually as pronounced as in conventional power plants. Thus, renewable sources could be used to add capacity when small increments are required, thereby obviating the need to build new and costly plants or to upgrade existing plants.

5. Energy efficiency

The above considerations deal with the scope for alternative energy sources on the basis of present costs of electricity generation and the need to include environmental costs. However, a better alternative in some areas would be to concentrate on efficiency increases in conventional systems and make these systems sustainable by causing less environmental damage or dangerous emissions per unit of output. Consumers, whether industrial, commercial or residential, could also improve the efficiency of their energy use. Such demand-side management (DSM) would not only reduce pollution but would have a large impact in reducing generating cost, lessening the need to add costly plant capacity.

The main areas in which fossil fuels are used are electricity generation, vehicular transportation and non-electrical industrial purposes. There is scope for increasing efficiency in all these areas. As Table 1.12 shows, developed countries have made considerable gains in energy efficiency. This indicates possibilities for developing countries also, since the methods used and the new technologies involved are available to developing countries.

A particular commercial consideration for small island developing states is the high cost of electricity generation arising from the inability to obtain significant scale economies. As they are small states with populations often below even 200,000, scale diseconomies are substantial and fairly general in small island developing states. Table 1.5 shows the generating capacity for selected small island developing states in the Caribbean and South Pacific. There is considerable variation and in some cases, as in multi-island states, more than one plant is involved. Some indication of cost variation according to size of plant is given by the great variation in the customer to employee ratio, with states with smaller generating capacity generally showing lower ratios. An exception is Dominica, where the situation is exceptional because of the substantial dependence on hydropower. Even where capacities are similar, there is great variation,

indicating substantial efficiency differences. The high efficiency of Barbados, even compared to countries with bigger capacity, is to be noted. The great variation of tariff rates also indicates cost variations, although the situation is complicated by substantial subsidization in some cases. A recent analysis indicates considerable differences in efficiency among Caribbean electricity-generating plants (Boopsingh and Byer 1993).

Areas which seem to offer good scope for increasing energy efficiency generally are:

- i) Reducing or eliminating subsidies for some forms of energy in order that competition could be fairer among energy sources;
- ii) Improving systems of pricing so that prices reflect marginal costs in order that competition could be fair in supplying outlying areas and in providing additional supplies;
- iii) Where possible, encouraging competition, e.g., in supplying incremental needs of electricity to grids or between electricity and other forms of energy generally;
- iv) Encouraging fully commercial operation in order that the profit motive could drive efficiency improvement and ensure adequate capitalization. Private ownership must be accompanied by efficient, transparent and capable regulatory mechanisms for price determination and setting standards;
- v) Encouraging DSM in order to reduce foreign exchange and other costs of expanding generating capacity. This might entail subsidies, for instance, to encourage fluorescent lighting in order to reduce demand; energy audits should be encouraged to facilitate DSM;
- vi) Reducing losses in electricity transmission and distribution: variation in losses is wide (see Table 1.5) and in some cases losses are not just technical ones but are higher because of thefts; privatization would provide greater incentives to reduce losses;
- vii) Relating taxes, incentives and regulations to environmental impact in order that costs and prices would better reflect sustainability and fair competition between alternatives;
- viii) Establishing and retaining small refineries only where they can be competitive internationally, taking into account all costs and benefits of local refining;
- ix) Improving technical and managerial capacity by increasing opportunities for training in order that human resource development would better respond to the needs of this important sector;
- x) Removing constraints to foreign investment in exploration and development, in electricity generation, and in developing alternative energy sources in order to assist in meeting the capital and technology requirements of the energy sector.

6. Scope for alternatives

Greater attention to environmental considerations in order to make development sustainable is giving increased scope not only to renewable forms of energy but also to less environmentally damaging sources of fossil fuels such as natural gas. Even oil has environmental advantages over coal. However, technologies are changing in ways that affect relative advantages. Substantial progress is being made, for instance, in developing cleaner coal technologies.

Natural gas now has however greater possibilities as a substitute for oil and coal, not only because it is much cleaner but also because technological change in the use of combined-cycle gas-fired generating stations has reduced capital cost, feasible plant size and nitrogen oxide emissions. Availability depends, however, on expensive exploration and pipeline infrastructure, whether for household use or for generating electricity. Export depends on expensive transboundary pipeline infrastructure or shipping as liquefied natural gas. For small island developing states, only where gas is available locally does it have scope for extensive use as a substitute for oil.

In the short run, efficient and sustainable energy use would mean for small island developing states a focus on energy efficiency and some shift among fossil fuels. The large current reliance on fossil fuels means that there is greater scope for gains in this area from improved technologies and for some change in the balance of use among them.

Scope for renewable energy is changing and in the long run it offers good prospects for small island developing states. But not all renewables are environmentally safe. The use of fuelwood encourages deforestation and large hydroelectric schemes could be ecologically disturbing and deny downstream agriculture of adequate and timely water supplies. While renewables are not yet competitive with fossil fuels in electricity generation in the developed countries, the higher cost of electricity generation in the small plants of small island developing states would make some renewables competitive earlier. With electricity costs at over 10 cents per kWh, some alternatives would appear already to be closely competitive. Table 1.18 provides up-to-date data on costs per kWh for alternatives in the United States of America. From technological and cost developments, expected incremental uses of alternatives in the United States of America are shown in Table 1.17. This indicates relative prospects in that country. Since these data reflect technological change that would influence similar change in developing countries, they are broadly indicative also of prospects in developing countries.

Environmental and cost considerations are not the only factors that make alternative sources of energy hopeful. Renewables are largely based on local resources and some of the equipment used in their energy conversion is even fabricated locally, as in the case of solar water-heaters. The resources that they use are widely available so that there is no regional concentration of their benefits. Their plants are usually on a much smaller scale and capacity can be more easily adjusted to demand, all of which results in capital saving. Thus, on the basis of the energy sources used and flexibility of

plant size, they save foreign exchange. They also create much more employment per unit of energy generated. In many cases, the resources are available in areas where it is costly to provide electricity – areas distant from population centres. The flexibility of plant size and cogeneration possibilities give them an advantage in handling small incremental demand and in use in complementary ways with other energy sources.

Attention in small island developing states should now begin to focus on the increasing opportunities that are arising and will be arising increasingly in the future for renewable energy. Consideration is given below to the sources of renewable energy that would seem to have the best prospects for small island developing states.

6.1 Biomass

Biomass has been historically the major source of energy and even today is the largest source for some developing countries, including small island developing states. Overall, it provides 35 per cent of the energy needs for developing countries and 23 per cent for industrial countries. For small island developing states, it supplies more than 50 per cent for nearly all South Pacific islands. It takes the form of fuelwood and agricultural wastes, such as coconut shells and husks and other residues. For Caribbean small island developing states, fuelwood is becoming less important (except in Jamaica, where charcoal is still much in use) and bagasse, used in cogeneration in sugar production, is given a significant role.

Biomass is a low-intensive energy source. However, it can take many forms, including direct combustion, biogas and liquid fuels. Thus, if in its newer forms it becomes economic, it could be a substitute with a wide variety of uses. Biogas is now widely used, especially in China and Cuba. Its role is also as a waste-management device. In small island developing states, it has made little headway. There are, however, about 1,000 farms in the Caribbean producing biogas for cooking and generating electricity – in one case in Puerto Rico for driving a 40 kW generator. About half of these farms are in Cuba (St. Aimee).

In the case of liquid fuels, Brazil has gone furthest in its production of fuel alcohol from sugar cane. Ethanol production in Brazil has made good headway. By 1985, 96 per cent of the new cars sold were running on alcohol. In 1989, 12 billion litres of ethanol were produced and one third of all cars used alcohol as fuel. The fall in oil prices since the mid-1980s has, however, disrupted Brazil's attempt to substitute ethanol for petroleum. In 1991, the cost of ethanol per barrel of oil equivalent far exceeded the price of oil. Nevertheless, ethanol remains of great interest to Caribbean sugar-producing small island developing states. Experimental work is taking place in Barbados.

An area in which biomass remains of interest in the short term is the use of fuelwood and bagasse in cogeneration activity. Bagasse is successfully used and could be more widely used in Caribbean sugar industries. It can produce surplus energy, which can be fed into national grids. There is also much waste in other agro-processing and agro-forest industries, such as rice-mill and sawmill wastes. A particular problem is that

unless used for cogeneration, high transportation costs and low conversion usually make collection of the waste or other agricultural material an uneconomic proposition. A close look is being given in Guyana to the use of sawmill and rice-mill wastes in view of the large amounts of these available there.

Fuelwood continues to be extensively used in the South Pacific and in Guyana. In some small island developing states, wood remains plentiful in relation to demand, but in others in both the South Pacific and the Caribbean, fuelwood use is already encouraging deforestation and watershed destruction, with substantial loss of environmental capital, and must be curbed. The increasing scarcity of fuelwood often adds to the high workload of women who in many small island developing states are responsible for fuelwood collection. Kerosene subsidy is one method used to ease the pressure on forests. It also has advantages for women in reducing both their workload and smoke pollution in kitchens. However, similar subsidies for solar cookers or improved stoves could also be beneficial in foreign exchange and environmental terms.

In the Caribbean, electricity supply is moving to total national coverage. This is not possible, in the near term, for most Pacific islands and in some cases agro-forestry in the form of wood farming needs to be encouraged to serve the purposes of watershed protection, land improvement and fuelwood production. In relation to biomass, such agro-forestry as well as scope for cogeneration using agricultural and other wastes and biogas offer the best near-term prospects.

6.2 *Solar*

6.2.1 Solar thermal

Solar thermal technologies for electricity generation are of considerable interest to small island developing states because of the large amounts of insolation they receive. However, these technologies are not yet competitive with conventional electricity generation. Costs are, however, coming down because of technological improvements. A particular problem is the lack of good storage technology, which means that solar thermal systems must take hybrid forms and must work as supplements to other systems or in a complementary way, e.g., with natural gas generating systems.

A few systems are under close examination in the United States of America, such as the parabolic trough, the central receiver and the parabolic dish. The first is already being tried commercially. Present costs of electricity from these systems in the United States of America are in the range of 9 to 14 cents per kWh in hybrid operation with natural gas (Ahmed 1994, see also Table 1.18). With solar alone, they are 13 to 20 cents per kWh (Ahmed 1994). In the next generation of these systems, costs are expected to be reduced to 5 to 10 cents per kWh (Ahmed 1994), which would make them of great interest to developing countries, including small island developing states, where existing generating costs already exceed these levels. Against the background of these cost developments, small island developing states and developing countries generally should already be trying solar thermal systems on an experimental basis with donor support.

Technological improvements are also expected to solve problems associated with storage so that neither evenings nor cloudy days would be significant constraints; to further improve conversion efficiencies; and to shorten the time required for construction and installation. A disadvantage of solar thermal systems for small island developing states, especially the smaller islands, is the large amount of land required for their installation – about 484 hectares for an 80 megawatt (MW) plant (Headley 1994).

6.2.2 Photovoltaics

Costs of electricity from PV systems have decreased by a factor of 10 over the past 15 years and by more than 50 since the 1970s. Conversion efficiencies have improved tremendously – from about 7 per cent in 1976 to 13 per cent currently (Ahmed 1994). The consequence is that PV systems have now become economic for many applications, especially to serve small isolated communities.

PV systems have considerable relevance to the South Pacific where rural electrification is difficult and costly because of the small and dispersed nature of populations. But low levels of development mean that such communities cannot afford high-cost systems. Some PV plants have been established in the South Pacific and on a more limited scale in the Caribbean. Most of those in the South Pacific have been installed by donors and even though operating costs are low, maintenance is posing a problem. A system of charges whereby consumers meet operating costs and part of the capital costs could help to ensure better care and maintenance.

Under United States conditions, current costs for generation are estimated at 16 to 22 cents per kWh (see Table 1.18). There are considerable prospects for reducing costs further. Hence PV systems offer good possibilities in the near future for the South Pacific and for isolated locations in larger small island developing states, such as Jamaica and Haiti. Wider use of PV systems would help to reduce capital and installation costs.

6.2.3 Other solar systems

i) Water heaters

Much energy is used for heating water for households and hotels in small island developing states, especially those with reasonable living standards and large tourist industries.

Solar energy is economic for water-heating and it has made considerable headway in some countries, e.g., Israel, including some small island developing states, e.g., Barbados and the Bahamas. In the South Pacific, use is limited to a few middle-income households. In Barbados, the situation has been helped by the offer of tax incentives both to firms producing solar water-heaters as approved enterprises under the Fiscal Incentives Act, and to householders installing solar water-heaters. These incentives have resulted in about 23,000 installations of solar water-heating systems between 1986 and 1992 and about 64 per cent of these are for households, indicating coverage of a good proportion of the 75,000 households on the island (Carmichael and Mohan 1994). Estimates made show annual savings on fuel bills of about US\$ 3 million (Headley 1994).

The Barbados experience reveals the considerable scope for introducing solar water-heating systems on a wider scale. Many households have water-heating systems in small island developing states, in the Caribbean, the Mediterranean and the Indian Ocean. There is also increasing use in the Pacific. It is estimated that there is quick potential for replacing about 10,000 water-heaters with solar systems in Jamaica. Nearly all Caribbean, Mediterranean and Indian Ocean islands have substantial tourist industries, and an increasing number of Pacific islands are becoming tourist resorts. The possibilities for reducing fuel bills and imports are therefore significant.

ii) Other solar applications

The use of solar energy for crop and timber drying has considerable scope in all small island developing states. There are so far only a few commercial ventures in small island developing states. It could be used for a variety of tropical crops grown widely among small island developing states – bananas, sorrel, papaw, coconuts, yam, sweet potatoes, ginger, nutmeg – some of which are being exported in dried forms. However, while research and development work has gone on in developing prototypes, commercialization remains undeveloped. This is an area with considerable potential, since economic use is possible immediately rather than in the future.

Solar energy already has limited applications in other areas – ovens for village bakeries, solar cookers and producing distilled water. Using solar energy to desalt sea water seemed a promising prospect in the drier small island developing states, but recent advances in alternative technology has put solar power at a disadvantage. A significant amount of experimental work is taking place in the Caribbean in these and other areas, such as solar refrigeration and sea water desalination.

iii) Solar: general

On the whole, solar energy offers exciting possibilities for the future. There are already significant possibilities for wider commercial application for water-heating and crop drying. PV systems also have good possibilities, especially in the South Pacific. However, it is in the solar thermal systems for electricity generation that exciting prospects are offered in the not-too-distant future for large-scale development, especially for the larger small island developing states and other developing countries where land is not too scarce.

6.3 *Hydropower*

Hydropower contributes significantly to local electricity generation only in Dominica, Saint Vincent, and Jamaica in the Caribbean, and in Fiji, Papua New Guinea and Samoa in the South Pacific. For Dominica only, the bulk of supply comes from hydropower. In Saint Vincent it is about 20 per cent of supply, in Fiji 10 per cent and in Jamaica 8 per cent.

There is considerable scope for mini- and micro-schemes in Fiji and other South Pacific islands. The prospect for further development is more limited in the Caribbean,

except for Guyana on the mainland. The near-term prospects are for small schemes to cater to nearby communities.

High installation and transmission costs because of remote location of sources are the present constraints to further expansion of hydropower. For large schemes that are possible in Guyana, close consideration would have to be given in costing to the environmental aspects. Despite these constraints, hydropower and to some extent windpower are the only significant existing competitors to fossil fuels for electricity generation in small island developing states. They are the only sources with good prospect for expansion in the near future at competitive costs, especially when the needs are for small projects. Their potential should always be kept in view, especially for the Pacific, where lower incomes give scope to small schemes for communities that cannot economically or at affordable costs be connected to the national grid in the near future. The cost shown in Table 1.18 is 18-28 cents per kWh for new sites in the United States of America, but these are for large schemes. Small ones in small island developing states have lower costs.

6.4 Wind turbines

Wind is another alternative power source that is already competitive with other power sources for some applications. Windmills have of course a long history. With improved technology, windpower has remained economic for very limited applications. However, here again technological change is advancing and cost per kWh at 4 to 5 cents in the United States of America (see Table 1.18) is competitive with other sources of energy for specific purposes. That prospects are becoming better for wind turbines is indicated by the increasing interest in selling them to developing countries.

Wind energy is not as easily accessible as solar energy. There are some constraints. Wind speed must be reliable and must be at least 12 miles per hour.

Some small island developing states are better endowed than others in this respect. Unobstructed exposure to the north-east trade winds provides many Caribbean islands, such as Antigua, Barbados and the Windward Islands with good wind speed. The South Pacific is not in such a favourable position. Wind speeds are lower, except in some islands – the Cook islands and some parts of Fiji. Windpower is scarcely used in the region for generating electricity. It is largely used for pumping water for irrigation.

Many electricity-generating windmills are in use in the Caribbean and more efficient and less costly machines are coming on stream. Some are operating satisfactorily. Montserrat, a very small island, uses two wind turbines to generate a significant proportion of its electricity needs. Operations are satisfactory and Montserrat demonstrates that there are wider possibilities in the Caribbean. A 40 kW-rated turbine, which was erected by a private firm in Barbados in 1984, is still in operation. A modest market has now developed for wind turbines. In 1991, United States utilities purchased 2,800 GWh of wind-generated electricity. This was useful to supply incremental demand without incurring the heavy capital costs involved in installing conventional generating capacity. Capital costs have come down substantially for wind turbines thus

reducing generating costs. The reliability of plants has also increased. Prospects are therefore good for windpower for isolated locations and also to provide incremental supplies to the national grid to obviate the need for expensive expanded generating capacity. Kodela, the government-owned water and electricity utility in Curaçao, has just opened its first windfarm of 3.3 MW, integrating the electricity generated into the national grid, no doubt to avoid costs associated with expanding generating capacity.

An advantage of windpower is that it is more employment-creating than conventional electricity generation. However, while it is a very clean form of power generation, it creates noise pollution, which must be taken into account in considering its prospects. Noise pollution intensifies when windpower is used for electricity generation. Despite these constraints, the possibilities seem better than they are generally perceived.

6.5 Other renewables: wave energy and ocean thermal energy conversion

Wave energy is still at an experimental stage. This technology is of interest to small island developing states as islands. However, it is at an early stage of development. Ocean thermal energy conversion (OTEC) devices were first suggested in the 1930s (Headley 1994). In more recent times, Lockheed, the United States aerospace company, built and operated one in Hawaii. These machines collect warm water at 28°C to 33°C from the surface of the tropical ocean, use it to boil a fluid like ammonia, expand the vapour through a turbine to produce mechanical energy, and then use cold water at about 5°C from about 1,000 metres down to condense the ammonia vapour and complete the cycle. Since the bottom water contains more nutrients than the surface water, plankton grows readily in the condenser discharge and fish feed on them. The OTEC plant can therefore produce fish. It can also produce fresh water from desalting sea water and most OTEC plants include the production of fish and/or fresh water in addition to their primary production of electricity. One planned for the north coast of St. Croix is expected to produce up to 1 million gallons of fresh water per day. This is important for an island like Barbados, where the seabed profile off the north coast also favours an on-shore OTEC plant. With increasing demand for fresh water, desalination may become more widely needed early in the next century. It is possible to boost the efficiency of the OTEC plant by feeding it with much hotter water from a solar pond sited on land near the plant. OTEC as a hybrid system would seem to offer an interesting longer-term possibility.

6.6 Geothermal energy

Geothermal energy has some prospects in the Caribbean, where there is some potential for its use. Geothermal energy is available wherever there is hot rock or magma near the surface. The hot rocks will produce steam when water comes into contact with them. Saint Lucia prides itself on having the world's only drive-in volcano at Soufrière and a drilling programme has been conducted. So far, no useful power has been extracted, but in other parts of the world, such as Costa Rica, Italy, New Zealand and California, geothermal plants have been operating for many years. Other islands in

the Caribbean – Dominica and Saint Vincent – have some volcanic activity, but the potential for its commercial exploitation remains a distant one.

The potential in the South Pacific is limited. The search for geothermal resources has advanced recently and surveys are planned for Fiji, Solomon Islands, Vanuatu and Samoa. There appears to be significant potential in Vanua Levi in Fiji where there are hot springs, the hot water from which is used for domestic purposes. The exact geothermal potential, however, needs investigation (Prasad 1990).

7. Conclusions and recommendations

For oil-importing small island developing states, the cost of fossil fuels is usually equivalent to a substantial proportion of the total value of imports and a larger proportion still of the total value of exports. Fuel imports are thus a great drain on foreign exchange and a significant constraint to development, especially where debt-services charges are high. These prior claims on foreign exchange could crowd out vital capital and social expenditures and inhibit the achievement of much-needed growth. Successful efforts by all oil-importing small island developing states to reduce energy imports, either through the achievement of energy efficiency or the use of locally available renewable energy resources, could therefore make a significant contribution to economic development.

Fossil fuels do damage to the environment. Some, such as gas, less so than others. They cause the emission of carbon dioxide, a greenhouse gas that is regarded as a major contributor to global warming and is therefore, at current rates of emission, possibly doing large-scale, irreversible environmental damage world wide. Fossil-fuel use is responsible for other pollutants, such as sulphur dioxide, nitrogen oxide, lead and other chemicals. Oil itself, through spillage in its transportation, storage and use, causes a build-up of pollution.

Taxes and regulations should ensure that such costs, imposed on the community should be internalized and taken into account so that environmental damage could be mitigated and costs for the use of all energy sources put on a comparable use. This would assist rational decision-making on energy use for the achievement of sustainable development.

For oil-importing small island developing states, energy costs tend to be higher because of small volume purchases, high shipping costs, the small size and old age of electricity-generating plants, little or no competition in electricity generation and distribution, limited competition in domestic marketing of oil and gas, and high costs of their marketing and distribution because of low volumes of sales.

While the cost of alternative energy sources, such as renewable energy, is not yet competitive with conventional energy in most areas of use, particularly for vehicular transportation, high costs for conventional fuels in oil-importing small island developing states should make renewables more readily competitive in small island

developing states than in other countries. When environmental costs and wider economic considerations are included in the calculation, the possibilities of renewable energy extend further. Prospects will become increasingly good since substantial progress is being made in reducing the cost of energy from alternative sources.

In view of the high costs of energy and its importance in both production and consumption, national energy policies should be established in small island developing states that give a positive role to renewable energy, taking into account its environmental, foreign-exchange and employment advantages, as well as its amenability to small-scale provision and flexibility in its use.

To put energy on a sustainable basis, fossil-fuel use must be reduced through the promotion of energy efficiency, which should include DSM. This promotes consumer efficiency and helps to avoid costly expansion of electricity-generating capacity. Where possible, switches should be encouraged to alternative fossil fuels, such as gas, which is less environmentally damaging and is becoming increasingly competitive in price and technological terms. Increasing use should also be made of renewable energy technologies, as these become competitive with fossil fuels in cost/benefit calculations that take full account of environmental and wider economic considerations.

Current policies of governments and utilities in most countries discriminate against renewable energy use in many ways: through subsidies on conventional energy prices; the provision of greater development assistance for the research, exploration and development of conventional energy; the use of pricing systems by utilities that do not reflect the marginal costs of peak-time supply or of supply to distant rural areas; and the lack of imposition of taxes and controls for social costs imposed by fossil-fuel industries – costs which are often absent from the production of renewable energy.

Governments and regulatory systems also encourage cost-plus pricing systems for electricity that remove from utilities the risks associated with price hikes. Renewables do not suffer from such price fluctuations. These pricing systems reduce prices for electricity in locations and for uses where renewables could otherwise be competitive.

Since developed countries have been the largest users of fossil fuels and have been mainly responsible for greenhouse gas accumulations, the major responsibility falls on them to bring emissions under effective control. However, by 2020 developing countries will be responsible for nearly half the total consumption of fossil fuels. They have a global responsibility, therefore, to accept targets on emissions, even though these must be much less stringent to take into account their lower historical contribution to greenhouse gas emissions and their development needs. Global imperatives and progress require greater international cooperation in the development of energy policy.

Small island developing states have a strong interest in preventing global warming since many of them are very vulnerable to consequent sea level rise and ecological change. They must therefore help to ensure an effective Framework Convention on Climate Change. Those who have not yet done so should ratify the

Convention and among developing countries, they should encourage interest and cooperation.

Small island developing states and other developing countries must promote efficient and sustainable energy use in relation to their national circumstances as a matter of national priority. This will do much to control fossil-fuel use. They must go further to assist in controlling global climate change but this should be facilitated by international assistance through greater access to technologies and capital resources to encourage shifts to environmentally benign energy uses. Small island developing states must also be assisted in doing more to monitor climate change and sea level rise.

To promote sustainable energy use, policies at national, regional and international levels should include those described below.

7.1 National action

Energy is important enough in production and direct consumption to require all small island developing states to develop national energy policies; a positive approach to renewable energy should feature in all such plans. Where electricity distribution reaches almost total national coverage, the service should be put on a fully commercial basis, with charges being levied on an economic basis. Where demand is large enough, competition should be encouraged in generation and distribution, e.g., in incremental generation, with large users being allowed to generate their own power and offer surpluses for sale through the national grid or directly to consumers.

Social and economic claims for subsidizing energy from fossil fuels should be examined carefully. Where it is deemed to be justified, its deterring effects on renewable energy should be taken into account and compensatory assistance provided.

Utilities should be encouraged to be as commercial as possible in their operations so that adequate capitalization, timely technological change and determined efforts to achieve efficiency will be forthcoming and energy provided in the long term at reasonable costs.

Where monopolies are unavoidable in generating and supplying electricity, an effective, fair and open regulatory mechanism should be established to assist in determining tariffs and setting standards.

Taxes and regulations should be imposed to mitigate environmental damage and internalize its costs so that benefits can exceed costs in a real sense.

The level of taxes imposed on cars and other motor vehicles should reflect the extent to which they are fuel efficient, and transport policy should emphasize savings on the fuel-import bill.

For environmental and efficiency reasons, including economizing on capital costs, incentives should be given to reduce demand through DSM, which generating companies should take a lead in encouraging.

All energy-related development projects, including economic activities that are fuel-intensive, should be required to undergo an environmental impact assessment before approval is given for implementation. Careful attention should be given to avoiding the location of major projects, such as power plants, refineries and storage tanks, in environmentally sensitive areas.

Small island developing states and all signatories to the Framework Convention on Climate Change, which have not yet done so, should ratify the Convention as early as possible.

Incentives should be given to encourage the use of renewable energy, taking into account the following: its advantages in reducing fuel-import bills; its environmental advantages; its larger employment impact; its capital saving; the spread of its employment and economic effects because of its wide regional availability; and existing subsidies and other assistance provided to conventional energy. Scope already exists for making greater use of mini- and micro-hydropower, wind turbines, solar water-heating and crop drying and biomass, such as agricultural wastes.

Close attention should be paid to the technological changes taking place in energy efficiency and in renewable energy in order to ensure the timely use of what is appropriate in relation to national circumstances.

Technical development requires that government, energy utilities and industry give adequate attention to research and development and training in the energy sector, generally taking into account past neglect of renewable technologies.

Awareness should be promoted through educational programmes and other means of the importance of promoting efficient and sustainable energy use.

In national efforts to monitor environmental damage and change, greater attention should be given to the impact of energy projects.

Policy should also take into account environmental damage from renewable energy, such as deforestation caused by excessive demand for fuelwood; in some cases it might be preferable to use a fossil fuel, kerosene, instead of a renewable fuelwood.

7.2 Regional action

The regional development centres for sustainable development that have been proposed for small island developing states should have energy efficiency and renewable energy as an important component of their concerns, paying particular attention to their research, training, technology and information needs.

Regional research and training efforts on energy efficiency, renewable energy and energy and the environment should be given greater support.

Regional integration and cooperation movements among or involving small island developing states should develop a regional policy on energy, in which renewable energy should be an important component.

Support should be given for the development or improvement of regional information systems on energy.

Greater attention should be given to monitoring regional environmental concerns that have a bearing on energy, such as climate change, sea level rise and marine pollution. Surveillance and contingency planning must be improved to deal with oil spills and other forms of marine oil pollution.

Regional and subregional development banks should give appropriate emphasis to the energy sector, including renewables.

7.3 International action

Any international centre established to deal with the many issues confronting small island developing states should have energy as an important component and renewable energy as a special focus.

Sustained efforts should continue to improve the effectiveness of the Convention on Climate Change in relation to: ensuring timely action on curbing greenhouse gas emissions and protecting carbon sinks; access to technology by small island developing states and other developing countries; and assistance for monitoring climate change and sea level rise.

International measures to encourage forest protection should recognize the serious extent to which deforestation is taking place in small island developing states.

Consideration should be given to means of ensuring adequate access by small island developing states to GEF for projects in energy efficiency, renewable energy and forest and developing technical capacity, especially by UNDP.

In financing energy projects, international and regional development banks and donor agencies should give greater attention to the promotion of energy efficiency as well as to the development and greater use of renewable energy.

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9. Tables to Case Study I

TABLE 1.1

SHARE OF FUELS IN TOTAL IMPORTS:
SELECTED SMALL ISLAND DEVELOPING STATES, 1991

(Millions of United States dollars)

	Imports of fuels	Total imports	Fuel imports as percentage of total imports
Barbados	83.0	691.8	12.0
Dominica	8.4	108.9	7.7
Grenada	10.6	123.7	8.6
Jamaica	214.8	1 799.5	11.9
Saint Kitts and Nevis	8.0	111.1	7.2
Saint Vincent	8.3	136.0	6.1
Cyprus	270.4	3 255.1	8.3
Malta	114.3	2 362.6	4.8
Mauritius	290.4	1 980.9	14.7
Solomon Islands	12.2	190.1	6.4
Tonga	7.8	58.8	13.2
Fiji	83.2	638.1	13.0
Vanuatu	2.5	67.6	3.6
Sarinoa	7.3	82.8	8.8
Total	1 121.2	11 607.0	9.65

Source: Caribbean Energy Information System; and World Bank (1992) *World Development Report 1992* (New York, Oxford University Press).

TABLE 1.2

SHARE OF FUELS IN TOTAL IMPORTS:
SELECTED CONTINENTAL DEVELOPING ECONOMIES, 1991

(Millions of United States dollars)

Country	Imports of fuels	Total imports	Import of fuels as percentage of total imports
Burkina Faso	97.9	879.1	11.1
Costa Rica	316.7	2 490.0	12.7
El Salvador	112.1	1 768.0	6.3
Ghana	436.2	1 755.9	24.8
Guatemala	309.4	2 196.1	14.0
Honduras	138.7	1 338.2	10.4
Panama	253.0	6 451.9	3.9
United Republic of Tanzania	256.9	1 774.7	14.5
Uruguay	243.0	2 324.9	10.5
Zambia	223.1	1 612.0	13.8
Total	2 387.0	22 590.8	11.0

Source: World Bank (1992) *World Development Report 1992* (New York, Oxford University Press); and Energy Division, South Pacific Forum Secretariat, Suva, Fiji.

TABLE 1.3

ENERGY CONSUMPTION IN SELECTED CARIBBEAN STATES: ALL ENERGY SOURCES

(Thousands of barrels of oil equivalent)

Year	Barbados	Grenada	Haiti	Jamaica	Trinidad and Tobago
1972	1 073	117	9 462	15 138	5 020
1973	1 189	120	9 670	15 522	5 081
1979	1 309	131	12 098	14 452	7 952
1980	1 368	127	12 368	13 604	8 485
1989	1 536	216	9 594	9 684	16 193
1990	1 511	238	9 694	11 877	17 630

Source: Boopsingh, T. M. and T. A. Byer (1993) 'Caribbean energy sector: review and perspectives' (unpublished paper) December.

TABLE 1.4

ELECTRICITY IN ENERGY CONSUMPTION:
SELECTED SMALL ISLAND DEVELOPING STATES, 1990

Countries	Electricity as percentage of total energy consumption
Barbados	23.5
Jamaica	16.1
Marshall Islands	14.3
Grenada	12.9
Federated States of Micronesia	11.0
Cook Islands	7.8
Fiji	4.4
Samoa	3.3
Tonga	3.2
Solomon Islands	1.6

Source: Energy Division, South Pacific Forum Secretariat, Suva, Fiji; and Boopsingh, T. M. and T. A. Byer (1993) 'Caribbean energy sector: review and perspectives' (unpublished paper) December.

TABLE 1.5

ELECTRIC POWER CAPABILITIES:
SELECTED SMALL ISLAND DEVELOPING STATES, 1991

	Installed capacity (megawatts)	Maximum demand	Load factor (percentage)	Losses	Number of customers	Customer/ employee ratio
Barbados	152.1	89.1	70.7	7.9	85 360	174
Dominica	10.0	7.5	57.1	14.1	18 544	112
Grenada	13.5	9.1	63.6	12.7	19 270	91
Jamaica	508.5	330.0	72.0	17.6	305 000	177
Saint Lucia	35.7	21.0	67.0	12.2	27 291	118
Montserrat	5.8	2.7	68.0	15.4	4 348	61
Saint Vincent	18.8	9.5	62.0	7.9	18 967	67
Fiji	159.8	68.6	64.6	9.6	72 498	..
Tonga	6.1	3.8	57.0	17.3	12 623	..
Vanuatu	8.8	4.9	80.0	4.2	2 999	..
Samoa	22.0	8.4	61.7	14.7	11 760	..

Source: Same as Table 1.4.

Note: Two dots (..) indicate that data are not available or are not reported separately.

TABLE 1.6

PER CAPITA CONSUMPTION OF ENERGY:
SELECTED SMALL ISLAND DEVELOPING STATES
AND CONTINENTAL DEVELOPING STATES, 1990

Countries	Per capita income (United States dollars)	Per capita energy consumption (tons of oil equivalent)
Small island developing states:		
per capita income below US\$ 1 200		
Vanuatu	862	0.463
Kiribati	555	0.337
Samoa	693	0.619
Tuvalu	702	0.384
Solomon Islands	430	0.532
Weighted average	584	0.515
Continental developing states:		
per capita income below US\$ 1 200		
Nicaragua	432	0.374
Honduras	590	0.444
Bolivia	630	0.305
El Salvador	1 100	0.388
Guatemala	900	0.277
Weighted average	759	0.348
Small island developing states:		
per capita income above US\$ 1 200		
Grenada	1 431	0.277
Jamaica	1 295	0.846
Cook Islands	2 589	0.780
Fiji	1 635	1.202
Marshall Islands	1 717	0.778
Weighted average	1 386	0.909
Continental developing states:		
per capita income above US\$ 1 200		
Costa Rica	1 900	0.638
Colombia	1 260	0.624
Panama	1 830	0.527
Uruguay	2 560	0.707
Chile	1 940	0.902
Weighted average	1 562	0.693
All small island developing states		
Weighted average	1 246	0.840
All continental states		
Weighted average	1 451	0.566

Source: Same as Table 1.4.

TABLE 1.7

PER CAPITA FINAL ENERGY CONSUMPTION:
SELECTED SMALL ISLAND DEVELOPING STATES, 1990

(Barrels of oil equivalent)

Countries	Per capita final energy consumption
Trinidad and Tobago	13.8
Cyprus	12.7
Malta	10.3
Fiji	8.7
Barbados	5.8
Jamaica	4.9
Samoa	4.5
Marshall Islands	4.2
Solomon Islands	3.8
Tonga	3.5
Vanuatu	3.3
Federated States of Micronesia	3.0

Source: Same as Table 1.4; and United Nations Conference on Trade and Development, *Handbook of International Trade and Development Statistics* (United Nations publication, Sales No. E.93.II.D.9).

TABLE 1.8

ELECTRICITY TARIFFS:
SELECTED SMALL ISLAND DEVELOPING STATES, 1990^(a) AND 1993^(b)

(United States dollars per kilowatt hour)

	Domestic	Commercial	Industrial
Barbados	0.15	0.15	0.15
Dominica	0.21	0.23	0.21
Grenada	0.21	0.22	0.18
Jamaica	0.15	0.15	0.13
Saint Lucia	0.14	0.20	0.20
Saint Vincent	0.22	0.25	0.22
Fiji	0.13	0.14	0.09
Vanuatu	0.17	0.25	0.25
Samoa	0.14	0.14	0.14
Papua New Guinea	0.17	0.17	0.17

Source: Same as Table 1.4.

Note: ^(a) South Pacific countries.

^(b) Caribbean countries.

TABLE 1.9

GLOBAL COMMERCIAL PRIMARY ENERGY CONSUMPTION PATTERNS:
SELECTED COUNTRY GROUPINGS, 1970, 1980 AND 1991

(Percentage)

Country groupings		1970	1980	1991
Developed market economies	Oil	49.6	49.6	42.3
	Gas	22.8	22.7	24.4
	Coal	24.9	23.4	26.7
	Electricity	2.7	4.2	6.7
	Total	100.0	100.0	100.0
All developing countries	Oil	44.2	39.6	41.3
	Gas	8.2	14.1	11.9
	Coal	44.8	42.3	43.7
	Electricity	2.8	4.0	3.1
	Total	100.0	100.0	100.0
Oil-exporting developing countries	Oil	25.8	27.4	25.5
	Gas	6.2	8.0	6.2
	Coal	66.2	62.5	66.1
	Electricity	1.8	2.2	2.2
	Total	100.0	100.0	100.0
Oil-importing developing countries	Oil	59.3	48.3	48.6
	Gas	3.2	8.8	8.3
	Coal	33.4	35.5	34.0
	Electricity	4.1	7.3	9.1
	Total	100.0	100.0	100.0
World total	Oil	43.9	38.7	40.0
	Gas	20.1	23.9	23.7
	Coal	33.6	32.4	31.4
	Electricity	2.4	5.0	4.8
	Total	100.0	100.0	100.0

Source: Report of the Secretary-General on changing global energy patterns (E/C.13/1994/2).

TABLE 1.10

GLOBAL COMMERCIAL PRIMARY ENERGY CONSUMPTION
GROWTH RATE OF SELECTED COUNTRY GROUPINGS, 1970-1991

(Percentage of oil equivalent)

Country groupings		Growth rate 1970-1991
Developed market economies	Oil	0.33
	Gas	1.4
	Coal	1.43
	Electricity	5.44
	Total	1.10
All developing countries	Oil	6.26
	Gas	8.38
	Coal	6.47
	Electricity	7.18
	Total	6.59
Oil-exporting developing countries	Oil	6.83
	Gas	6.92
	Coal	6.87
	Electricity	7.75
	Total	6.88
Oil-importing developing countries	Oil	4.45
	Gas	9.98
	Coal	5.49
	Electricity	9.21
	Total	5.40
World total	Oil	2.07
	Gas	3.31
	Coal	2.20
	Electricity	5.87
	Total	2.51

Source: Same as Table 1.9.

TABLE 1.11

**FOSSIL FUEL CONSUMPTION:
SELECTED GROUPINGS, 1990 AND 2020 ^(a)**

	1990		2020 ^(a)		Growth rate
	Per capita income	Per capita consumption (kilograms of oil equivalent)	Per capita income	Per capita consumption (kilograms of oil equivalent)	
World	4 230	1 306	7 046	1 705	2.23
Developed market economies	18 295	3 786	36 771	4 525	1.04
Developing countries	974	449	2 214	1 002	4.21
Newly industrializing countries	2 526	702	6 832	1 624	4.00
Other developing countries	895	303	1 591	599	4.26

Source: Same as Table 1.9.

Note: ^(a) Projected.

TABLE 1.12

**ENERGY INTENSITY:
SELECTED COUNTRY GROUPINGS, 1960-2020**

(Tons of coal equivalent per thousand United States dollars of GDP, in 1990 United States dollars and at 1980 exchange rates)

	1960	1973	1988	2000 ^(a)	2020 ^(a)
World	0.82	0.78	0.67	0.61	0.48
Developed market economies	0.70	0.70	0.50	0.42	0.29
Newly industrializing economies	0.44	0.52	0.54	0.55	0.49
Other developing countries	0.28	0.34	0.62	0.78	0.61

Source: Same as Table 1.9.

Note: ^(a) Projected.

TABLE 1.13

ENERGY INTENSITY:
SELECTED CARIBBEAN STATES, 1980-1990

(Barrels of oil equivalent per thousand United States dollars (1980))

Year	Barbados	Guyana	Jamaica	Trinidad
1980	1.6	10.8	5.2	1.5
1982	1.5	13.4	4.8	2.0
1984	1.6	12.8	3.1	1.9
1986	1.7	12.1	2.9	1.9
1988	1.5	11.5	2.7	2.6
1990	1.6	11.5	3.8	3.0

Source: Same as Table 1.3.

TABLE 1.14

AIR EMISSIONS:
SELECTED COUNTRY GROUPINGS, 1990 AND 2020

(Millions of metric tons)

Country groupings	1990			2020		
	Carbon (a)	Sulphur oxides (b)	Nitrogen (c)	Carbon (a)	Sulphur oxides (b)	Nitrogen (c)
Developed market economies	2 790	45	36	3 800	46	43
Economies in transition and CIS	1 320	45	21	1 900	37	29
Developing countries	1 530	37	22	5 550	99	83
World	5 640	127	78	11 250	181	154

Source: Same as Table 1.9.

- Note:
- (a) Carbon from fossil fuels.
 - (b) Sulphur dioxide equivalent.
 - (c) Nitrogen dioxide equivalent.

TABLE 1.15

**CARBON DIOXIDE EMISSIONS FROM ELECTRIC GENERATION:
UNITED STATES DATA**

(Metric tons per gigawatt hour)

Technologies	Rate of emission
Conventional coal plant	964.0
Plant integrated gasification combined cycle electric plant	750.9
Oil-fired plant	762.2
Gas-fired plant	484.0
Ocean thermal energy conversion	304.0
Geothermal steam	56.8
Small hydropower	10.0
Wind energy	7.4
Photovoltaics	5.4
Solar thermal	3.6
Large hydropower	3.1
Wood (sustainable harvest)	-159.9

Source: Kazloff, K. C. and R. C. Dower (1993) *A New Power Base: Renewable Energy Policies for the Nineties and Beyond* (World Resources Institute).

TABLE 1.16

**RELATIVE COST-EFFECTIVENESS OF CARBON DIOXIDE REDUCTION
FROM SELECTED ELECTRIC TECHNOLOGIES**

Technology	Reduction relative to conventional coal plant (tons per gigawatt hour)	Incremental reduction (dollars per ton)
Gas-fired plant	480	0
Geothermal	907	0
Wind	956	10
Photovoltaic	959	62-73
Solar thermal	960	10-20
Large hydropower	961	10-31
Biomass direct combustion	1 124	0-9

Source: Same as Table 1.15.

TABLE 1.17

NATIONAL AIR POLLUTION PREVENTED FROM RENEWABLES ENHANCED MARKET
SCENARIO:
UNITED STATES DATA, 1990-2010

Technology	Incremental generation (gigawatt hours per year)	Air pollution prevented (thousands of tons per year)			
		SO ₂	NO _x	Particulate matter	CO
Biomass electric solid	344 464	2 515.4	818.2	-28.9	-480.26
Biomass electric MSW	37 071	220.4	48.7	-381.98	-15.15
Biomass electric gas	11 547	52.4	-50.0	1.87	-33.12
Geothermal electric	133 935	225.2	389.6	13.52	21.36
Hydropower	45 508	271.7	176.6	10.32	6.70
Photovoltaic	195 040	891.7	689.5	37.06	29.64
Solar thermal	114 323	142.4	361.3	13.00	18.14
Windpower	139 675	602.9	567.2	33.68	20.46
Total	1 021 563	4 922.1	3 001.3	-301.42	-432.23

Source: Same as Table 1.15.

TABLE 1.18

RELATIVE COSTS FOR RENEWABLE ENERGY TECHNOLOGIES
FOR NEW ADDITIONS TO SUPPLY

Type of technology	Cost of energy (United States cents per kilowatt hour in constant 1989 dollars)	Avoided cost
Hydroelectric (new sites)	10-28	4-7
Hydrothermal	7-12	4-7
Direct biomass combustion	7-12	4-7
Biomass gasifier	6-8	4-7
Ocean thermal	9	4-7
Wind	4-5	5-10
Parabolic trough/gas hybrid	9-12	5-12
Utility scale flat plate photovoltaic	16-22	7-12
Ocean wave	7-21	6-10
Residential active solar water heating	6-17	10

Source: Same as Table 1.15.

CASE STUDY II

TOURISM AND SUSTAINABLE DEVELOPMENT
LESSONS FROM THE CYPRUS EXPERIENCE

George Vassiliou

1. Introduction

1.1 The growth of world tourism

Tourism and the tourist industry are phenomena of our era and our generation. In the second part of the century we have witnessed a phenomenal growth of tourism and travel, which has in the short period of a few decades become one of the most important economic activities worldwide.

Travel is, of course, part of human nature and people have been visiting other countries for thousands of years, but there is no doubt that up until the second part of this century, tourism was an activity of the privileged few and did not play an important role in the economy of any country, nor did it touch or affect the way people lived in the various countries that tourists visited.

Mass tourism started becoming a reality in the second part of this century and has grown continuously and consistently since then at a rate much faster than that of the world economy. From 25 million arrivals in 1950 there were nearly 500 million last year, whilst incomes from receipts from tourism have grown at a staggering pace, from around 2 billion dollars in 1950 to nearly 300 billion in 1993.

On an average day during this year there will be nearly 1½ million persons travelling somewhere in the world, spending just under 900 million dollars each day on accommodation, food, shopping and entertainment. These figures refer only to international tourist arrivals and receipts. Domestic tourist activity far exceeds international tourism: tenfold in terms of arrivals and seven times in terms of expenditure levels, according to World Tourism Organization (WTO) estimates. Overall, the total contribution of travel and tourism to the world's economy amounted to nearly two trillion dollars in 1987, equivalent to 10 per cent of global GNP, over 5 per cent of global sales of all goods and services and 15 per cent of global service sector sales according to the same WTO study. In 1994, according to the World Travel and Tourism Council, the industry will generate a gross output of US\$ 3.4 trillion and ensure employment for over 200 million people.

In the beginning this phenomenal growth of tourism and travel was greeted with enthusiasm and greatly praised, but as the numbers of visitors continued to grow from

year to year and thousands of tourists began to descend on, until then, quiet and forgotten locations all around the world, perceptions and attitudes started to change. The pendulum swung in the opposite direction, with politicians, environmentalists and journalists lamenting the rapid growth of tourism and its negative, many claimed distortional effects, on the economies of the countries concerned, their social fabric and environment.

If tourism has an effect on the world economy and is an important factor affecting the economy, employment, allocation of capital and the environment in the world as a whole and in the larger developed countries, it is easy to visualize how much bigger and more important the role of tourism is for small island states. For small islands the earnings from tourism can play a crucial role in their overall economic development. Their small size and limited natural resources constrain the development of most types of other productive activity.

We know that for many of these island states, tourism is virtually the only serious source of foreign income and by far the biggest employer and creator of wealth. Tourism is the economic activity that can, within a very short period of time, change in a dramatic and permanent way the environment of any small state, because it is at the same time the most important and promising potential resource but it also presents the greatest danger to the environment and social fabric of small island states. It was, therefore, appropriate for the organizers of this conference to devote a substantial part of the deliberations to sustainable development in small island states, to the role of tourism or the need, if you like, for 'sustainable tourism'.

Before we embark on the study of the various aspects relating to sustainable tourism, one key question has to be answered: What is the future of world tourism?

If tourism has reached its peak and we can look forward to the same or a marginally higher number of arrivals than today, a completely different set of policies has to be devised and adopted than would be needed if tourism continues its massive growth.

The patterns of growth in the last few decades, as well as all economic and social indicators, clearly show that the trend will continue. The number of people travelling for vacations, short or long, will continue to grow at a fast pace although not as fast as in the 1970s or 1980s. According to forecasts prepared by the World Tourism Organization, by the year 2000 the number of international arrivals will have exceeded 600 million and the amount of receipts will have exceeded 500 billion dollars. This rapid growth is expected to continue into the 21st century, leading to a near doubling of international arrivals by the year 2020 compared to today's levels.

Many factors militate in favour of this continuous and unstoppable growth of tourism. Changes in the demographic structure, educational and social patterns of the populations of all developed and developing countries show that more and more people will not only have a greater inclination, but also the time and income, to travel abroad.

Increased life expectancy, a shorter working week, more leisure time and holidays, changes in the family structure, with the increasing importance of single member households and two-income households are all factors that create the urge for travel and lead to a continuous increase in the number of tourists every year.

Furthermore, the end of the Cold War and the revolutionary changes taking place in the whole of Central and Eastern Europe have opened up new markets and create possibilities for travel for hundreds of millions of Europeans. Relaxation in travel and travel arrangements and the coming on stream of the new generation, larger and long-distance aircraft, as well as the increasing safety in air travel, create both the conditions and possibilities for continuous growth in world tourism.

We, therefore, have to embark on the consideration of our subject not on the basis of the present volume, but with the certain knowledge that both the opportunities, pressures and dangers created by the rapid increase in worldwide tourism will continue.

The first question that automatically comes to mind is 'why worry?'. It is accepted that tourism is beneficial to the economy, generates incomes, creates employment opportunities, contributes substantially to people getting to know each other, becoming familiar with foreign cultures to a better world understanding. Nobody can doubt the correctness and validity of the above statements. We also know, however, that too much of a good thing can also be harmful. Milk is one of the most nutritious products that ever existed, but the other day I was reading that in Rwanda they used to kill their kings by making them drink milk until they were drowned. The idea was not to spill royal blood. The message therefore is clear. Tourism is good but too much tourism can be dangerous, particularly for small island states.

For small island states a sudden rapid and unplanned growth of tourism can have lasting and, in some cases, disastrous effects. 'Sustainable tourism', therefore, is not only a fashionable slogan, but a necessity indispensable for the survival of many small island states and the protection of the world's environment.

I would now like to examine briefly the effects of tourism on the economy of a country, the social and environmental problems that it creates and the policies that need to be adopted to address these problems. I will rely for this purpose mainly on our experience in Cyprus and draw conclusions concerning policies which I hope have a more universal validity. However, we all know that advisors should remain advisors and it is the policy makers of each country that should formulate the right policies.

I will, therefore, talk about our experiences and our conclusions and leave it to policy makers to decide which of these are appropriate for, and can be adapted to, the conditions pertaining in their own countries.

2. The development of the tourist industry in Cyprus and its impact on the country

2.1 Overall growth

The tourist industry in Cyprus has developed since independence in 1960. Growth has been really phenomenal, with an increase of thirty times the number of arrivals, from 63,000 in 1960 to nearly 2 million in 1992 and an even bigger increase in receipts, from CY£ 2.3 million in 1960 to nearly CY£ 700 million in 1992, i.e. 350 times greater (see Table 2.1). The tourist industry began to develop in the second half of the 1960s and by 1973 Cyprus was already a major destination in the Mediterranean, with more than 300,000 arrivals. The Turkish invasion of 1974 put an end to that spectacular growth and in 1975 there were only 78,000 arrivals, as most of the hotel industry had been lost to the invading forces which had occupied the tourist resorts of Famagusta and Kyrenia. Shortly afterwards, as a result of hard work on the part of all Cypriots, the entrepreneurship of Cypriot businessmen and government support, the industry took off again and by 1980 the number of arrivals had already reached the level of 1973. From then on, it continued to grow at the extremely fast rate of 15 per cent to 20 per cent per annum, only being interrupted by the Gulf War in 1991 and the recession in 1993.

During all these years supply was running ahead of demand. An unprecedented construction boom led to the building of hundreds of hotels and hotel apartments and to an increase in the number of beds from under 13,000 in 1980 to over 73,000 by 1993.

The rate of growth of Cyprus tourism during that period was substantially higher than that of world tourism during the entire period, as can be seen from Table 2.2.

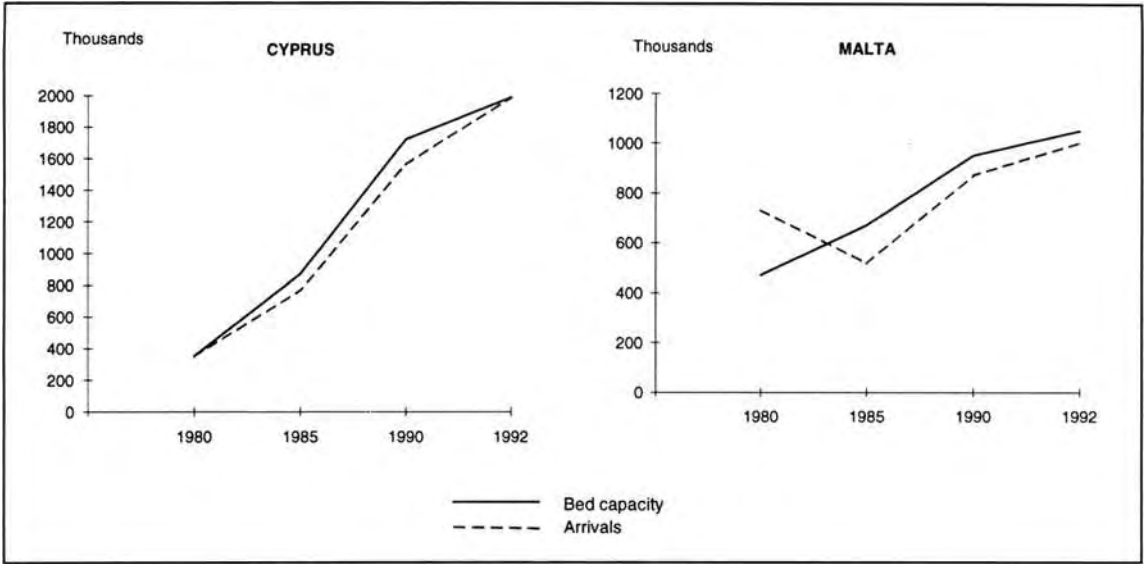
This very rapid growth in tourism was not a characteristic of Cyprus alone. Many small island states experienced similar explosive rates of growth, some of them even higher during the second part of the 1980s (see Table 2.3). Overall, however, Cyprus has had one of the fastest growing tourist industries during the last two decades.

It is interesting to compare tourism arrivals for the two small island states of the Mediterranean, Cyprus and Malta (see Table 2.4). In 1980 Malta had virtually twice as many arrivals as Cyprus, 728,000, compared to 348,000. In 1992 Cyprus had nearly twice as many arrivals as Malta, nearly 2 million for Cyprus compared to 1 million for Malta.

The explosion in the number of arrivals in Cyprus was the result of an unprecedented boom in the construction of new hotels, hotel-apartments and other tourist accommodation. Within a short period of twelve years, bed capacity increased from 12,830 in 1980 to 69,750 in 1992. As can be seen from the following graph, the increase in the number of beds moved in parallel with the increase in the number of arrivals.

FIGURE 2.1

GROWTH OF TOURIST ARRIVALS VS GROWTH OF BED CAPACITY



The same correlation between beds and arrivals can be established in the case of Malta, also from 1985 onwards. The difference between the two countries was in the rate of growth of new accommodation: fivefold for Cyprus compared to 2.5 times for Malta.

2.2 *The impact of the growth of the tourist industry on the Cyprus economy*

2.2.1 Major contributor to fast growth and higher standards of living

The growth of the tourist industry in the 1970s and 1980s radically transformed the Cyprus economy and greatly contributed to the substantial increase in per capita income and the standard of living, and was the main contributor to the so-called small economic miracle of the Cyprus economy. The rate of growth of the tourist industry has outpaced several times that of the other sectors of the economy. Using 1980 as a base, when it was substantially higher than 1973 or the first year after the invasion, 1975, we still see that the index for tourist-generated income had gone up to 967 by 1992, as compared to 130 for the export of agricultural produce and 158 for exports of manufactured goods (see Table 2.5).

In 1980 the total receipts from tourism were less than half the receipts from exports of domestic foods. By 1992 receipts from tourism were already three times as high as those from exports of domestic goods.

As a result, the structure of the Cyprus economy changed substantially. The share of tourism receipts in GNP increased from 9.4 per cent in 1980 to 22.6 in 1992 (see Table 2.6) and the correlation between tourism and the other sectors of the economy

changed radically. Tourism alone provided the foreign exchange required to pay for nearly half the total imports compared to only 17 per cent in 1980.

The effect of this extraordinary growth of the tourist industry on the economy, however, was much greater than can be deduced from these figures. The building of new hotels, with nearly 60,000 beds in a relatively short period, provided the basis for the rapid growth of the construction industry and the related industries of cement, bricks, aggregates, furniture, steel structures, *inter alia*, as well as a wide range of services relating to tourism and construction.

Furthermore, the continuously increasing number of visitors has provided a steady market and demand for a wide range of locally-produced products. It has created a greatly needed market for Cyprus wines and contributed to their substantial improvement in terms of quality and presentation, as well as all kinds of agricultural produce, from vegetables and fruit to meat and dairy products and has provided the impetus for the establishment of fish-breeding industries in the island. It has also led to the revival and growth of the handicrafts and goldsmith industries, which had only a negligible output in the early 1970s, but are now able to produce a wide range of products based both on Cyprus tradition and modern designs, not only for the Cyprus market but also for export.

I could give many more examples of the very dramatic effects that tourism has had on the economy of the island and how this continuous increase in the flow of tourism has acted as a motor to accelerate other sectors of the economy and has contributed to Cyprus having one of the fastest, highest rates of growth in Europe, averaging at 9.9 per cent in the 1980s and reaching 10.2 per cent in 1992. As a result, by 1992, Cyprus had attained a per capita income of nearly \$12,000 compared to less than \$1,000 in 1975.

The positive effects of tourism on the economy of all countries has been established through a series of studies. In the case of Malta, a study by L. Briguglio of the University of Malta showed that the tourist weighted multiplier (taking consumption and transport together) indicates that for every LM 100 spent by tourists the GDP grows by LM 87.2, disposable personal income by LM 57.4, taxes by LM 21.5 and imports by LM 56.1.

This growth of the tourist industry also led, of course, to the great dependence of the economy on tourism, which was clearly demonstrated on two occasions when there was a downturn in tourism. The first was in 1991 during the Gulf War and the second in 1993 as a result of the recession in Europe. In both cases the drop in tourist arrivals had as a result a substantial deceleration in the growth of the economy. However, in both cases the industry quickly recovered, particularly in 1991, helped by prompt action by the government. The experience of Malta in 1991 was similar to that of Cyprus. This proved, *inter alia*, that in the longer term the tourist industry is much more stable than is the prevailing perception.

This phenomenal growth of the tourist industry, while contributing to the development of the economy of the island, has at the same time created substantial constraints and distortions. The most important economic effects have been on employment and the capital markets.

2.2.2 Effects on employment

The population of Cyprus (we refer to the population in government-controlled areas) has been increasing at a rather slow pace and grew by only 20 per cent between 1980 and 1992, from 509,000 in 1980 to 601,000 in 1992. The gainfully employed population in the island has increased at a faster rate, rising between 1980 and 1992 from 188,000 to 265,000, as a result of the entrance in the labour market of an increasing proportion of women (see Table 2.7).

During that period employment in agriculture and mining showed a marginal decline, in utilities it remained basically steady and in construction only marginal growth was recorded. By far the fastest increase in employment was in the hotel, restaurant and trade sector (which doubled from 33,000 in 1980 to 64,000 in 1992) and in the finance and related services. The proportion of persons employed in hotels, restaurants and trade increased from 17.9 per cent of the total employed population in 1980 to 24.3 per cent in 1992. However, the real effect of tourism in employment cannot be seen from these figures because a wide range of activities in banking and finance, real estate development, travel services, industry and agriculture are directly or indirectly related to tourism.

The most important effect on employment, however, was that it created a shortage of labour and rapid wage increases.

Cyprus has been enjoying a full employment situation for many years, with unemployment rates in the region of 2 per cent and therefore new hotels, restaurants and other services could only secure their labour force:

- i) by attracting the new entrants in the market and
- ii) partly by taking labour away from existing industries, particularly the clothing industry.

The shortage of labour has created an inflationary pressure on wages, the growth of which has considerably outpaced that of productivity of the economy. In the period between 1980 and 1992 average earnings in current prices increased by 10.9 per cent per year or by 244 per cent for the whole period.

As a result, the value of inputs in agriculture and manufacturing industries increased substantially, which created problems of competitiveness that have only recently become apparent. At some stage it became obvious that the local labour market could no longer supply the amount of labour required and therefore the need to import labour arose and thousands of workers at various skill levels entered the labour market in the early 1990s. Even so, however, the problem in securing experienced staff for the

hotel industry and trade remained and as a result on many occasions the standard of service suffered.

2.2.3 Effect on capital

The construction of new hotels was financed partly by internal resources and savings and partly by foreign borrowing by individual entrepreneurs. A characteristic of the Cyprus economy is that practically all investment is by Cypriot entrepreneurs with a very small, rather insignificant share of foreign investment. Particularly in the latter part of the 1980s, a substantive part of the capital needed for the construction of new hotels was obtained through foreign borrowing, which accounted for the bulk of all private foreign borrowing in Cyprus.

At the same time, the share of advances and loans by the banking sector to the tourist sector more than doubled, from under 5 per cent in 1970 to 10.5 per cent in 1992. In fact, the amounts used for investment in tourism were substantially larger than that. Businessmen investing in tourism diverted overdraft and loan facilities they had secured for their existing businesses to the new hotels or hotel apartments that they were developing.

In this respect, even more negative was the influence on investment in manufacturing because entrepreneurs, sensing that the tourist sector was much more profitable than traditional industrial activities, were diverting all their profits and sometimes cash flow from manufacturing to tourism. As a result, the profile of most Cypriot industrial enterprises remained basically the same. This is one of the major factors that has contributed to the problems of competitiveness manufacturing is facing at present in foreign markets.

2.3 *Impact on environment*

The rapid growth of the tourist industry has dramatically changed the coastline of Cyprus and caused a construction boom in all seaside urban centres, which in a very short period has transformed, in some cases beyond recognition, these urban conglomerations. A charming fishing village with an old monastery, which before 1974 had a population of a few hundred, in a few years was transformed into a large tourist centre with more than 20,000 beds. The ancient city of Paphos, famous since the time of Saint Paul, succeeded in retaining its character for thousands of years, only to lose it in the 1980s when it suddenly became a major tourist centre. The few old houses that were not demolished in order to become plots for hotels or hotel apartments were all, or almost all, converted into restaurants, coffee-shops or retail shops.

The cities of Limassol and Larnaca have more than trebled in area in a short period of ten years, thus creating huge pressures on the local authorities, which face great difficulties in servicing a now much larger built-up area.

Prices of land have soared beyond recognition. At present land prices at the seaside are competing with prices in prime areas on the Cote d'Azur and other major

European centres, causing, among other things a shortage of building plots for housing purposes.

The rapid construction of hotels and the horizontal line or 'ribbon' type development across the coast soon led to saturation on the beaches and created a backlash reaction by the local population as access to the sea became more and more difficult for local people. Similar problems are now encountered in many Caribbean islands where locals are banished from the shores by hotels with exclusive beaches and all-inclusive tourist villages.

Very rapidly, pollution, unknown until the 1970s, became an acute problem. The sea, which was known for its cleanliness, was becoming polluted as a result of the discharge into the sea of sewage from the multitude of hotels and new housing developments, the areas used for the disposal of waste very quickly filled up, while the municipal authorities had great difficulties in finding new sites and the cleanliness of the roads and countryside deteriorated.

In an island known for its picturesque and quiet countryside, suddenly a new form of pollution appeared, that of noise, with hundreds of loudspeakers dispensing all kinds of music late at night and thousands of motorcycles used both by tourists and young Cypriots roving around the tourist areas. Visual pollution was also created, both as a result of the construction of unimaginative apartment blocks or hotels and by thousands of store signs and neon advertisements in many cases on elegant traditional houses, which completely distorted the appearance of these buildings.

Considerable pressure was brought to bear on the utilities of the island, with demand for water, electricity and telephone lines growing very rapidly and creating the need for huge investments in all three sectors in order to catch up with demand.

The existing road network very quickly proved incapable of meeting the new demand, as traffic jams became the rule rather than the exception, creating a need for investments of hundreds of millions of dollars for the development of airports and new highways. Cyprus is full of historical monuments and sites from the Palaeolithic age to modern times. The sudden growth in the number of visitors created problems concerning their maintenance and security.

The structure of the retail trade of the island completely changed with hundreds of shops, supermarkets, restaurants and coffee-shops being built in areas around hotels, creating havoc with all previous urban development plans.

3. The search for a policy on sustainable tourism

Towards the end of the 1980s it was becoming obvious to everybody concerned that the fast growth of the tourist industry was getting out of hand. The economy was being distorted, the pressures on the environment were already visible, huge constraints and bottlenecks were emerging, requiring investments of hundreds of millions in order

to keep up with the demands created by this rapid expansion. It gradually became clear that instead of tourism serving the economy of the country and its well-being, we were running into the danger of all becoming the servants of tourism.

Social pressures were not yet that great, as more than 90 per cent of the tourists were of European origin. Cypriots, who identified themselves with Europe, had no feelings of antagonism towards the rapidly increasing number of tourists, but the warning signs were there and the effects on the behaviour of young people were already visible. Morals were changing very quickly and there were worrying signs of hooliganism and unruly behaviour.

If the unchecked growth of tourism, the construction of new hotels and other tourist accommodation were to continue, Cyprus beaches would very quickly reach saturation, and Cyprus as a sun-sea destination would lose its attraction. Thus we would be left with huge investments in the tourist industry lying unutilized. Forecasts prepared by the relevant government departments showed that it was absolutely necessary to slow down the growth of tourism, create the conditions for proper regulation and save the environment from further destruction. In other words, it had become a necessity to create the conditions for sustainable tourism, a tourist industry that would grow in harmony with the economy, the society and the environment and be an integral part of a sound, sustainable development policy for the economy as a whole.

To formulate the right policies we needed time. Time to develop the policies, time to pass new legislation through Parliament. But time was the only thing we did not have. In the last half of the 1980s, if anything, the rate of construction of new tourist accommodation was accelerating and more and more businessmen wanted to become hoteliers? Something had to be done urgently with immediate effect and the only measure which could achieve that was to impose an immediate moratorium on the granting of any new licences for the construction of hotels. The development of tourism is regulated by the Cyprus Tourism Organization (CTO), which is the only body authorized to approve the construction of new hotels and subsequently supervise their activities. In great secrecy all the work was prepared and on June 1, 1989, the Council of Ministers decided to impose a moratorium with immediate effect and to instruct the Cyprus Tourism Organization not to receive any new applications for hotel or tourism establishments and not to approve any applications that were already submitted but not yet approved.

All prospective hotel developers had to submit their plans to the Cyprus Tourism Organization for the purpose of examination in order to ensure that these plans were in accordance with the regulations concerning the various types of hotel establishments. These regulations specified the characteristics of hotels of various categories, i.e. the density permitted, the size of the rooms, the facilities that had to be offered, etc. The intention was to ensure that the hotels being constructed would be up to the best possible international standards. However, the Tourism Organization was only entitled to examine if an application was in accordance with the regulations. It had no authority to limit the number of applications approved nor to reject an application on other than technical grounds. Once CTO approval had been obtained, the developer could address

himself to the municipal authorities for a building permit and proceed with the construction.

By means of this decision we were able to put an immediate stop to new applications and convey the message that the growth of tourism had gone too far and too fast and that in future it needed to be regulated. This decision was welcomed both by the political and business world. All realized that something had to be done to control the unchecked growth.

The moratorium gave the government the time it needed to develop its new sustainable tourist policy and was to be lifted when this policy was formulated and approved. The cornerstone of this policy was the new Town Planning Act, which was to replace the existing planning regulations that were still in force from colonial days.

The new Town Planning Act was prepared and became law as from January 1, 1991. We do not have time here to present the details of this act but I will simply give in summary the main provisions:

- i) Building coefficients were slashed by at least 30 per cent and in some areas by more than 50 per cent;
- ii) The whole coastal area, three kilometres deep, was designated a protected area and within that area very strict regulations were imposed concerning the type and density of development from area to area. Overall, the minimum size of plot for the construction of the various types of hotels was more than doubled, thus imposing a most efficient limit on the building of new hotels, taking into consideration the small size of land-holdings and the very high price of land. The coastal area, on average 300 ft in depth, was strictly protected and no building or structure of any type was permitted;
- iii) In certain developed areas only luxury hotels of four and five stars were permitted to be built, thus putting a further constraint on development;
- iv) Many important and sensitive areas of the island were declared protected, where no kind of tourism or other development was permitted. Thus the Akamas Peninsula, a unique environmental area, was saved;
- v) The requirements for new hotel establishments were considerably enhanced in order to improve the quality of the product and for existing establishments, special permits were granted, encouraging them to improve facilities offered to tourists;
- vi) The Cyprus Tourism Organization prepared guidelines for the desired development on an area-by-area basis and the lifting of the moratorium was permitted only after the detailed urban town planning regulations were agreed to by the local authorities. In the case of two local authorities, which insisted on maintaining a higher building efficiency, the moratorium was maintained for two more years until they were also obliged to accept the guidelines of the new Town Planning Act.

It was considered, however, that in addition to planning regulations a series of fiscal and monetary measures were required. Thus:

- i) All import duty concessions introduced in the late 1970s in order to promote tourism development were withdrawn;
- ii) Within the frame of the tax reform that was prepared more or less at the same time, the very generous depreciation allowances that permitted hotel owners not to pay taxes at all were changed, ensuring that a minimum tax of 10 per cent would be paid by all establishments showing a trading profit;
- iii) Financing of new hotels from foreign borrowing was greatly limited. By the late 1980s the increase in the cost of construction, the relatively large size of new hotel projects and the limits imposed by the Central Bank as to the size of loans per individual project, made it necessary for Cypriot developers to borrow most of the money needed for new developments from foreign sources. It was, therefore, considered that the best way to limit new hotel development was to reduce the percentage of foreign borrowing permissible. This was reduced from over 80 per cent to 25 per cent of the cost and could be increased up to a maximum of 40 per cent only in very special cases and with the permission of the CTO;
- iv) Cyprus being an island, the bulk of tourists were arriving by chartered flights. Hence the need to regulate these was very important. By means of this regulation we were able to diversify the product and also limit the uncontrolled growth of tourism from several destinations.

The measures worked. New permits were not granted and a great number of projects for which permission had been granted could not be realized due to lack of funds. When the moratorium was lifted and developers were permitted to submit applications based on the new rules, the rush was halted. In two years applications for only a few thousand beds were submitted, compared to tens of thousands per annum previously. At last we were able to control the development of tourism and to do that by using market forces and not by imposing a licensing system that would have opened the door to corruption and failed to control the situation.

The search for sustainable development, however, could not end there. We had achieved the most important objective, which was to control future growth, but at the same time a great number of measures had to be taken in order to improve the product and create the conditions for what we call sustainable tourism. The most important of these measures were the following:

- i) A huge programme for sewage disposal was instigated and in a short time sewage systems were designed and were being executed in all major urban and tourist centres of the island at the cost of several hundred million dollars. By the time the construction of these systems would be completed, all major tourist areas would have the most up-to-date sewage systems permitting the

recycling of water, which is one of the most scarce and valuable resources of Cyprus;

- ii) A very ambitious road-building programme was prepared, aiming at creating a modern highway system, linking all urban and tourist centres of the island, avoiding congestion and limiting traffic accidents;
- iii) A comprehensive plan for the redevelopment of the Larnaca and Paphos airports was prepared, which would turn the two airports into the most modern and efficient airports before the end of the decade, capable of handling 20 million passengers;
- iv) Area and landscape improvement plans were drawn up for all areas. This included the construction of pavements and the resurfacing of all roads, building paths for walking and cyclists, assuring an adequate supply of utilities and telecommunications at the highest possible level, a coastal management system which protected the coast and helped to enhance the sandy areas of the beaches, an intensive programme for the greening of the towns and tourist areas.;
- v) The creation and development of national parks in all environmentally sensitive parts of the island, a programme for the protection and development of all archaeological and historical sites, enabling tourists to visit them without endangering the sites.
- vi) The whole system of training of staff for the hotel industry was redesigned. A range of secondary hotel training centres and schools was established all over the island and the central Hotel Training Institute became a tertiary institute;
- vii) Other measures included the better policing of tourist areas, strict control of prices in tourist establishments to protect tourists from exploitation, improvement in public transport, etc.

4. Planning for future growth

The main objective of the policies described above was to control the growth of tourist accommodation, protect the environment, create a balance between the available resources and utilities and the tourist industry and improve the tourist product overall. All that, however, was still not enough. The main task of any government is not simply to make up for past mistakes and limit the negative effects of uncontrolled growth, but what is more important is to plan for the future, to decide on the policies that need to be implemented in order to achieve sustainable tourism and sustainable development overall and at the same time to aim at maximizing the benefits from any future growth. The main elements of this policy are:

- i) Deciding on the optimum number of visitors per annum and defining a maximum ceiling;
- ii) Assuring the better utilization of the available tourist resources;

- iii) Improving the stability of the tourist product through diversification of arrivals;
- iv) Widening and deepening the tourist product;
- v) *Optimizing the benefits for the economy and the population.*

4.1 What is the optimum number of visitors per annum?

In 1994 approximately two million tourists are expected to visit Cyprus. If the forecasts of the World Tourist Organization for the future growth of the tourist industry were to be considered as applying equally to all destinations, then sometime early in the 21st century, before 2020, the number of visitors to Cyprus should be approaching five million. On this same basis, it would mean nearly 2.5 million visitors for Malta and similar increases for other small island states.

The question is: Can the concept of sustainable tourism be reconciled with the continuous and unstoppable growth of arrivals? Is there no saturation point beyond which tourist products deteriorate to the degree that it discourages people from visiting a place?

Certainly there is. At least as far as beaches are concerned, experts consider that there is a beach saturation point, which varies from six to eight persons per square metre for the average type of beach, to a maximum of ten persons per square metre for the best quality beach. In Cyprus, there are certain areas of the island where at peak periods in summer this saturation point has already been reached and even exceeded.

Another way of examining the capacity of tourism per country is to correlate arrivals to local population. On that basis, in Cyprus the number of arrivals per thousand local inhabitants increased from 1,496 in 1985 to 3,312 in 1992. The corresponding numbers for Malta were 1,524 per thousand in 1985 and 2,783 in 1992, while for the Bahamas it was in the region of 6,000 (see Table 2.9).

For other countries in the area the ratios were significantly lower than those of Cyprus or Malta – 190 persons per thousand in Israel in 1991, 96 in Turkey, 818 in Portugal. In all these countries, which are not small island states, although the number of visitors are in the millions, the large population creates a completely different picture in terms of tourists per capita. Even in such cases, however, what it is more significant is to look at the density of tourists per area or per specific tourist centre, where the situation would probably be similar to that of some small island states.

Under any circumstances it is not possible to define today the maximum level beyond which one should not permit more tourists in a country. This is a number which can be ascertained only through scientific work, which would aim at assessing visitor satisfaction and community attitudes towards tourists, while at the same time relating the number of visitors to the available capacity and the available resources of the specific area at a given point in time.

There is no doubt, however, that such a ceiling exists. It is the task of the relevant authorities in every country to try to assess what this ceiling is and make sure that it is not quickly reached.

4.2 Assuring the optimum utilization of the country's tourists resources

As pointed out above, a theoretical ceiling exists for every country at any given period of time. This ceiling, however, is closely related to the length of the tourism season. Traditionally, sun-sea destinations like Cyprus, Malta and other islands in the Mediterranean had a relatively short tourist season, limited to the summer months. Gradually this season was prolonged to the extent that the tourist season can now be considered as lasting from April to October, with an increasing number of tourists also for the winter months of November to February. A comparison of the seasonal pattern of tourist arrivals and the changes between 1988 and 1992 clearly shows the increase in the number of visitors during the non-summer months (see Table 2.10). But the overall pattern has not changed greatly and is surprisingly similar for the two countries.

The season can be extended even more by improving the type of accommodation offered and making sure that tourists visiting Cyprus, Malta or other Mediterranean destinations during the winter have adequate opportunities to enjoy their vacations. This implies the availability of covered and heated pools, gym rooms and other facilities. At the same time, it requires, on the part of those providing services to the tourists, particularly the shop and restaurant owners in specifically tourist areas, the assurance that an adequate number of shops and restaurants are working throughout the year and that the areas do not give the impression of a dead sea ambience in the off-season period. This was, to a great extent, the case in the Ayia Napa area in Cyprus, which local hoteliers are now, with the help of the government and the CTO, trying to reverse.

The building of golf courses and the development of sports tourism can contribute considerably to this objective and thus help the tourist industry to improve its occupancy rate during the off-season periods.

4.3 Diversifying arrivals and securing a greater degree of stability in the tourist industry

The tourist industry is regarded as the most volatile industry, as the number of arrivals can be influenced by a number of factors, such as political instability, natural calamities or economic recession. The greater the dependence of a market on one country of origin, the greater the danger of significant fluctuations from year to year. This has been the experience of all countries and specifically, in our case, both Cyprus and Malta, which depend to a very great extent on the UK market, saw their tourist incomes significantly decrease in periods of recession in the UK. This was the case also in Cyprus in 1993 when arrivals from the UK dropped by several hundred compared to 1992.

Today there is still a significant dependence on the UK market in both Cyprus and Malta, which accounts for nearly half of the arrivals, but in both countries in the last

few years a consistent attempt has been undertaken to diversify the product and make Cyprus and Malta better known as holiday destinations to continental Europe. Recently, the opening-up of Central and Eastern Europe has created new opportunities and Cyprus is thus expecting between 50,000 and 100,000 tourists from Russia in 1994, compared to only a few thousand some years ago.

To achieve greater diversity, a systematic effort has to be undertaken by the tourism authorities of the various countries. This includes advertising, a comprehensive programme of promotions, including visits by tour operators, journalists and other influential people in the various localities, ensuring an adequate number of flights from various points of departure in each country and making certain that the specific requirements of potential visitors from the new markets can be met.

4.4 Improving the tourist product

Cyprus, Malta and the other Mediterranean islands, as well as many other small island states in the Caribbean, Asia or the Indian Ocean, are essentially sun-and-sea destinations. There was a period when a good hotel on a nice beach was enough to attract a continuous flow of visitors. Partly the gradual saturation of beaches and the increasing requirements of tourists made it necessary to improve the product and add other dimensions to the sun and sea elements. In the case of Cyprus, this meant the development of agro-tourism, i.e. adding the mountains to the sea and providing more cultural and leisure activities for potential visitors.

4.4.1 Promotion of agro-tourism

Traditionally, Cyprus developed as a sun-sea destination. This limited development to the coastal area and disregarded the very beautiful mountainous and rural areas of the island. To help reverse this trend, a comprehensive agro-tourism development programme was prepared. This included:

- i) The identification of those villages and rural areas that were suitable, either because of their location and natural beauty or for historic and architectural reasons;
- ii) The preparation of special plans for the development of these villages, imposing very strict rules as to the type of development and building permitted;
- iii) The redesigning and rediscovering of the traditional centres of these villages by correcting the destruction caused by unplanned development over the decades;
- iv) The allocation of special grants to owners of houses for the renovation of their houses and the creation of facilities for letting houses to visitors, as well as for the establishment of restaurants, coffee-shops and small family-managed hotel units;
- v) A comprehensive programme for the promotion of agro-tourism internationally, the creation of nature walks and development of other tourist facilities in the mountain areas.

4.4.2 Sports and 'theme' tourism

An increasing number of tourists are now attracted by the possibility of visiting a place because of the availability of good golf courses and tennis courts, the organizing of special sports tournaments or other sports facilities or so-called 'theme' tourism. Particularly golf is becoming a major attraction and a must for every tourist destination interested in attracting visitors with higher income levels. In order to attract sports tourism, special sports facilities are being built in all major towns and tourist centres thus giving football teams and athletes from countries with colder climates the opportunity to come to Cyprus during the winter months and continue their training in a more favourable climate.

4.4.3 Culture

The biggest weakness of Cyprus and most other traditional sun-sea destinations was the lack of adequate cultural activities. Visitors were limited to swimming in the sea and visiting restaurants or discotheques in the evenings. In all these countries, because of the lack of either traditions or adequate facilities, the best way to provide for cultural opportunities was through the organization of special festivals. This would help not only to provide entertainment facilities for visitors, but also to give local inhabitants the opportunity to enjoy performances that would otherwise be out of reach. At the same time, the promotion of special folklore festivals, which aim at reviving and maintaining traditions in the various villages and localities, help to provide colour and enrich the tourist product.

4.4.4 All-inclusive tourist villages and exclusive beach hotels

Recently in the Caribbean, a new kind of tourist activity has been developed to provide all-round entertainment for visitors. In the Windward islands and many other destinations in the Caribbean, a special type of hotel has appeared which caters to all the requirements of a visitor and promotional campaigns encourage them to leave their wallets at home. This may, at first sight, seem like a good idea, but it is our opinion that in the end, this kind of tourist development will backfire and have negative effects.

This complete segregation of the tourists leads to alienation and gradually to the creation of a climate of animosity and confrontation between local people and the visitors. It is certainly against the very concept of sustainable tourism which *inter alia*, requires that tourists should be able to mix with the local inhabitants and enjoy their holidays in as natural an environment as possible. In Cyprus it is strictly prohibited to create hotels with exclusive beaches and where such hotels were built in the early 1970s, it has now become necessary to build roads separating the hotels from the beach, which should be open to every visitor, whether local or foreign and not only to hotel guests.

4.5 *Optimizing the benefits for the local economy*

4.5.1 Creating the right balance of tour operators and individual tourism

Tourism has beneficial effects on the economy of the recipient state and, as we have already demonstrated, through the multiplier effect contributes substantially to the increase of the gross domestic product and the disposable income of the local population. The income from tourism, however, can be larger or smaller, depending on

the way the tourist industry is organized. The higher the average income of the visitors and the greater the proportion of the individual tourist, as opposed to those coming through package tours, the greater the benefit to the local economy.

Unfortunately, in most small island states, as is the case for Cyprus, a relatively small number of large tour operators control the market.

Tour operators have contributed to the development of tourism in many such destinations, but at the same time it has to be pointed out that their main objective is to maximize their profits and meet the requirements of their clients, rather than take into consideration the requirements of the recipient country itself. The basic concept of sustainable tourism is an asset-led growth of tourism rather than a demand-led growth, i.e. the development of tourist facilities and opening up of new areas within a country, taking all the factors into consideration – environmental, social, availability of resources, etc. – rather than simply responding to the requirements of the tour operators. A major condition, therefore, for assuring sustainable development and sustainable tourism in any country is the control of development by the authorities and avoidance of the creation of oligopolistic situations, with a few tour operators, controlling the market.

With the government help, local authorities and local hoteliers have to develop their own marketing efforts and make certain that a great number of suppliers from as many points of origin as possible operate in the country. Controlling the tour operators is closely related to the well-known conflict between local carriers and chartered flights or international carriers.

4.5.2 Protecting the local carriers

The liberalization of air transport and the increasing concentration of the world's airline industry is increasing the pressures on the national carriers of small island states. Unless adequate protection is provided, these carriers will not be able to stand up to international competition. In such cases, the local authorities will completely lose control over their tourist market, which will be concentrated in the hands of a few large tour operators. This, among other things, increases the danger both of pressure on prices and the exploitation of the local industry by foreign groups as well as the danger of great losses in the case of bankruptcies by such groups, which in the last few years has been the rule rather than the exception. An important element, therefore, of a sound policy for the future is the protection of local carriers and the avoidance of the oligopoly of large foreign charter-operators.

4.5.3 Taxing tourism

Such a policy would certainly contribute to an increase in incomes for the local tourist industry and in the benefits to the local economy. In addition to that, however, more and more governments nowadays realize the need to tax tourists. Particularly in small island states, the resources available – beaches, water, labour and land – are relatively limited and in some cases really scarce. It is therefore unfair to the local population to have them carry the whole burden of the investment required for the development of the necessary infrastructure for the tourist industry and it is fair and makes sense economically to tax the tourists for the use of these scarce resources.

In Cyprus this is achieved by the following means:

- i) Landing fees and airport fees per tourist, adequate to finance the enlargement of airports;
- ii) A 3 per cent CTO tax which is added to all hotel and restaurant bills paid either by tourists or local inhabitants;

The money collected accrues entirely to the CTO, which has thus become self-sufficient and is able to fund the cost of the organization, as well as the promotional and marketing expenditure needed for the promotion of tourism;

- iii) The VAT, which was originally at 5 per cent, and has now increased to 8 per cent, and which is payable by tourists on all local purchases and is not refundable;
- iv) At some stage the idea of an environmental tax was also raised, but not carried further as the VAT was introduced.

There is no doubt, however, that at some point in the future and in relation to the concept of a maximum ceiling in the number of arrivals, such a tax may have to be introduced in order to slow down the growth in the number of arrivals and generate the incomes necessary for the development of the infrastructure and the protection of the environment.

4.6 The need for an international tax on tourism and travel

The implementation of a sustainable tourism policy cannot be divorced from the need for sustainable development on a worldwide scale, and bridging the gap between the poor and rich countries of the world. This can be achieved only by securing adequate resources in order to provide all the help needed to less developed countries and particularly to small island developing states to protect their environment and to exploit their resources in an optimum and sustainable manner. Goodwill and conferences may be useful but not adequate. Most of all there is a need for money, for large sums of money that probably will never be provided from the taxpayers of the richer countries.

This is why I would like to propose the introduction of an internationally managed, probably jointly by the United Nations and the World Bank, tourism and travel tax. This tax will consist of a levy on departures both international and domestic. It will be incorporated by the airlines on their ticket price and paid directly by the airlines to the collecting authority. By the year 2000, it is estimated that there will be approximately 700 million international departures and 7 billion domestic departures. A levy at that time of 10 dollars for each international departure and 2 dollars for all domestic departure would generate 21 billion dollars and would go a long way in filling the gaps that are now created because of the lack of adequate funds for promoting sustainable development. Such a levy would be easy to manage, politically neutral as it would be an international levy accepted by everybody in the world and just, because it would be paid by those who can afford to do so.

By describing our experience in Cyprus, I tried to present to you the benefits as well as the problems arising from the above-average growth of the tourist industry of the island.

I hope that through the presentation of our policies I have managed to show you how the search to achieve sustainable tourism in Cyprus has proceeded. It is possible that the new measures were introduced slightly late and in some cases the damage had already been done. What is more important, however, is that we recognized the problem and tried to introduce rules and policies that would create the conditions for sustainable tourism in the future.

No country is the same and we all know that each small island state has its own problems, its own characteristics. I am not therefore advising you to copy us, neither in what we did well nor in what we did not do. But I hope that this presentation has helped to illuminate some of the key issues that, in my opinion, any state, large or small, faces at some stage in the development of its tourist industry. If our example and experiences can prove useful in formulating your policies, then I am happy to have made a small contribution to our common objectives – sustainable development for the good of all of us, for the well-being of the citizens of each state and for the preservation of our planet Earth.

5. Conclusions

The main conclusions from the experience of Cyprus can be summed up as follows:

- i) Fast growth of tourism may at first seem advantageous, but ultimately has a boomerang effect. There is, therefore, an absolute need to control the growth of the tourist industry in any island state and define the upper limit of visitors and development on an area-by-area basis. If necessary, the authorities should not hesitate to impose a moratorium on new development;
- ii) In every country a strict Town Planning Act should be introduced to control development, protect the coastal area and ecologically fragile areas and make certain that new hotel and tourist accommodation is in harmony with the environment;
- iii) Through planning, it is essential to create a proper balance between available resources and utilities and the tourist industry;
- iv) Pollution of the valuable seashores should be avoided through the construction of sewage systems, recycling of water and efficient waste disposal;
- v) A carefully planned programme for road construction, airport development and development of basic utilities like electricity, water supply and telecommunications should be implemented;

- vi) The optimum utilization of the country's tourist resources needs to be assumed by extending the tourist season and developing alternative types of tourism to the simple sun-sea destination. This includes the building of golf courses, the development of sports tourism, the proper exploitation of marine resources and promotion of special theme tourism;
- vii) Arrivals have to be diversified in order to secure a greater degree of stability for the tourist industry and avoid over-dependence on one market;
- viii) In larger islands, like Cyprus, the harmonious development of the whole country can be ensured through the promotion of agro-tourism which leads to the rediscovery and proper utilization of mountain and rural areas;
- ix) It is necessary to prohibit or strongly discourage the development of all-inclusive tourist villages and exclusive beach hotels, which creates foreign enclaves within the islands and leads to the alienation of tourists from the local population with potentially very negative effects;
- x) The benefits from tourism for the local economy should be optimized by reducing dependence on a small number of large tour operators, supporting the national carriers and appropriately taxing tourists;
- xi) The effects of tourism on the social fabric and particularly on the behaviour of young people need to be monitored to ensure the harmonious integration of tourism and local society by spreading the benefits widely and controlling negative phenomena.

6. Tables to Case Study II

TABLE 2.1
GROWTH OF CYPRUS TOURISM

	Arrivals (000s)	Receipts CY£ MIL
1960	63.4	2.3
1973	328.2	23.8
1975	77.9	5.4
1985	769.7	232.0
1990	1 561.5	573.0
1991	1 385.1	465.0
1992	1 991.0	694.0

Source: Cyprus Tourism Organization.

TABLE 2.2
GROWTH OF INTERNATIONAL TOURISM

	Average annual growth on arrivals, % 1980-1990	Average annual growth on receipts, % 1980-1990
World	4.2	9.3
Europe	3.5	8.3
Southern Europe	4.3	9.3
Cyprus	16.0	23.0

Source: The Economist Intelligence Unit.

TABLE 2.3

INTERNATIONAL TOURIST ARRIVALS AND RECEIPTS

	Tourist arrivals (000)			Tourist receipts (MIL US \$)		
	1985	1991	% Change	1985	1991	% Change
Aruba	207	501	142.0	127	401	215.7
Bahamas	1 368	1 427	4.3	995	1 222	22.8
Barbados	359	394	9.7	309	453	46.6
Bermuda	407	386	-5.2	357	454	27.2
US Virgin Islands	412	512	24.3	507	708	39.6
Jamaica	572	845	47.7	407	764	87.7
Bahrain	65	589	806.2	175	162	-7.4
Cyprus	770	1 385	79.9	380	1 026	170.0
Malta	518	893	72.4	149	528	254.4
Fiji	228	259	13.6	147	211	43.5
Singapore	2 738	4 913	79.4	1 659	5 020	202.6
Mauritius	149	301	102.0	59	262	344.1
Seychelles	73	90	23.3	51	99	94.1
Guam	236	729	208.9	231	1 093	373.2

Source: WTO (1985-1992) Yearbook of Tourism Statistics.

TABLE 2.4

TOURIST ARRIVALS, CYPRUS VS MALTA

	Cyprus (000s)	Malta (000s)	Ratio Cyprus vs Malta
1980	348.5	728.7	1000:2091
1985	769.7	517.8	1000:673
1990	1 561.5	871.7	1000:558
1992	1 991.0	1 002.3	1000:503

Source: Central Bank of Malta (1993) Quarterly Review, September.
Cyprus Tourism Organization (1992).

TABLE 2.5

COMPARISON OF THE GROWTH OF VARIOUS SECTORS
(CY POUNDS, MILLIONS)

	GNP		Earnings from exports of:				Earnings from exports of:		% of tourism receipts to total exports
	Value	Index	Tourism Value	Tourism Index	Agricultural goods Value	Agricultural goods Index	Manufactured goods Value	Manufactured goods Index	
1980	760.4	100.0	71.7	100.0	36.3	100.0	109.8	100.0	48.3
1985	1 508.0	198.3	232.0	323.6	49.3	135.8	142.9	130.1	116.4
1990	2 598.3	341.7	573.0	799.2	57.9	159.5	185.7	169.1	224.0
1992	3 075.0	404.4	694.0	967.9	47.5	130.9	174.0	158.5	310.1

Source: (1970-1993) Central Bank of Cyprus.

TABLE 2.6

IMPORTANCE OF THE TOURIST INDUSTRY TO THE ECONOMY OF CYPRUS

	GNP		Tourist receipts		
	CY£MIL		CY£MIL	% Share	As % of imports of goods and services
1980	760.4		71.7	9.43	17.0
1985	1 508.0		232.0	15.38	30.4
1990	2 598.3		573.0	22.05	48.8
1992	3 075.0		694.0	22.57	46.5

Source: (1993) Central Bank of Cyprus, September.

TABLE 2.7

EMPLOYMENT

	Gainfully employed population (thousand)	Change in labour force %	Employed in trade		% Employed in trade restaurant and hotels
			restaurants and hotels (thousand)	Change in labour force %	
1980	188.0	..	33.7	..	17.9
1985	217.8	15.9	47.3	40.4	21.7
1990	254.0	16.6	61.1	29.2	24.1
1992	265.0	4.3	64.5	5.6	24.3

Source: Central Bank of Cyprus (1992) Annual Report.

TABLE 2.8

RELATIONSHIP OF POPULATION TO TOURIST ARRIVALS

(Thousands)	1985	1990	1991	1992
Cyprus	1 496	2 715	2 355	3 312
Turkey	44	86	96	n.a.
Israel	299	228	190	n.a.
Tunisia	276	392	385	n.a.
Morocco	99	161	162	n.a.
Portugal	504	813	818	n.a.
Malta	1 524	2 449	2 493	2 783
Bahamas	5 897	6 125	5 488	n.a.
Barbados	1 419	1 681	1 473	n.a.

Source: WTO

TABLE 2.9

ANNUAL TOURIST ARRIVALS – SEASONAL PATTERN

	1988		1992	
	Cyprus	Malta	Cyprus	Malta
Summer	37.86	37.77	36.16	35.35
Fall	27.52	27.92	27.94	25.69
Winter	9.36	11.80	9.57	13.47
Spring	25.25	22.52	26.34	25.34
Total	100.0	100.0	100.0	100.0

Source: CTO (1993) Tourism statistics 1988-1992.

CASE STUDY III

NATURAL DISASTERS AND SUSTAINABLE DEVELOPMENT OF SMALL DEVELOPING ISLANDS

G.O.P. Obasi

1. Introduction

Small islands are found all over the world; in the Pacific, Atlantic and Indian Oceans, as well as in the smaller seas such as the Caribbean and the Mediterranean. Only a small number of small islands are inhabited, but some have high population densities which, with other factors, make them more vulnerable to hazards when compared to larger islands and continents. The disaster threat to the small island states is considerable, although not all countries are exposed to the same type, frequency or severity of threat.

Natural phenomena which produce disasters affecting small island states can be classified into two groups: meteorological and geological. Figure 3.1 illustrates the location of the small island developing states with specific reference to major earthquake zones and tropical cyclone regions.

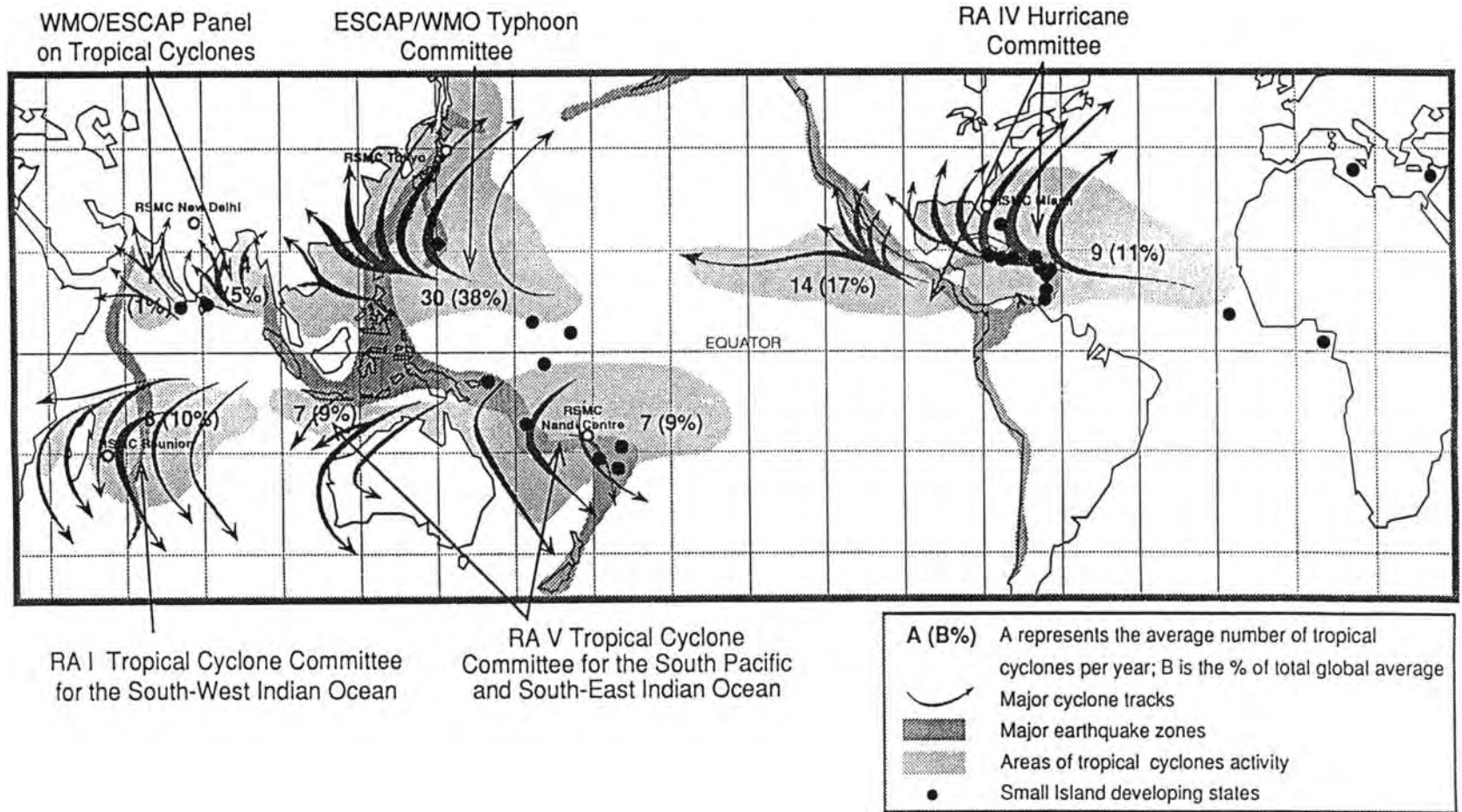
The most notorious weather event to produce a disaster is the tropical cyclone, and since most of the world's small developing island states lie in or just outside the tropics, they are thus potentially at the mercy of this phenomenon. An average of 80 tropical cyclones, also known as typhoons or hurricanes, form over tropical waters every year, producing winds in excess of 118 km/h and occasionally up to 300 km/h in the most severe cases, along with associated floods and storm surges. In addition, small islands suffer from disasters due to other meteorological/climatic events such as dust-storms, wildfires and droughts, although such phenomena are less prevalent than tropical storms and floods.

A large number of small islands are volcanic in nature with steep slopes and rugged topography, and lie in the principal earthquake zones. Others are very flat or raised atolls (often only a few metres above sea level), which are vulnerable to a multitude of other natural hazards besides the tropical cyclone, such as volcanic eruptions, earthquakes and tsunamis. In addition, the threat of global warming might also cause loss of coastal territory and produce an increase in the frequency of coastal floods due to a rise in sea level.

Any single event which causes loss of life and great destruction can reverse years of development. Some islands are remotely located, often with poor but expensive communications to the outside world. Depending on the scale of the disaster, recovery is often slow and difficult for islands with limited economies.

FIGURE 3.1

LOCATIONS OF SIDS WITH SPECIFIC REFERENCE TO MAJOR EARTHQUAKE ZONES AND TROPICAL CYCLONE REGIONS



2. Impact of natural disasters on economic and social infrastructure

Small islands are nearly wholly coastal zones, with a heavy concentration of population and settlements in relatively small areas. This implies that economic as well as recreational activities are concentrated on coastal plains, which need integrated management in order to achieve sustainable development. One of the common characteristics of small island states is that natural resources are limited (in particular surface freshwater), i.e., a limited and fragile resource base exists that allows little room for mistakes in its utilization and management.

Sustaining the development of a small island is in itself a very challenging exercise for any government and people. The factors which could adversely affect this development could be divided into the following categories: those relating to socio-economic issues and those due to natural disasters. The first category includes the over-exploitation of resources, adverse terms of trade, outward migration of skills, foreign debt servicing and drug trafficking. In the other category, the devastation and deaths caused by natural hazards such as severe tropical cyclones or earthquakes often bring thriving societies and economies to a sudden halt; and there is the cost of reconstruction which is often beyond the capabilities of some countries to bear alone. A disaster is said to occur when a specific event causes 'widespread human, material or environmental losses that exceed the ability of the affected society to cope using only its own resources'.

Small islands are most vulnerable to the impact of natural disasters because of the limited size of their economies. In many cases, islands rely on a few key industries for economic activity. Very few small islands have any significant natural resources such as minerals or petroleum. Agriculture, tourism and fisheries normally make up the prime industries, contributing a substantial part of the gross domestic product (GDP), but small-scale manufacturing activity is also fairly commonplace. Each of these industries is susceptible to the ravages of tropical cyclones and associated phenomena, namely intense rainfall and flooding, violent winds, landslides and coastal storm surges. Agricultural crops are flattened by strong winds, fields are flooded and valuable topsoil often washed away by heavy rains. Foreign visitors are forced to leave due to damaged hotels and the flow of tourists comes to a halt. Fishing fleets or individual boats are often damaged or destroyed. An increase in unemployment, a slowdown in economic activity and the reduction in valuable foreign exchange earnings are some of the results.

Disaster-related GDP reductions of 20-30 per cent in a single year are not uncommon. Such disasters might have an impact lasting several years. For example, Hurricane Allen destroyed the entire banana crop and severely damaged most hotels (located mostly near the coast) on the Caribbean island of St. Lucia in 1980. The return to full banana production took well over one year to be achieved, and it was much longer than that before tourism returned to normal. Since bananas and tourism make up the two principal industries on St. Lucia, significant unemployment and a dramatic loss of earnings ensued. Large numbers of private homes, public utilities and other infrastructure sustain intense damage in these cases. These problems are magnified by the fact that many of the island states are not only small, but consist of a number of

small islands, like the Maldives with some 1200 islands of which only 200 are inhabited. In such cases, communications are easily disrupted by a natural disaster. The recovery process itself has an impact on continuing development, as government funds earmarked for capital projects, or funds from foreign aid, are often diverted into the recovery process. The extent of the human suffering can be missed by the foreign media who have other 'better' things to cover.

Even though tropical cyclones frequent the oceans, the chances of any one small island being hit very often by one of these severe storms are not very great. In addition, tropical cyclone activity tends to occur in cycles. A period with a normal or above normal number of these storms in any one region may be followed by a decade or more of very little activity. This means that development on an island can continue for many years without interruption and a certain amount of complacency can result. This complacency often becomes widespread within the community; that is, among the public, government officials and even the industrial and commercial sectors. Since islands tend to have small economies, any new development is viewed as vital. Unfortunately these developments often take place without regard to the potential impact of natural disasters. For example, increased settlement and overdevelopment in vulnerable locations, such as beach-front property, reclaimed land, or along river banks, may be permitted without adequate safeguards, and adherence to building codes (if they exist) may be disregarded. This is precisely the setting for a disaster to occur.

On an annual basis the tropical cyclone represents a much greater risk than 'geological' events such as volcanic, seismic and tsunami disasters which have a lower frequency and a very long return period. But historical records show that the disasters which result from these events have the potential to be even more catastrophic than tropical storms.

A large number of small islands have had little or no volcanic activity for centuries, but there are those with several active volcanoes. Volcanic unrest without eruptions is much more frequent than an actual eruption, with a disruptive impact on life and sections of the economy (e.g. tourism and agriculture). The possible impact is country-dependant since many volcanoes are located in the rugged interior of islands. Naturally, a full eruption has a much more serious social and economic impact. For example, the entire population of near 100,000 had to be evacuated from the island of Vanuatu when the volcano Lopeve erupted in 1960.

The level of earthquake activity depends largely on the how close an island is to the tectonic plate boundaries, and how deep beneath the surface the disturbance occurs. Seismic activity on many of the small island developing states may be frequent, particularly on the Pacific islands, but local intensities tend to be fairly low. Deep earthquakes seldom cause damage on the land surface, and the fact that 70 per cent of the world's deep focus earthquakes are recorded in the Fiji area is not of great concern (Carter, Chung and Gupta 1991). Significant damage is normally caused by shallow earthquakes, or by earthquakes centred just off shore. Fiji experienced its worst earthquake in 1953 from this type of situation.

A direct result of seismic and some volcanic activity is the tsunami, a large wave or series of waves that is generated by a sudden violent disturbances in the Earth's crust, or by a major coastal volcano. The Pacific Rim, the world's most seismically active region, generates about 80 per cent of all tsunamis. They are very difficult to predict as these long waves are almost never apparent on the open ocean, and can travel over an entire ocean as fast as a jet aircraft and appear suddenly in bays or harbours as giant killer waves. More than 50,000 people have been killed by tsunamis over the last century, many without warning (McCredie and Scott 1994). Most of the tsunamis occur on the large islands or continental areas of the Pacific, such as Japan or Hawaii, but the small islands are also very vulnerable. For example, a tsunami generated by the 12 December 1992 earthquake centred on the Indonesian Island of Flores, reached its beaches in 2 to 5 minutes, with loss of life and much destruction (Sunarjo 1993). One thousand people in one village were killed as some villages were totally destroyed (*Tsunami Newsletter* 1993).

2.1 Risk assessment and insurance issues

The significant developments which have taken place on many small islands have received a sudden jolt in recent years, because of the impact of some major disasters around the world due to tropical cyclones and other natural hazards. Most insured property on small islands tends to be reinsured with the big international companies. Those international companies now face tremendous losses due to the escalating cost of damage caused by 'the big ones' like Hurricane Gilbert in Jamaica in 1988, Hurricane Andrew in the Bahamas and the USA in 1992 and Cyclone Kina in Fiji in 1992, coupled with losses due to the California earthquakes of 1991 and 1993 and the 1993 Mississippi floods. Small islands are now being classified as high-risk areas because of their vulnerability to natural disasters. As a result, insurance rates have risen dramatically by 300 to 400 per cent in many places, or insurance companies are withdrawing coverage altogether against tropical cyclones. Consideration of the impact of these changes on the development of small island states is important. With the insurance costs of private, commercial and industrial property becoming very expensive, and new development projects thus becoming financially risky, the sustainable development of the islands is being affected. A big fear for some insurance experts, is that new lulls in the activity of tropical cyclones and other major hazards will lead to renewed complacency and a fall in insurance rates. Then the question will be 'Who will pay for the next big disaster?'

This is a crucial question for the small island developing states. It is easy to see that any direct hit by a tropical cyclone on a major population centre on an island or elsewhere, will lead to significant damage and likely loss of life. But it is important to ask the question whether the increased damage cost is really due to above normal storm activity, or due to the effects of global warming on tropical cyclones, or whether it is due to other factors such as the increasing development in vulnerable areas, sub-standard infrastructure and the like, or even to mistakes within the insurance industry itself. As indicated before, tropical storms in each oceanic basin have their own cycle of activity. The activity in the Caribbean area has remained near or below the long-term average for over a decade, although a few large and strong storms struck the islands

during that time (WMO 1990-1993). In the southwest Indian Ocean, with a number of small developing island states, statistics for the last few cyclone seasons suggest below normal activity (Service Meteorologique de la Réunion), but direct hits on some of the islands have also occurred, such as cyclone Hollanda on Mauritius in February 1994. As will be discussed later, any significant global warming has serious consequences for coastal areas and flat islands, but it is uncertain whether it would have any significant impact on the number or intensity, or even the general area of occurrence of tropical cyclones. At the present moment there is no evidence that there has been any increase in their number or intensity over the last few decades (IPCC 1991, International Workshop on Tropical Cyclones 1989; 1993).

These facts do not in any way suggest a reduction in risk; far from it, for even a return to historical levels of tropical cyclone activity would continue to produce the type of losses that have been experienced. What can be done is to focus the attention of the appropriate authorities on corrective measures to reduce the risks, the damage and thus the cost of rehabilitation, instead of accepting the notion that there will automatically be an uncontrollable escalation of disasters. Corrective measures and building standards must be aimed at the specific hazards which affect an island or community. What is applicable for one may be unsuitable for another. Tomblin suggests that changes in building styles and construction materials have had a great impact on the relative vulnerability of housing to earthquakes and tropical cyclones (Tomblin 1992). The general move to masonry in place of traditional wood or tapia as a building material, has resulted in houses with greater mass and hence with a greater resistance (except the roofs) to destruction by the tropical cyclone, but conversely, it has resulted in much greater exposure to damage by earthquakes. Growing industrialization has resulted in the building of earthquake-susceptible structures such as dams, refineries, pipelines, electric power transmission grids and harbour facilities. For example, the earthquake of 1974 in Antigua produced ground failure in artificial land-fill, severely damaging the island's only oil refinery and newly-built deepwater harbour, both built on that type of ground.

2.2 Climate change and associated sea level rise

Much of our knowledge on climate comes from global scientific and technical programmes coordinated by the World Meteorological Organization (WMO). The issue of climate change helped draw the attention of the world community to the subject of sustainable development. Climate change and sustainable development are intrinsically linked, as climate change poses a serious threat to the viability of life on earth.

The phenomenon of global warming is one of the threats for the future. Very low-lying islands and atolls, such as the archipelagos of the South Pacific and the Indian Ocean, are already vulnerable to flooding from tsunamis and storm surges. This would increase in the future if the sea level rise resulting from global warming projected by the WMO/UNEP Intergovernmental Panel on Climatic Change (IPCC) (30-50 cm by the year 2050) were to occur (WMO 1990). Two of the most probable impacts of sea level rise on small islands include the loss of land below a new water line as gently sloping or flat coastal areas would become permanently inundated, and an upward movement of

the water table which could result in the impairing of water quality through the intrusion of salt into the coastal freshwater. In such cases therefore, loss or reduction of fresh water may render small atolls and limestone islands uninhabitable even before erosion results in land loss.

Coral reefs which form protective barriers for some tropical islands are vulnerable to quite a small change in sea level and are likely to be strongly affected by a possible global sea level rise. In the cases where the conversion of mangroves to other uses such as mariculture is widespread, the coastal protection against wave erosion and storms is seriously reduced. Subsistence and commercial activities of inhabitants may be affected by adverse impact on fish and shellfish resources due to changes in nutrient levels in coastal waters.

Human activity can exasperate the pending impact of sea level rise. An example would be the way in which the reef system in the Republic of the Maldives has been used over the past 2400 years. Coral has been mined over the centuries for building and construction materials, but the demand for coral has increased dramatically since the early 1970s. Severe erosion has occurred on those islands with a history of coral mining. The country's survival is threatened by sea-level rise since none of the islands of the Maldives is more than two metres above the mean sea-level. The government has now banned the use of coral as building material in hotels and other facilities for tourists in an effort to render future developments of the Maldives sustainable.

The economy of many of the small islands, especially in the Caribbean and the Indian Ocean, but also to a high degree in the Pacific Ocean, depends heavily on tourism. It is assumed that any rise of sea level will have a profound effect on the tourist industry, which again might put the sustainability of the economy in jeopardy.

3. How information supporting warning and monitoring services is obtained and used

3.1 Weather and climate services

The atmosphere is a dynamic fluid and weather patterns in any one region have an impact on all other parts of the globe. To determine weather patterns fully, and thus predict the formation and behaviour of disaster producers like tropical cyclones, data must first be collected on a global basis.

Weather data are collected by national meteorological and hydrological services around the world and are rapidly exchanged via the World Meteorological Organization's Global Telecommunication System. Data on the surface and upper atmospheric conditions are collected by land stations, ships at sea, ocean buoys, commercial aircraft and by geostationary and polar-orbiting satellites. All this information is used to detect and monitor the current weather and then to predict future weather patterns. Figure 3.2 illustrates this data acquisition and exchange process. The tropical cyclone is a very special weather phenomenon, forming over the data-sparse

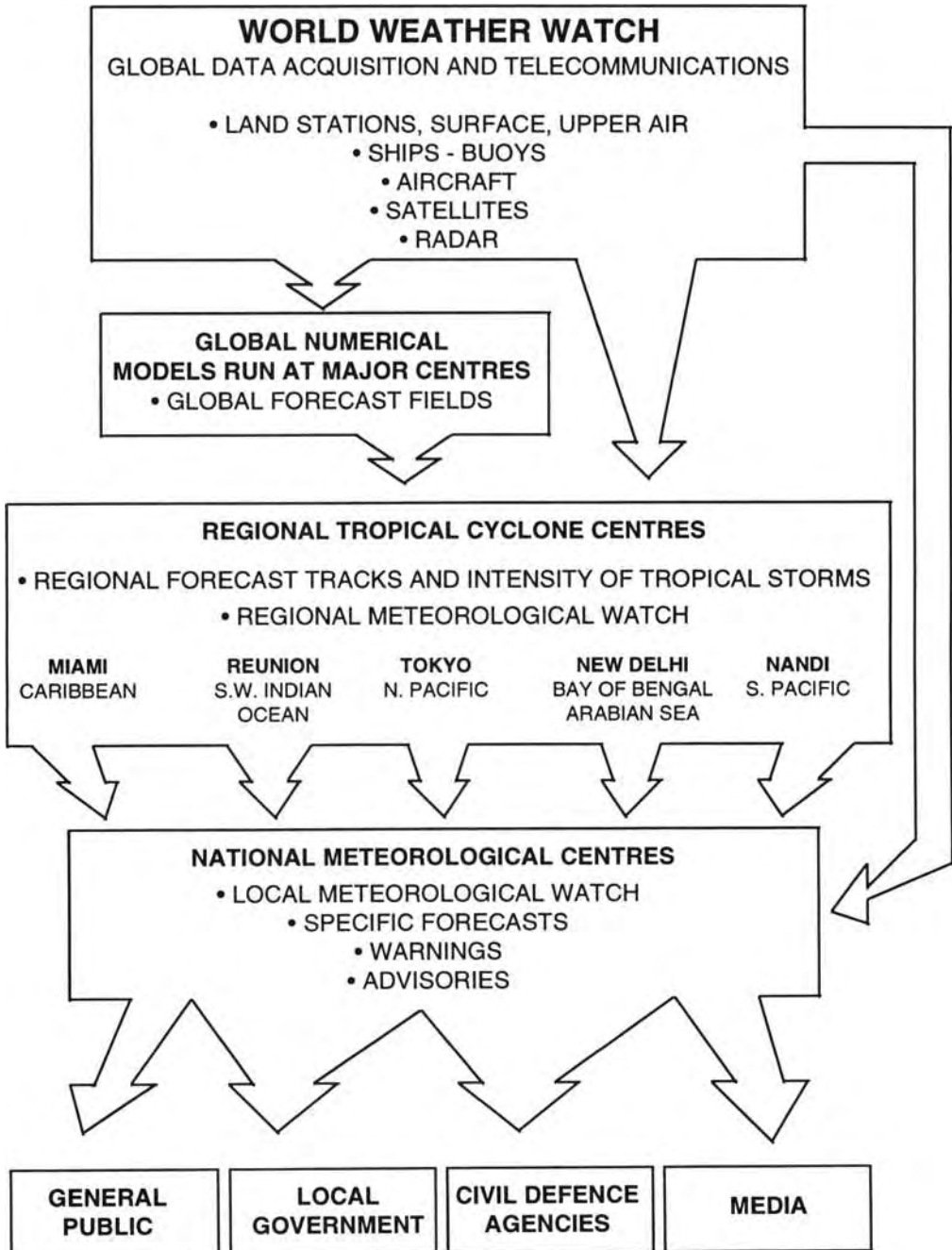
warm tropical oceans, affecting international shipping lanes, and carrying its great destructive power towards island states and continental land masses. The network of global data acquisition and telecommunications and the support to national meteorological and hydrological services provided by regional/specialized meteorological centres (RSMC) allow virtually all nations, including the small island developing states, to institute forecast and warning services (see Figure 3.2). The international cooperation accomplishes much more than any single country, developed or developing, can do by itself.

In this regard, World Meteorological Organization has formed five regional bodies for oceanic basins prone to tropical cyclones, namely the South-West Indian Ocean, the North Indian Ocean and Bay of Bengal, the South Pacific, the South-East Indian Ocean, the western North-Pacific, the eastern North-Pacific Ocean and the North Atlantic Ocean-Caribbean Sea. The purpose of these bodies is to organize coordinated mitigation against tropical cyclones through cooperative actions in the detection, monitoring, forecasting and warning processes within each region. At the heart of each of their regional tropical cyclone warning systems is a regional/specialized meteorological centre, indicated in Figures 3.1 and 3.2, whose role is the detection, monitoring and forecasting of cyclone strength and motion in the open ocean and to provide scientific guidance to the national meteorological warning offices. National services then issue warnings for their territory and coastal waters.

In many parts of the tropics, routine monitoring by weather satellites and radar stations has greatly increased the probability of tropical cyclone detection, with a relatively low false-alarm ratio for timely warnings. In most cases this system works well, but not without difficulties. A major problem continues to be insufficient data over the tropical oceans, which hampers the proper understanding of the storms. There is also insufficient data from some of the very islands which are vulnerable to the effects of the cyclones. More data means better forecasts and better warnings. Many small island developing states have not been able to keep up with the advances in telecommunication and computer technology, thus their meteorological systems are not able to cope with the increasing volume of data and speed of transmission. The upkeep or replacement of old weather radar is a problem for some developing countries. On islands, loss of this system means the loss of 'the last line of defence'. These deficiencies mean that without external assistance, some small islands are in danger of providing inadequate warning services for their citizens. These problem areas are targeted by the World Meteorological Organization for special attention. A number of modern telecommunication systems are being set up through WMO projects to improve weather forecast and warning services in developing countries, including many small island states. The World Meteorological Organization's efforts in the supply of radar detection systems for small islands are also continuing, despite the tough economic climate donor countries are experiencing. The acquisition of meteorological data supplemented from other data sources such as the chemical composition of the atmosphere from the Global Atmospheric Watch are systematically archived and made available for the study and monitoring of climate and for the provision of climate services.

FIGURE 3.2

GLOBAL NETWORK OF TROPICAL CYCLONE WARNING SYSTEMS



3.2 Hydrological services

Assessment and monitoring of water resources are essential parts of water management on small islands. Without a thorough understanding and knowledge of the types and sustainability of island water resources, no proper decisions can be made about their development, management, conservation and protection. River basins are quite often numerous but are small in size with limited capacity. Consequently, flood waters in these small basins rise very rapidly – in minutes in some cases. Mapping of flood zones is an important strategy for combating floods. Generally, larger islands and continents have much more complete data collection and monitoring systems for flood events than the small islands. Because of limited resources, islands tend to channel their efforts towards the principal hazard, usually the tropical cyclone. The hydrometric network in most small islands is insufficient for a proper assessment of the water resources available, and for forecasting purposes.

3.3 Seismology and volcanoes

Information on the world's active volcanoes is summarized in the Smithsonian Institute's monthly bulletin – Global Volcanism Network. The information is obtained mainly from volcano observatories, found in locations where volcanic activity is particularly frequent. Scientific methods have been applied to prediction in the last few decades and there have been major improvements in the ability to identify precursors to volcano activity. However, considerable uncertainty remains as to how far and how fast an abnormal situation could escalate (Hunt 1994).

With regard to earthquakes, the International Seismological Centre in Berkshire, UK, collects worldwide seismic data and produces monthly bulletins giving summaries of location, magnitude and damage reports. These normally take some time to be produced, but for large earthquakes, information is immediately transmitted to the respective locations, using the facilities of WMO's Global Telecommunication System (GTS).

3.4 Tsunamis

Tsunami information in the Pacific Rim is handled by the International Tsunami Information Center (ITIC) in Hawaii, USA. The Center is maintained by the USA for the Intergovernmental Oceanographic Commission (IOC) with a mission to mitigate the effects of tsunamis throughout the Pacific. Information on possible tsunamis is sent from this Center to 26 Pacific countries, once more via the GTS.

4. Disaster preparedness and response

Warning services make up one part of the entire disaster management process. The principles are almost the same for all natural disasters, dividing the process into risk

assessment, disaster preparedness, prevention and response categories. In each of these categories, there are guidelines for activity before, during and after a disaster.

In general, the process *before* a disaster involves:

- i) hazard and vulnerability assessment;
- ii) establishment and enforcement of hazard-specific construction standards;
- iii) updating and testing of national disaster plans;
- iv) public education campaigns by the disaster management units such as the warning services (weather, earthquake, volcano and tsunami), civil defence authorities, public health officials;
- v) storage of emergency supplies.

During an emergency, the process includes:

- i) the issuance of advisories and warnings to the public;
- ii) public preparation;
- iii) evacuation if necessary.

After an emergency, this will include:

- i) clean-up activities;
- ii) relief and care for displaced persons;
- iii) damage assessment;
- iv) rehabilitation activity (mostly with foreign assistance and the help of NGOs).

In theory, this basic plan looks good and in many places it works quite well. The key to the system is clearly to have good detection and warning capabilities and much of the effort at the national, regional and international levels goes into this area. The *effective* systems are those in which there has been focus on the public education, warning and response aspects; the *best* systems are those which also include the enforcement of hazard-specific construction standards.

A distinct problem in disaster management within small islands is that of complacency. Because long periods can pass without any major incident, less and less attention and resources are allocated to preparedness. Standards tend to be relaxed, public education is minimized and tests of emergency plans cease. At the regional and international levels, efforts can and do continue to keep preparedness levels high, in the hope that this will also continue at the national level. As an example, WMO cooperates with regional disaster-related agencies to hold joint training workshops or seminars for

senior meteorological and disaster preparedness officials, and is becoming more and more involved in providing assistance in the risk assessment activities.

5. Case study

A few examples were given above of natural disasters with major impacts on the economic and social infrastructure of small island developing states. Good case studies, including comprehensive evaluations of the impact of a disaster on all aspects of an economy of a small island state are very difficult to find. For illustrative purposes I have chosen one case study – the impact of Hurricane David (1979) on Dominica, from Collymore (Collymore *et al.* 1993). The data has been obtained from the 1981, 1982 and 1983 Annual Reports of the UN Economic Commission for Latin America and the Caribbean (ECLAC).

5.1 Hurricane David – Dominica

When hurricane David hit Dominica in 1979 serious damage was done to 50 per cent of the 16,000 houses on the island, and 2,000 houses were completely destroyed. Two thirds of the island's population of 80,000 were left homeless. Nearly all school buildings were badly damaged, while Princess Margaret Hospital in Roseau, the capital, lost the roof sheets from almost all of its buildings. The main port in Woodbridge Bay was badly damaged and required major reconstruction estimated at East Caribbean (EC) dollars \$ 10.8 million (US\$ 4 million). The total cost of reconstruction, including public, private and industrial buildings, public utilities and agriculture was estimated at EC\$ 64.3 million (US\$ 23.78 million). The impact of the hurricane is clearly demonstrated in Table 3.1 below.

TABLE 3.1
COMPARISON OF SELECTED ECONOMIC INDICATORS – DOMINICA,
FISCAL YEARS 1978-1983
(Millions of East Caribbean dollars)

Selected indicator	1978	1979	1980	1981	1982	1983
Population (x 1000)	82	83	84	84	85	87
Gross domestic product (base year 1977=100)	102	81	88	100	103	107
Agriculture/fishing	41	26	24.5	27.7	31.4	33.3
Mining/construction	6.4	7.2	11.7	12.7	10.4	10.3
Manufacturing	5.5	4.5	5.0	5.4	8.0	8.2
Wholesale/retail trade	10.8	7.1	9.4	10.6	12.0	11.0
Hotels/restaurants	1.3	1.0	0.9	1.0	1.1	1.2
Total exports	42.9	25.4	26.3	50.9	66.0	74.2
Total imports	76.8	59.9	128.7	136.6	128.2	121.7
GDP per capita (EC \$)	1 243	975	1 047	1 190	1 212	1 230
Change in consumer price index	+9.3	+34.1	+21.4	+8.1	+4.1	+2.7

The impact of Hurricane David was felt in the island's economy for many years after the event. Up to 1983, agriculture and fishing had not regained the share of gross domestic products that they held in 1978. Exports declined drastically in 1979, whilst GDP per capita in 1979 and 1980 fell to 78 per cent and 84 per cent respectively compared to the 1978 level. Even in 1983 the GDP per capita had not reached the 1978 level.

This case study illustrates the long-lasting impact that major natural disasters have on the economy and social infrastructure of a small island state. Other examples can be shown, both for other parts of the world and for other disaster types. A full case study on the effects of a tropical cyclone on the Pacific island of Fiji is given in the annex to this paper. One must approach such studies in an interdisciplinary way – involving all sectors and disciplines. It is hoped that one outcome of the International Decade for Natural Disaster Reduction (IDNDR) will be some level of standardization in this type of analysis so that the true cost of natural disasters can be estimated accurately and to evaluate the contribution early warning services and preparedness measures make to disaster mitigation.

6. Conclusion

Most of the world's small island developing states lie in or just outside the tropics, and thus are potentially at the mercy of the tropical cyclone. It is not the cyclone itself which is a disaster, but its effect on a country or community. The devastation and deaths caused by severe tropical cyclones often bring thriving societies and economies to a sudden halt, and the cost of reconstruction is often beyond the capabilities of developing countries to bear alone. Volcanic and seismic disasters are much less frequent on islands than meteorological disasters, although a number of small island developing states are volcanic in nature and lie in or near seismic zones.

Efforts to reduce the impact of natural hazards often suffer from the fact that the irregularity and the uncertainty of the future occurrences of these hazards foster the notion that they do not qualify for high priority or urgent attention. The argument that precious resources should be devoted to cases where the benefits are assured within a defined time frame is difficult to rebut, particularly in areas which have not recently experienced these hazards. Uncontrolled development, non-existent or non-compliance with disaster-related safety regulations codes, and ill-prepared populations often provide the background to many of the major disasters. Today the high cost of reconstruction and rehabilitation, along with the escalating cost of insurance as a result of recent disasters in various parts of the world, is putting considerable strain on the sustainable development of small island states.

There is no doubt that natural hazards, meteorological, seismic and volcanic, would have different impacts on a society if there were organized systems in place within the community to prepare for and combat their impact. These systems must include long-term measures aimed at the provision of early warning mechanisms and the establishment and enforcement of local preventive measures along with community education, preparedness, response and rehabilitation. The statistics show clearly that,

even in less-developed countries, adherence to these measures leads to a reduction of damage and loss of life. Programmes in the World Meteorological Organization in the tropical cyclone-prone regions of the world, which include the majority of small island developing states, have brought about considerable progress in this regard. Other international organizations are also addressing the issue of the improvement of early detection and warning services for other natural hazards, in the context of the International Decade for Natural Disaster Reduction (IDNDR). Considerable assistance is usually required from the large developed donor countries to make this possible, but resources are not always easy to find in the current world economic climate. It should be pointed out there are no worldwide international agreements about the exchange of data on these geophysical processes for certain (e.g. non-commercial) purposes in other countries, including those obtained from very costly earth satellites that are only provided by certain countries (e.g. through national meteorological services). It seems that the procedures of WMO for agreeing, instituting and operating meteorological and hydrological forecasts and warnings would be quite suitable for other kinds of geophysical events and natural disaster. This opinion is shared by a wide range of geophysicists (UNCTAD 1983).

The consideration of climate change issues invokes certain options concerning possible responses to sea level rise, such as construction of sea-walls and reclamation and maintenance of reclaimed land, installation of pumping and drainage systems, land raising and beach nourishment projects, all of which are very costly. On very small islands and atolls, the most widespread response to sea level rise is likely to be abandonment and migration, which may be the most costly and, from the social and cultural point of view, the most disruptive option. On the other hand, the only realistic and economically viable option for many developing countries with weak economies, appears to be through long-term and environmentally sound development.

The IDNDR is providing a focus within the UN system on the theme of this paper. I would hope that this UN Global Conference on the Sustainable Development of Small Island Developing States will bring to light the unique needs and requirements for sustainable development that can go hand in hand with the efforts which are being addressed in the context of the IDNDR towards the reduction of natural disasters globally.

In summary, I would like to propose seven specific actions:

- Undertake an internationally coordinated comprehensive risk assessment programme that will provide a standardized base-line for disaster reduction initiatives nationally, regionally and internationally;
- Strengthen the meteorological and hydrological data acquisition, telecommunications and data processing infrastructure, utilizing regionally coordinated mechanisms such as the WMO World Weather Watch and Tropical Cyclone Programmes, so that improved prediction of tropical cyclones can be accomplished;

- Initiate the development of prediction capabilities of other geophysical phenomenon, such as volcanoes and earthquakes, and promote worldwide international agreements for the exchange of these data, using the procedures of the WMO as an example;
- Invest in specific programmes for preparedness, including the development or improvement and enforcement of hazard-specific building codes and land-use practices, public education and warning dissemination systems;
- Participate fully in the international programmes such as the World Climate Programme so that the specific concerns of small island developing states are placed high on the priority list of studies determining the impact of climate, its variation and change, and potential sea level rise which are central to this issue;
- Organize and promote specific regional technical cooperation programmes designed to assist small island developing states to reduce the impact of tropical cyclones, floods, volcanoes, earthquakes, tsunamis and climate change including sea level rise;
- Develop effective public information services, based on scientifically sound studies and analyses that will help eliminate confusion and controversy and lead to concerted international action to promote sustainable development.

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**NATIONAL ECONOMIC IMPACT OF A NATURAL DISASTER
EXTRACT FROM A CASE STUDY ON CYCLONE KINA
(DECEMBER 1992) FIJI**

*Article source: Asian Disaster Preparedness Center, Asian Institute of Technology,
Bangkok, Thailand*

FIJI			
Population	74,000	GNP US\$	1,624
Area	7,054 sq mi	Agriculture	21%
Pop. dens.	105/sq mi	Industry	19%
Urbanization	39%	Services	60%

Natural disasters have over the years caused serious setbacks to the national development process, and lessons learned have led to the

increased recognition that natural disasters are an integral part of the national development programme. This was the major factor that prompted the Government of Fiji to review its emergency service organization, shifting the emphasis from emergency response to disaster management, aiming to draw up a national strategy to tackle problems associated with natural disasters affecting Fiji. The following shows the extent of economic impact of one natural disaster, the Cyclone Kina.

1. Impact on the 1993 government budgets

The government budget, in particular that relating to capital works programme, had to be reprioritized and a large portion was redeployed to meet the cost of rehabilitation work. The redeployment of funds represents 31.6 per cent of the total 1993 capital budget.

2. Impact on prices and economic production

The consumer price index showed a slight increase of 2.4 per cent between December and January due to the cyclone. This increase can be attributed to the increase in food prices. The food price index increased by 8 per cent from December to January. The price of cassava and kumala increased drastically after the cyclone. Kumala went from 10 cents/kg in December to 114 cents/kg in March and cassava increased more than 400 per cent. The availability of fruits and vegetables in the market was reduced significantly, and prices increased drastically. Prices began to stabilize around May, with

¹ This summary is based on a case study prepared by Joeli Rokovade and Luc Vrolijk: *Case Study Fiji: Disaster and Development Linkages*. Workshop Paper No. 8, UNDP/DHA Disaster Management Training Programme South Pacific Workshop, Apia, Western Samoa, 29 November-4 December 1993.

supplies returning to normal levels. Fruit prices increased equally drastically. Immediately after the cyclone, the government imposed a ban on the export of all food crops; exports were only allowed if crops were grown under contract. The ban was lifted in May, except for cassava. There was no significant increase in the price of building material.

The available statistical data on industrial production does not allow for a full appraisal of the impact of Kina at this stage. However, it seems that a slight dip in the industrial production index for the first quarter of 1993, when the brunt of the cyclone was most drastically felt, largely recovered in the second quarter of 1993. It could be estimated that the drop of production was mainly due to the disruption of power supply and other immediate effects of the cyclone, and not so much to long-term impacts of disaster.

3. Impact on education and schools

A total of 294 schools were either completely destroyed or partially damaged and the start of the 1994 school year was deferred for up to two weeks to enable school authorities to carry out urgent reconstruction work. It appears that rural schools (except government schools) were the worst affected; this is a reflection of the different standards of buildings that exist in rural and urban areas.

4. Impact on agriculture

Cyclone Kina caused widespread devastation to the main staples, export crops and livestock. Also agricultural infrastructure, including drainage and irrigation schemes were damaged. The total cost of the rehabilitation programme was prepared by the Ministry of Primary Industries, but the Ministry was only able to implement the short-term rehabilitation programme due to lack of funds.

5. Impact on dwelling houses and rural development programme

A considerable number of houses, mainly in the rural area, were either completely destroyed or suffered extensive damage. Altogether 5,544 people qualified for the government emergency housing assistance. Damage to buildings in urban areas was fairly minimal as they are structurally sound as most of them are constructed in accordance with required standards. People should be encouraged to take advantage of the existing government rural housing programme, and it is worth noting that houses constructed under this programme stood up well in previous cyclones, including Kina.

However, the Self-help Programme, Rural Reading Programme and Rural Housing Programme were suspended and funds redeployed to cater for housing rehabilitation after the cyclone. The suspension of the Rural Housing Programme put a stop to the completion of 5,362 houses, construction work for which had already been underway when the suspension of the programmes came into effect, leaving them vulnerable as they entered yet another cyclone season.

6. Impact on infrastructure and public utilities

Extensive damage was sustained by power lines. However, all rehabilitation activities have since been completed. Telecommunications and roading infrastructure also suffered considerable damage. Damage to roads and bridges crippled road transport for some time and mobility was restricted, which affected all of the government, the public and private sectors. There were electricity power cuts during and after the cyclone. Government institutional buildings and quarters also sustained damage, which affected the services provided by the ministry concerned.

7. Impact on the sugar industry

The sugar industry is one of the main economic sectors in Fiji. It provides a main source of income for the country and employment for a significant population group. Cyclone Kina had a very marked effect on the industry. The Fiji Sugar Corporation (FSC) had most of its assets insured but now suffers a major hike in insurance premiums due to the impact of the cyclone. The sugar industry may also suffer from the long-term impact of the flooding, due to the loss of fertile top soil. It is further noted that the damage to FSC assets has also had a considerable impact on other sectors of the community, in particular because part of its infrastructure is also used by the general public. These linkages make it necessary to seek closer cooperation with other sectors of society in mitigation, preparedness, emergency operations and rehabilitation.

8. Impact on tourism

Another major sector of the Fiji economy is the tourism industry. Most of Fiji's tourism industry escaped direct damage because the path of the cyclone stayed well clear of the main tourism areas. The most significant impact of Kina on the tourism industry may well be on the insurance of resorts. Many of the smaller resorts had insured their properties overseas, and these premiums increased considerably due to Kina. Some of the resorts are now turning to the local insurance market, but will first have to upgrade the technical standards of their properties before insurance can be given, still at considerably higher prices than before Kina.

9. Impact on the insurance market

The total insured damage caused by cyclone Kina amounted to F\$ 50M, of which F\$ 42M was reinsured on the international market. The cost for reinsurance of calamities increased significantly over the last year due to major international disasters such as Hurricane Andrew and the Mississippi floods. This seems the main reason for the hike in overseas reinsurance cost, although cyclone Kina may have alerted the international market to calamity insurance in Fiji. Reinsurance costs for calamity insurance have increased by 100 per cent to 300 per cent for insurance operators in Fiji. There is no insurance for crop damage.

Insurers indicated that insured damage to housing caused by Kina was limited because of measures taken by the industry following cyclones Eric and Nigel in 1985.

These cyclones triggered a restructuring of the insurance market. The number of insurers dropped from 12 companies to four, and the remaining introduced engineering codes and guidelines for insurance. Cyclone damage can now only be insured if the house has been inspected and approved by an engineer who then issues an 'engineering certificate'. According to the insurers this has considerably improved housing standards, particularly in urban areas.

10. Some lessons learned

10.1 Rural housing

The vulnerability of housing in rural areas was well demonstrated. Damaged houses in urban areas were located in mostly squatter settlements or villages along the fringes of urban centres. Rural housing needs strengthening through the continued promotion and implementation of the government rural housing scheme and construction of structurally sound buildings.

10.2 Pre-disaster planning

The absence of relevant information and statistical data as experienced during the emergency relief operation has highlighted the need to establish a sound information management system not only on a national level but also at division and district levels. To this end the establishment of a national database is vital. Government overall state of readiness was also affected to some degree by the absence of any clear direction or instruction from the national disaster management council. Coordination between key agencies was a problem largely because operational procedures and administrative instructions were lacking both at departmental and national level. The question of training came to the fore as it became obvious that some operators were not fully conversant with their roles and responsibilities which affected the emergency and relief operations.

10.3 Coordination of the overall rehabilitation programme

Each Ministry was responsible for planning and organizing its own rehabilitation programme and apparently there was no coordination of the overall national rehabilitation programme and strategies. This being the case, international assistance was fairly limited as potential donors were not in a position to usefully consider Fiji's rehabilitation needs.

10.4 Advisory precautions

Public response to Kina was to some degree affected by the absence of specific advisory precautions which were supposed to be issued by the national disaster management office to the main radio network for public broadcast.

10.5 Cyclone warning system

Warnings and advisories issued on the system were reasonable accurate and timely. It is a pity that the cyclone could not be located by radar as it approached Fiji, which would have helped track the system more precisely. This in turn would have allowed the public to be warned slightly earlier of changes in the path of the cyclone and the resultant threat. Recent installations of radar should see some improvements in future tracking and forecasting.

These and other issues are currently being addressed in the new national disaster management plan under preparation.

CASE STUDY IV

COASTAL MANAGEMENT IN SMALL ISLAND DEVELOPING STATES

Vili A. Fuavao ¹

1. Abstract

The concept of integrated coastal zone management (ICZM) should be viewed as promoting the sustainable development of coastal resources. In the context of small island developing states (SIDS), effective integrated coastal zone management can only be achieved through the adoption of 'island appropriate' methodologies and approaches. That is, SIDS problems require SIDS solutions. In this paper we examine a range of issues that need to be considered when developing integrated coastal zone management approaches in small island developing states. The coverage is by no means comprehensive, and the issues will vary in importance from state to state. However, these issues, when considered in terms of past small island developing states coastal management experiences, dictate the need for a *process-oriented* approach to ICZM. A number of recommendations are provided, both general and specific, that we feel are important for promoting and establishing effective integrated coastal zone management in small island developing states.

2. Introduction

2.1 *International agreements and coastal zone management – UNCED and the Barbados Conference*

Decisions taken at the United Nations Conference on Environment and Development (UNCED) have without a doubt influenced the direction taken in the management of coastal areas. Whether these international agreements are responsible for a *paradigm shift* in the way we manage the coastal zone (Cicin-Sain 1993) or whether they have simply formalized a trend towards integrated management, the increased support for this approach is a measure of the change in perspective that has occurred. While there is agreement to the general direction, the approach to coastal management and its application to specific groups, in this case small island developing states, requires some discussion. Indeed this is true of much of Agenda 21, which reflects a global consensus but requires more specificity if it is to be applied to particular groups. The Global Conference on the Sustainable Development of Small Island Developing States (Barbados Conference), called for in Chapter 17(g) of Agenda 21, recognizes this need.

¹ Prepared by Andrew Smith, Roger Cornforth, Gerald Miles, Vili Fuavao and Chalapan Kaluwin.

During the negotiations in preparation for the Barbados Conference there has been recognition that the lack of an integrated approach to coastal and marine area management has increasingly resulted in degraded coasts and coastal resources in small island developing states.² As sustainable development in small island developing states depends largely on coastal and marine resources (UN 1993), the development of any coastal management technique is fundamental to their future. In doing so it is important to recognize that for islands their *smallness* has a profound influence on their social goals and development options, as well as magnifying the impacts of poor decisions. This is true for both inappropriate development as well as ill-conceived solutions. The particular constraints and opportunities facing small island states in the management of their coastal resources must therefore be carefully considered before any particular model or solution is proposed.

Particular dimensions of the 'coastal management problem', recognized in the Action Programme for the Sustainable Development of Small Island Developing States, to be considered and endorsed by the Barbados Conference, are the paucity of 'data'³ necessary to manage the coastal zone, the lack of institutions at the national level, and the need for an approach to integrated coastal zone management that is relevant to islands. As a result the Action Programme calls for better information to assist decision-making, the strengthening of appropriate institutions and legislation, and the development of island-appropriate methodologies for integrated coastal zone management. By examining a range of special issues for sustainable development in small island developing states, including population, climate change, waste management, economic and institutional capacity, it is possible to better describe how these issues can be addressed by ICZM.

2.2 Objectives

To assist countries make progress with the broad recommendations in the Action Programme this paper aims to:

- i) Examine a range of issues that need to be considered, as relevant integrated coastal zone management approaches are developed for small islands;
- ii) Provide an overview of the coastal management issues and problems confronting small developing islands;
- iii) Assess the effectiveness of coastal management in the context of small developing islands;
- iv) Explain the concept of 'integrated coastal zone management' and its relevance to sustainable development in small developing states; and

² Table 4.1 lists the small island developing states, their population and population growth rate estimates, and land and sea areas (adapted from Griffith and Ashe 1993 and UN 1992).

³ The term 'data' is used here in its broadest sense - while the information or understanding exist in terms of traditional knowledge it is not readily available to assist collective decision-making.

v) Provide recommendations concerning future actions.

There is no doubt that practical arrangements to improve management of the coastal zone are required in small island developing states. It is hoped this paper will provide some insights concerning the next steps to be taken with the use of ICZM for islands.

TABLE 4.1

SMALL ISLAND DEVELOPING STATES – POPULATION, POPULATION GROWTH RATES, LAND AND SEA AREAS

Country	Population (000) 1990	Population growth rates (1980-90) ^(a)	Land (km ²)	EEZ (x 10 ³ km ²)
Atlantic				
Cape Verde	370	2.5	4 033	
Sao Tome and Principe	121	2.6	964	
Caribbean				
Antigua and Barbuda	76	0.1	444	
Bahamas	253	1.9	13 935	759
Barbados	255	0.2	431	167
Dominica	7 170	2.3	751	20
Jamaica	2 456	1.4	10 991	
Grenada	85	-0.6	344	27
Trinidad and Tobago	1 281	1.7	5 130	77
St. Kitts and Nevis	44	-0.1	268	68
St. Lucia	150	1.9	616	68
St. Vincent and the Grenadines	116	1.2	383	68
Indian Ocean				
Comoros	550	3.4	1 862	
Maldives	214	3.1	298	959
Seychelles	69	0.9	280	349
Mauritius	1 082	1.1	2 045	1 183
Mediterranean				
Cyprus	701	1.1	9 241	99
Malta	353	-0.3	316	66
Pacific Ocean				
Cook Islands	18	-0.2	240	1 830
Federated States of Micronesia	99	2.7	701	2 978
Fiji	764	1.9	18 272	1 290
Kiribati	72	2.1	690	3 550
Marshall Islands	39	2.7	181	2 131
Nauru	9	1.8	21	320
Niue	3	-1.9	259	390
Northern Mariana Islands	22	2.6	471	1 823
Palau	17	2.7	424	629
Papua New Guinea	3 874	2.3	462 243	3 120
Solomon Islands	320	3.6	27 556	1 340
Tonga	95	-0.2	699	700
Tuvalu	9	1.1	346	857
Vanuatu	158	3.1	11 900	680
Western Samoa	159	0.3	2 935	120
South China Sea				
Singapore	2 723	1.2	581	

Source: Adapted from Griffith and Ashe (1993:273) and UN (1992).

Note: ^(a) Population growth rate figures include migration.

It will first be important to briefly outline some concepts and definitions used in relation to coastal zone management. Without examining all aspects of sustainable development in small island developing states, a number of special issues are discussed in terms of their impact on the planning and management of the coastal zone. The evolution of coastal zone management and the potential role or approach to ICZM for islands is then discussed before recommendations are presented.

3. Concepts

There has been considerable discussion in the literature concerning the terms to be used and their definitions (e.g. Brachya *et al.* 1993; Clark 1992; Kenchington and Crawford 1993; Sorensen and McCreary 1990; World Coast 1993). The vast majority of this literature derives from, and largely relates to, the developed, continental situation.

In small island developing states, particularly where the traditional culture predominates, much of the standard coastal zone management terminology is quite alien. For example, what is the 'coastal zone' to a community which manages all its resources (from the catchments to the open sea) through customary tenure and use rights, semi-autonomously and irrespective of government authority? How and why should such a categorization be made? What purpose does it serve? What does 'integration' mean, especially between communities which have largely acted in complete independence of each other longer than anyone can remember? What is 'planning' to a community which reacts to a very different set of social, cultural and economic objectives and concentrates all the resources of the extended family on immediate, up-coming key events of local and cultural significance? More generally, what is 'planning' to societies which have traditionally had an abundance of natural resources for their needs requiring minimal strategies to ensure continuity of supply? What are 'plans' for coastal management to communities used to managing their affairs day by day and week by week through meetings and verbal consensus? Or to communities which manage by focusing more on a highly refined process than on a 'planning system' of prearranged progress towards long-term objectives?

While some small island developing states may find the basic concepts and terminology of coastal zone management more compatible with their own resource management practices, any rigorous application of standard methodologies would be both overwhelming and inappropriate to the range of small island circumstances. For example, while 'integration' or perhaps more appropriately 'coordination' of activities and decision-making is needed in most small island developing states, the nature of that integration is likely to be quite different to the standard developed, continental nation model often proposed for coastal zone management.

3.1 Coastal zone

For conventions sake we will use the term 'coastal zone' rather than 'coastal area' as it appears to be the more widely accepted. However, it would be more appropriate for

small island developing states to adopt terminology that is appropriate to their individual circumstances, to minimize in-country misunderstandings.

Continental and large island states recognize their coastal zones as distinct regions with resources that require special attention, resulting in the well established sectoral approach to these areas – this same concept has been transferred, inappropriately and unsuccessfully, to the small islands context.

The 'coastal zone' in many small islands, from a systems and ecological perspective, is for all intents and purposes the whole island. Layered on top of this are a range of political, cultural and legal arrangements which affect the utilization and management of resources in the coastal zone.

Defining the coastal zone in the small islands context should involve flexibility. From an ecological perspective, generalizations concerning what constitutes the 'coastal zone' can be made for small islands. However, from the cultural and political perspective the definition of the 'coastal zone' needs to be developed on an island by island basis. For example, what constitutes the coastal zone based on customary tenure? In small island developing states it varies from only small areas of land adjacent to the coast, through to systems incorporating areas from the centre of the islands out into the oceans, or in some cases even the entire island.

3.2 Coastal zone management

Generally speaking, where coastal zone management has been attempted in small developing islands it has been based on the developed, continental countries' models of sectoral management. This has been due to at least three factors: political (and therefore administrative) structures in small islands based on former colonial systems; coastal management techniques and methods developed in and for the larger developed countries; and overseas development assistance for coastal management being driven by the experiences of developed countries. The evolution of coastal management is discussed later in this paper.

3.3 Integrated coastal zone management and sustainable development

There are many definitions of integrated coastal zone management. The concept of integrated coastal zone management has been described in the Noordwijk Guidelines for Integrated Coastal Zone Management as:

'...a governmental process and consists of the legal and institutional framework necessary to ensure that development and management plans for coastal zones are integrated with environmental (including social) goals and are made with the participation of those affected. The purpose of ICZM is to maximize the benefits provided by the coastal zone and to minimize the conflicts and harmful effects of activities upon each other...' (World Bank 1993:1)

It has also been described as:

'...a comprehensive, multi-sectoral, integrated approach to the planning and management of coastal areas. This encompasses a process of assessment, planning and management for the sustainable development, multiple use and conservation of coastal areas, resources and ecosystems... It is a *process* that must be tailored to fit into the institutional and organizational environments of the countries involved, including political and administrative structures, cultural patterns and social traditions (Scura *et al.* 1992). With the ... diversity of environmental, social, cultural and economic conditions [in SIDS] the ICZM process will, by necessity, differ from island to island.' (SPREP 1993:3).

The World Coast Conference's pre-conference workshop for the Eastern Hemisphere (McLean and Mumura 1993) defined the ICZM 'frame' as:

'...a dynamic process in which a coordinated strategy is developed and implemented for the allocation of environmental, socio-cultural, and institutional resources to achieve the conservation and sustainable use of the coastal zone.'

It is important to note that all of these definitions/descriptions, refer to integrated coastal zone management as a 'process'. However, in reality it is often an amorphous process without a clearly defined methodology. Small island developing states need to take advantage of this, as it will be the flexibility of approach that will enable integrated coastal zone management to be of such relevance to the SIDS situation.

The concept of sustainable development is best described as a process, rather than an end-point, guided by a range of principles. The Rio Declaration, that was endorsed by the world's leaders at the Earth Summit 1992, contains a range of principles that reflect the political will of the day. While these principles may require interpretation at the national and local level, sustainable development to meet the needs of the present without compromising the ability of future generations to meet their own needs will commonly involve:

- i) Participation of local communities and relevant groups in the planning and implementation of development and conservation activities;
- ii) Integrated planning, in particular the incorporation of environmental and population considerations into economic and sectoral policies and plans;
- iii) Application of the precautionary approach to planning and development.

Where the definition of the coastal zone includes the entire island, then successful coastal zone management would essentially be synonymous with the sustainable development of those zones. As suggested by Griffith and Ashe (1993), integrated coastal zone management is designed to promote sustainable development of coastal resources. Ideally, integrated coastal zone management in the small islands context should be viewed as being synonymous with 'integrated island management'. This has considerable importance for small islands, especially those yet to establish

coastal management programmes. Separate sustainable development and ICZM programmes would for all intents and purposes be an unnecessary duplication of effort.

4. Sustainable development of small island developing states – some issues for integrated coastal zone management

If appropriate models for sustainable development are to be developed for small island developing states, then a number of special issues need to be taken into account. This section does not seek to address the full range of such issues, rather it discusses those with particular implications for integrated coastal zone management in the small island developing states generally. Appropriate models for sustainable development will require tailoring to the particular circumstances of individual small island state and their regional context. The issues considered below, therefore, serve to illustrate the need for a different overall approach to the integrated coastal zone management of the small island states to that generally assumed for the large developed countries and within the context of which the concept of ICZM arose.

4.1 Population

It is often suggested that growing populations pose the greatest threat to the environment and sustainable development. While population growth is an important concern, there is no simple connection between the number of people and the extent of damage. Environmental degradation and constraints to sustainable development are not caused simply by more people, but, perhaps more importantly, by what they do – their economic activities, the technology they use, and their patterns of resource consumption (Chung 1993).

With a limited land area and often fragile environments, the rapid growth of populations is often an important concern for island countries. As the great majority, if not all, the population of small island developing states is within the coastal zone, population has become a major consideration for SIDS coastal zone management.

A common feature of many small island developing states is the concentration of people in small, predominantly coastal, areas as a result of internal migration from rural to urban areas, outer islands to main islands, or small to large islands, compounded by often high rates of natural population increase. This is hardly surprising given the limited land areas able to support people in many SIDS. In such cases, however, it is not unusual for small island developing states to support extremely high population densities, such as in Male (Maldives) and Funafuti (Tuvalu). These localized concentrations of population usually contribute to considerable environmental stress on the resources of the immediate coastal zone.

Even for large high islands, degradation of coastal resources (particularly lagoon, reef and mangrove environments) is for SIDS an early, and perhaps the most significant, environmental impact of a high population density with an unsustainable intensity of terrestrial resource use. In such situations the overuse and degradation of marine

resources of islands with high coastal populations are compounded by the large burdens of topsoil, associated organic matter and agricultural chemicals transported by streams from the water catchments. It is clear, therefore, that the integrated coastal zone management of the small island developing states must take account of activities inland of the coastal areas and promote the use of less damaging practices in these areas by appropriate means.

In this light, the concept of 'carrying capacity' – that the number of people that can be sustained on an island is largely a function of limited land area, fragile environments and technology – has a basis in common sense. As does the opposing concept of 'critical mass' – where many small island developing states, either for their total population (e.g. Niue), or for outer or smaller islands of island groups (e.g. Kiribati, Maldives), are close to or below what may be considered to be the minimum level of population for sustainable communities. Calculating the thresholds for either, however, can be very difficult and becomes more of an academic question than a practical tool for coastal zone management, particularly in the context of small island developing states. It is clear, though, that both conditions exist for SIDS, often simultaneously in the same island group, making both significant considerations for the integrated coastal zone management of the small island developing states.

Another feature of the small island developing states is that many have dominant, or at least prominent indigenous cultures. While it is difficult to generalize for all small island developing states, nonetheless regional patterns may be discerned. In the Pacific region most SIDS have strong cultural traditions, which are largely centred on the extended family. In such cultures it is often the case that large families are the norm and as a result, rates of population increase around the region are commonly between two and five per cent. The comments expressed by some of the Pacific region's leaders at a special population seminar organized by the South Pacific Forum in 1993 demonstrated how strongly the cultures of the Pacific hold to their current views on large families.

The relatively high rates of population growth of many small island developing states are masked by another regional population trend, that of high external migration. The effects of migration on coastal zone management and sustainable development go beyond the artificial lowering of population growth rates. These migrants often remit large amounts of cash to their families which has a distorting effect on the sustainable development equation of the SIDS. In some cases remittances routinely exceed export earnings. This tends to mask environmental problems, by supplying an easy alternative to dealing with the root of the problem – for example the rapid decline in the inshore subsistence fishery can be more than matched by the importation of canned fish.

4.2 Economic development conditions

In addition to those conditions referred to above, there are a number of common elements to economic development in small island developing states. Due to the location of development activities almost entirely in the coastal zone, and the cumulative effects of inappropriate development on coastal resources, these conditions

are of particular significance to the development of integrated coastal zone management appropriate for the small island developing states.

The majority of development is government initiated and aid funded. Often aid projects are targeted at infrastructure development. Increasingly there is a trend to developing in-country capacity for self-sufficiency, stimulation and nurturing of small private sectors, and a growing emphasis on human resource development. Integration of development efforts towards long-term sustainability is a relatively new development objective, and one which almost without exception has yet to show tangible results in SIDS. The coordination of government sector planning which has begun, with varying degrees of success, does not fulfil the objective of long-term integration of both government and community planning and management efforts.

Many small island developing states have economies that are still largely subsistence based, but with a slowly growing cash economy. Few have economies that could continue in anything like their current direction without on-going substantial aid inputs, and/or remittances. Even fewer small island developing states have diversified economies – instead most rely on a few key economic activities (e.g. tourism, fishing, tropical fruit production and export). This makes most SIDS vulnerable to the performance of a few external markets, and the task of establishing long-term sustainable development even more problematic. It also gives rise to a particular view of resources and development that is not often recognized for large developed nations – all resources are there to be used and will be used. There is often little or no opportunity to consider options for the preservation of coastal resources by such means as national parks and reserves in the established meaning of these terms.

In terms of the coastal zone, the majority of exploitation occurs adjacent to the coast and will often involve the development of coastal resources. Management, and particularly the planning for and integration of development in the coastal zone, is often a problem in small island developing states. There is unlikely to be a tradition of, or capacity for, planning developments – particularly in terms of integrating project planning with other development objectives. National economic reliance on only a few economic activities also tends to preoccupy decision makers with the survival and development of key sectors, especially when markets for these sectors are depressed. Integration of planning and development effort is thus not always a logical new direction for decision makers.

In small island developing states with strong subsistence activity (and particularly those with customary tenure and management of resources), management of coastal resources is usually even more focused on use of all possible resources. Apart from government development projects, economic development at this level is likely to be small scale, but may cumulatively have considerable negative environmental impacts on coastal resources. Planned resource development at this level, however, is usually confined to the lands of individual customary authorities (frequently the village council). There is often no practice of, or opportunity to, coordinate effective long-term economic development between these units of authority. In these circumstances, therefore, coastal resource development is characterized by a relatively large number of discrete

administrative and management units along the coastline, although each unit is likely to have responsibility for resource development from the catchments to the open ocean.

The development of appropriate models for integrated coastal zone management in the small island developing states needs to be appropriate to their circumstances as developing nations. As discussed by Bloye Olsen (1993), the accepted guideline for developing countries is '... to define sustainable patterns and intensities of development'. More popularly this is expressed as meeting the needs of the present without compromising the ability of future generations to meet their own needs. If this approach were adopted as a principal objective for integrated coastal zone management for island developing nations, it would require plans to identify what human activities and intensities of use are sustainable in the coastal zone, and then propose appropriate strategies for achieving them.

This contrasts markedly with the standard Western model of integrated coastal zone management, which may be considered to have largely developed to bring order to the chaos existing between the competing uses of the coastal strip of land and water and to reverse the resulting severe degradation of coastal resources.

4.3 *Climate change and sea level rise*

Small island developing states are particularly vulnerable to climate change and variability and sea level rise. With the concentration of population and development found in the coastal zone, any changes due to sea level, as indicated by IPCC scientists ('business as usual'), will have significant and profound effects on the economies of these nations and therefore coastal zone management. The existence of certain low lying countries would be threatened by sea level changes. Inundation of outlying islands and loss of these lands may result in loss of exclusive economic zone rights over large areas. Global climate change may alter the distribution of zones of up-welling and may affect fisheries production. In addition, it may impact on vegetation and saline intrusion will adversely affect the freshwater resources. The increased frequency and intensity of cyclone and storm surges that may result from climate change will have profound effects on both economies and the environments of small island developing states. Public access to and more information on climate change and its effects on small island states should be made available to enable appropriate response strategies to be developed and implemented. These response strategies may well be an integral part of coastal zone management plans.

The Framework Convention on Climate Change (FCCC 1994) which came into force on March 21, 1994, is expected to make a significant contribution to reducing the threat of global climate change and sea level rise as well as mitigating and assisting countries to adapt to these impacts. In particular, parties to the FCCC have recognized that small island countries are particularly vulnerable to the adverse effects of climate change and have committed themselves, *inter alia* to:

- '(d) Promote sustainable management, and promote and cooperate in the conservation and enhancement ... of ... coastal and marine ecosystems;

- (e) ... develop and elaborate appropriate and integrated plans for coastal zone management...' (FCCC Article 4.1 (d) and (e))

While there is still debate about the magnitude of climate change and sea level rise, for small island developing states the issue is too important not to take into account. A precautionary approach needs to be used throughout coastal zone management to ensure that climate change and sea level rise are adequately addressed in coastal zone plans and management approaches.

4.4 Waste and sewage

This is one of the most visible and commonly perceived environmental problems in the coastal zones of the small island developing states. Many pollution control programmes of small island developing states focus on 'land based sources' of pollution. As discussed above, this is in part often simply due to local overpopulation, but is also a function of the nature of the economic activities being undertaken, the technologies being used, and the intensities of resource use being practised by that population. In many areas traditional ways of disposing of waste are still being employed, even though the products and wastes of industrialized society are now being widely imported and are not amenable to traditional waste management practices.

Solutions to these problems, however, tend to be rather difficult in that while some relatively small, localized coastal areas may have heavy population densities, the total population and the government's financial capabilities are likely to be too small to support the investment in infrastructure necessary to provide collection and disposal of the wastes in question. In particular, scattered and generally small island populations make the economic operation of recycling almost impossible for all but the most lucrative items without some form of subsidy, or regional approach.

With the exception of some small island states with relatively heavy investment in particular single sector industries which create significant pollution (such as fish canneries in American Samoa), many small island developing states tend to exhibit pollution problems that result from the cumulative effects of individual actions, for example: the disposal of toxic materials such as used engine oil, car batteries, and old stocks of agricultural chemicals, or the end results of water catchment forest clearance, disposal of plastic items and contamination of ground water by inadequate sewage disposal facilities.

In many cases the small island developing states need help to reach their people in order to educate and inform them of appropriate ways to manage modern wastes, or to integrate national policies to limit importation of particularly damaging materials. Often developed nations' solutions are proposed from outside which take little account of relevant circumstances in the small island developing states.

4.5 Institutional arrangements

Some general characteristics of small island developing states have particular implications for the development of appropriate institutional arrangements for sustainable integrated coastal zone management. These include:

- i) The generally small size and limited ability of government machinery to administer and manage complex new programmes;
- ii) The often ex-colonial nature of many bureaucracies;
- iii) Government bureaucracies that are often heavily dependent on the support of aid programmes, both financially and in terms of expatriate staff and advisers;
- iv) Often disproportionately large bureaucracies in relation to the size of the population and the economy; and
- v) Often a disjunction between government and its bureaucracy, which may be more inclined to see the machinery of government as existing to carry out government and ministerial decisions rather than to participate in the decision-making process.

In addition, the day to day work of island governments tends to be strongly sectoral, and slow to respond to new directions in any sustainable way. While many contain environment and/or planning units with a mandate to coordinate government sector planning and management, these can generally be considered to be new and still unable to strongly influence the way that government has become accustomed to carrying out its business. As a consequence, there is often little capacity to plan and undertake new approaches, especially strongly integrating programmes involving both government and community levels of decision-making.

If, as seems inevitable, relatively radical approaches are required on the part of the governments of small island developing states to integrate resource planning and management in their coastal zones, then a particular commitment and direction is required of governments to discover and implement processes and plans appropriate to their particular circumstances. This will require creativity, for example it may be that in those SIDS with customary resource tenure and management, that 'integration' between villages is likely to be objectionable and even impossible, and instead some form of coordination should be aimed at.

A common feature of many of the small island developing states in the Pacific is the traditional role of decision makers in strongly authoritarian, hierarchical cultures. This often results in decision makers taking decisions without first seeking technical advice. It may even make it difficult for decision makers to accept technical advice delivered by new government structures and mechanisms such as those which may be proposed to carry out integrated coastal zone management.

Another related socio-cultural feature in the Pacific is the likelihood that most of the effective decision-making occurs at the local level. In small island states with strong

traditional cultures and customary land tenure, village authority is paramount in managing the daily activities on village lands and for village resources. National or government-level decision-making may have a limited impact on these more traditional practices, which has obvious implications for attempts to initiate planning, and to integrate or coordinate the decision-making of a number of separate villages. In these circumstances there may even be a strong antipathy towards the coordinated decision-making and management required by ICZM. Even in the small island developing states without strong traditional cultures, island life often fosters a feeling of self-sufficiency that may cause less extreme but nonetheless significant difficulties for integrated planning and management.

Many small island developing states have traditional cultures which influence the way in which decisions are made and resources managed. Often this places a greater emphasis on local community decision-making than might be expected under developed continental nations' models for integrated coastal zone management. Even where traditional cultures are not strongly represented, the scattered and self-sufficient nature of island communities can give rise to a more strongly parochial view of local coastal resource management.

Certainly the way in which integrated coastal zone management programmes are developed for the small island developing states will often need to be more participatory and afford greater authority to local communities than may be indicated by Western concepts of integrated coastal zone management. The process by which an ICZM programme is developed is likely to be particularly critical and will need to be designed in ways that are appropriate to cultural tradition or local practice. This is likely to be essential in the small island developing states where traditional culture based on customary resource ownership is dominant. It should therefore be a feature of integrated coastal zone management in small island developing states to seek to assist and complement traditional or existing decision-making bodies rather than to try from the outset to introduce new and alien structures or try to replace existing ones.

5. Coastal management in the context of small developing islands

5.1 The evolution of coastal management

In general, the use of coastal zone management in SIDS, either to address sustainable development or coastal development issues is not well developed. It is important, however, to consider the evolution of such coastal zone management programmes in existence in small island states in order to identify the features of coastal zone management which have proven to be appropriate for their particular island circumstances.

The evolution of coastal management in small island states had its beginnings in the importation of concepts and models originating in the developed, continental nations. These were either introduced by aid programmes, or in the case of the US Territories as part of a federal programme, on the basis that these approaches were

necessary in order to resolve problems then becoming evident in the coastal zones of small island developing states. While the aims of coastal zone management were, and still are, widely appreciated as being important and necessary for small island states, early approaches to SIDS coastal zone management, however, often belied the fundamentally different environmental, economic and social context from which they arose.

Some of the earliest coastal zone management in SIDS was undertaken in the US Territories as extensions of the US Federal coastal zone management programme. Essentially this amounted to direct transfer of the Western (US) model of coastal zone management to small island developing states. In Majuro, for example, the Coastal Conservation Act, modelled on US Federal law, gives a definition of the coastal zone extending inland 25 feet from the mean high water mark. This results in a coastal strip along both seaward and lagoon coasts, but excluding the central portion of the narrow, low-lying atoll islands from the coastal zone.

Other early coastal zone management approaches in SIDS were issue driven and therefore sectoral in original principal. In order to resolve single sector problems in the coastal zone, it was recognized that other matters beyond the immediate focus of the sector in question needed to be considered, but the approach remained monosectoral in essence. Examples of this approach can be seen in coastal management centred on mangroves in the British Virgin Islands and American Samoa, coastal defences in the Maldives and Kiribati, and tourism in Fiji.

The use of more comprehensive approaches than might otherwise have been employed to plan for the long-term resolution of a single sector or resource problem, has occurred in some small island states. Most notably this has involved the expansion of other 'standard' planning mechanisms such as land use planning into a form of coastal zone management. Examples of this approach are current in Jamaica, Cyprus and Mauritius. Again, while the focus of the approach is wider and the objectives perhaps more integrative than might otherwise have been possible, nonetheless the focus still usually represents only an aspect of a full coastal zone management approach.

A variation on the expanded planning approach for coastal areas, and one which perhaps more closely resembles coastal zone management is that of special area planning for coastal areas, such as for Pago Pago harbour in American Samoa. In this instance, however, the emphasis is on the clean-up of pollution. Special area planning will usually be found to have arisen in response to a particular problem and it is unusual for the planning process to lose its obsession with the particular problem, which weights the exercise against a more comprehensive coastal zone management approach.

One feature likely to be common to all these approaches is that each has as its basis the resolution of a particular problem or set of problems, and while these approaches might perhaps be sensitive to coastal issues and processes, their purpose is essentially more narrowly based than would be the case for integrated coastal zone management. The objective is rarely, if ever, to establish what are sustainable activities in the coastal zone, their appropriate intensities of use, and to establish plans and a

process to achieve them. In other words, if this is to be a principal objective of coastal zone management for SIDS, then we must look at other examples to discover possible models for the introduction and achievement of coastal zone management in ways that are appropriate for the special circumstances of the small island developing states.

There are a small number of projects designed specifically as ICZM projects in a few small island developing states. These tend to be one of two types – either a comprehensive island-wide project, or a pilot project focusing on a particular or representative area. For example, Barbados is nearing completion of the development of a feasibility study for the preparation of an ICZM plan for the whole island. Examples of the pilot project approach are beginning in Western Samoa under the South Pacific Regional Environment Programme (SPREP) and New Zealand bilateral assistance. While it is too early to judge the success of these projects, nonetheless they are attempts to make integrated coastal zone management relevant to the particular circumstances of small island states. All are characterized by being designed to cope with the full range of coastal issues, and not driven by a particular sector or resource problem. They are also characterized by particular emphasis on institutional arrangements and the process of development and implementation, and especially the role of local communities and levels of decision-making and management. At least some of them are attempting to identify sustainable coastal activities and their appropriate intensities of use.

In the Pacific, Western Samoa has developed an approach to villages that seeks to fulfil the special requirements of this particular small island developing state in an appropriate way. This acknowledges that:

- i) The individual village is the primary authority for coastal resource management;
- ii) Government authority for the overall approach is an essential first element;
- iii) The *process* of beginning discussion with the villages and introducing information as a basis for discussion aimed at reaching an agreement to work together towards common objectives is critical and the key focus of project development;
- iv) The sustainability of the project, and indeed long-term coastal management, depends upon exploration and assistance in the development of sustainable levels of appropriate development; and
- v) The development of a mutually acceptable and culturally appropriate mechanism for the implementation of coordinated management both in and between villages.

One further mechanism for the development of appropriate ICZM is also currently being experienced in several of the oceanic regions of the world. These are integrated management strategies. In the Pacific Islands region they are called National Environment Management Strategies (NEMS), and are an example of a regional approach, with the initiative coming from the South Pacific Regional Environment Programme. These strategies seek to consider all environment and development issues

and, following an integrative analysis of the national situation, propose integrated, sustainable development strategies. Clearly for Pacific Island SIDS such a strategy incorporates integrated coastal zone management, but takes it further in the sense that it also includes macro-economic analysis and other such over-arching development issues. Each NEMS does, however, consider coastal issues, and most specify the needs and programmes of integrated coastal zone management.

5.2 Constraints and opportunities

A relatively comprehensive listing of the special constraints on sustainable development of the small island developing states has been proposed by Griffiths and Ashe (1993). Table 4.2 is adapted from this listing, with some special characteristics relating to the institutional capacity for ICZM included.

TABLE 4.2

ISLAND CHARACTERISTICS AND THEIR CONSTRAINTS ON SUSTAINABLE DEVELOPMENT

ECOLOGICAL/ENVIRONMENTAL CHARACTERISTICS

- * small size
- * narrow range of natural resources
- * limited and fragile resource base that allows less room for error in its utilization and management
- * susceptibility to natural environmental events (earthquakes, hurricanes, cyclones, typhoons, etc.)
- * little natural organic biological diversity
- * distance from continents and external competition fosters species endemism
- * generally little overall climate variability, but potential for climate upsets
- * tendency towards ecological instability when isolation is breached
- * abundance of marine biodiversity and similarly high rates and number of species due to environmental change

GEOGRAPHICAL CHARACTERISTICS

- * relative isolation
- * a completely circumferential sea frontier and EEZ, giving a high ratio of ocean space to land
- * extensive land-sea interface which increases the fragility of coastal ecosystems and the demand for coastal zone management
- * no interior hinterland or central terrestrial core area that is essentially distant from the sea such that coastal resource planning and management are essentially synonymous with national resource planning and management
- * dominance of the sea and its use for shipping makes these countries particularly vulnerable to hazards associated with international shipping and waste disposal
- * small land mass to ocean space makes islands especially vulnerable to global environmental phenomena such as sea level rise

TABLE 4.2 (con't)

SOCIO-ECONOMIC CHARACTERISTICS

- * extreme openness of their economies (external relations of trade, aid technology flows and investment)
- * more dependent on foreign trade than larger countries and having less influence on the terms in which that trade is carried on
- * extreme dependence on the external sector (other states, and agencies and large translational corporations)
- * low economic resilience in recovering from shocks
- * intimate association/relation between economic development and environmental assets
- * a narrow range of skills and specific difficulty in matching local skills with jobs

INSTITUTIONAL CAPACITY FOR ICZM

- * likely to lack technical expertise in-country
- * likely to have poorly developed institutional systems to manage ICZM
- * may have disjunction between national and local decision-making
- * may have poorly developed planning ethic
- * may have government decision-making reflecting authoritarian and hierarchical cultural systems (i.e. not participatory)
- * small overall size of individual islands may be offset by non-ecologically based units of local administration, the management of which can be highly parochial
- * concepts behind ICZM may be quite alien and cut across established/traditional practice

Source: Adapted from Griffiths and Ashe 1993:279.

It is not sufficient strategy, however, to simply look at constraints when considering the adaptation of integrated coastal zone management concepts of the developed, continental nations to the SIDS context. While it is important to recognize constraints to this process and plan to overcome or avoid them, it is equally, if not more important to recognize those unique features of small island states which offer particular opportunities for the development of appropriate models for integrated coastal zone management in small island developing states. The following list includes those features of Pacific Island SIDS considered to be particularly significant in this context. Other regions and/or small island developing states may find that for them a slightly different listing better fits their particular circumstances. The opportunities:

- i) Small island developing states will generally exhibit a high level of community involvement in resource management across the coastal zone. This is partly because of the restricted size of island coastal zones, but also because of the involvement of people in organized families and wider communities in the range of resource management activities from ocean to water catchment. Small island developing states with a high level of subsistence economic activity and especially those with strong customary land and marine tenure systems will be particularly involved in land and resource management.
- ii) Small island developing states with strong indigenous cultures also have traditional, and therefore widely accepted and appropriate, decision-making

and management mechanisms for natural resource management. While some of the concepts of integrated coastal management may be new to such authorities, many will have mechanisms that may not have been used for some time that can adapt to new circumstances. This is a distinct advantage over Western cultures where local resource management is vested in organizations and institutions with a less intimate connection with their immediate environment.

- iii) Most SIDS demonstrate a high degree of subsistence use of coastal resources. This dependence on local resources should be able to be translated into a vital interest in, and commitment to, their sustainable development and conservation management.
- iv) Many island cultures and communities are more closely attuned to the concepts of family and community, which will generally assist an easier understanding of the importance of allowing for the needs of future generations.
- v) Sustainable development is a goal which requires active community participation and commitment. Most small island developing states are well placed to manage community debate and decision-making, being generally more structured and active in this regard compared to the majority of large developed countries.
- vi) The areas of concentrated human impact on coastal resources in most SIDS are relatively small. In addition, the range of human activities is likely to be somewhat less than in more populous developed countries.

6. Integrated coastal zone management and small developing islands

6.1 The need for integrated planning and management

The need for an integrated approach to coastal and marine management has been investigated and documented for a number of areas, but rarely in the small island developing states. Kenchington and Crawford (1993:112-115) note a number of studies and reports for the US, Australia, Indonesia, Europe and the Mediterranean, which identify the issues and problems necessitating integrated planning and management. They conclude that the problem is that sector-based, short-term, small area management systems do not address the broader issues of ecological sustainability and long-term community interest. A need for coordination or integration of decision-making at the sectoral and local level was recognized (Kenchington and Crawford 1993). It is that sectoral approach, which until relatively recently, had been the model inherited from and/or imposed by the developed, continental countries, and proven to be ineffective in the long-term, especially in SIDS. In many small island developing states it is obvious that the special issues facing small developing islands (outlined above) have not been adequately addressed by past and most current management strategies.

There has recently been a general increase in international awareness of the need for integrated coastal zone management since the IPCC process started and UNCED was held. This is exemplified by the proliferation of literature on integrated coastal zone

management, especially guidelines by international agencies (e.g. World Bank 1993; OECD 1993; Chua and Scura 1993, Clark 1992). The statement emanating from the World Coast Conference on Coastal Zone Management recognized the urgency and '...need for coastal states to strengthen their capabilities for ICZM, working towards the development of appropriate strategies and programmes by the year 2000.' (World Coast 1993:4).

The greatest need for integrated coastal zone management programmes appears to be in the developing nations, and especially in the small island states. Sorensen (1993) has identified five arguments for ICZM in developing nations which are equally compelling for the small island states. They are: the maintenance of coastal zone dependent fisheries' productivity; coastal aquaculture development; increasing coastal tourism revenues; sustaining mangrove forestry; and avoiding costs associated with natural hazard devastation. He further suggests six reasons why coastal countries are not considering integrated coastal zone management: '...the issues are not of significant magnitude to force coastal management onto the national or state agenda; opinion leaders are not aware of the ICZM concept and its potential benefits; insufficient political stability of the national administrations; insufficient economic resources to initiate new programs; availability of alternative national programs to achieve integrated coastal zone management objectives; and the lack of support by international assistance institutions.' (Sorensen 1993:55).

The urgency for some model or form of successful coastal management has escalated in most small island states as population and development related environmental pressures have also increased. The economic, environmental and social costs of not adopting an integrated approach to management and planning far outweigh the costs of developing such a process. However, the problem facing small island developing states is to identify appropriate approaches and/or methodologies for integrated coastal zone management that are applicable to their circumstances and perspectives.

6.2 ICZM development in the small developing islands context

As noted above, it is as important for small island developing states that integrated coastal zone management reflects the particular island circumstances and the ethics and directions of development initiatives in developing countries, as it is to seek to reflect developed countries' models of ICZM. That is, SIDS problems require SIDS solutions. The challenge for sustainable SIDS ICZM under such circumstances, therefore, is to bring together the essential concepts of integrated coastal zone management in ways which meet community and cultural needs and aspirations. This will dictate a largely *process-oriented* approach, but the bottom line is that unless this is achieved there will be only a limited possibility of interesting, involving, and committing the very communities whose actions are at the centre of the coastal management equation and who dictate the day-to-day resource management over their part of the coast. Nonetheless, the challenge for traditionally-oriented small island developing states is considerable: to put in place appropriate and acceptable new structures to assist local authorities to appreciate, manage, and cooperate/coordinate

with each other to meet the new threats. The positive side of this is that many such small island states are living examples of traditional cultures successfully and continually adapting to modern circumstances.

The level at which integrated coastal zone management in small islands states should be developed needs to be identified. Fully national programmes may be the most appropriate for some countries, but for others, especially those with strong customary tenure systems, may find it more effective to begin at the sub-national/community level – that is, at the level of cultural appropriateness. The scale at which success is most likely should be the entry level for establishing ICZM in small island developing states. However, no matter what the entry level is determined to be, it will be extremely beneficial to have official sanction from the highest possible political level.

For small island developing states with dominant traditional cultures, such as in the Pacific Islands region, a different conceptual approach to ICZM development should be encouraged. The customary systems, structures and processes should form the basis of integrated coastal zone management, and it should be developed around those systems, rather than merely including customary processes into ICZM, as tends to be currently attempted. Such an approach would require the *initial* development and implementation of integrated coastal zone management to be based on the scale of the most 'effective management unit', be it the village, district or whole island level. This type of approach may in the short-term be slower and more difficult to develop, but it should in the long-term prove to be far more effective, especially when scaled up to encompass larger areas.

Although it is extremely clear that there is no 'one solution' to developing ICZM in small island developing states, there are, however, certain principles which should be adhered to. The following principles were among the recommendations contained in UNCED's Agenda 21 action programme, and highlighted in the Noordwijk Guidelines (World Bank 1993), they are:

- i) The precautionary principle;
- ii) The polluter pays principle;
- iii) Use of proper resource accounting;
- iv) The principle of trans-boundary responsibility; and
- v) The principle of intergenerational equity.

In developing an integrated coastal zone management project for the Pacific Islands region, SPREP felt it was important that the linkages between the regionally identified principles for sustainable development and those for integrated coastal zone management be made. The principles adopted were:

- i) The needs of present generations must be met in a sustainable manner without compromising the ability of future generations to meet their own needs;

- ii) Equity in participation must be promoted in sustainable development;
- iii) Adverse environmental impacts of economic development must be minimized;
- iv) The precautionary principle must be taken into account;
- v) Policies relating to resource use and development planning must integrate environmental, economic and social considerations;
- vi) Pacific island governments need to uphold their international responsibilities, as should the international community towards the Pacific islands region;
- vii) The culture and traditions of the region must be taken into consideration.

The current development of ICZM approaches in small island developing states has occurred over time and with each being able to draw on information of relevant past experiences. One of the most recent developments has been the preparation of regional integrated coastal zone management projects. South Pacific Regional Environment Programme is currently seeking to implement its regional ICZM project, the Caribbean Environment Programme is believed to be also preparing such a regional project. Others such as the Mediterranean 'Guidelines for Integrated Management of Coastal and Marine Areas' are also under action.

It is apparent that there are a number of critical regional needs which combine to give rise to the need for such a regional approach. At both a regional and sub-regional level there are:

- i) Substantial commonalities in terms of island socio-cultural, economic and ecological characteristics;
- ii) Similar infrastructural and human resource needs for the development of appropriate country ICZM; and
- iii) Similar information needs with important benefits to be gained from shared basic resources, capability to deliver translated and targeted information, networking between small island developing states in the region and with developed country experience and practice, delivery of appropriate training and human resource development programmes.

In addition regional organizations have the appropriate status with member governments to bring the basic concepts of integrated coastal zone management before senior politicians in ways that national public servants are perhaps unable to access. This is a most significant component of the SIDS effort, because while it is vital that local communities and decision-making be centrally involved in the process, it is the government politicians who are the ultimate decision makers in terms of project acceptance and compliance for the large national development projects. They are also the respected elder statesmen of their culture and wield considerable influence which may not be amenable to advice from within the public service.

Of vital importance for establishing integrated planning and management in the small island developing states are the 'triggers' in-country that start the process. Ideally, the process should originate from within rather than from outside. The Noordwijk Guidelines (World Bank 1993:11-12) touch on this:

'Any one of a number of problems can trigger the need for a more effective, better integrated approach to the management of a given coastal area, that is, for ICZM. Typically, some major crisis or event precipitates action by awakening the stakeholders as to the urgency of a problem or condition. Governments then become involved and seek ways to remedy the problem. Unfortunately, given human nature, a decision to embark upon a major management strengthening and improvement effort such as the ICZM process, is seldom undertaken in advance of the appearance of major problems and/or conflicts in spite of the fact that the problems are likely to be more tractable and solutions less costly at an earlier stage. Many coastal problems are not calamities but creeping disasters such as pollution, erosion and disappearance of biodiversity.'

In the SIDS situation, the 'creeping' disasters would tend to manifest themselves faster than in the continental situation, and the resultant 'disaster' proportionally greater in effect, due to the small island size (i.e. proportion of total habitat and population affected). Many of the 'creeping disasters' listed above are already at a critical level within many small island developing states. However, any solution will also tend to be similarly affected by the small size – it should be possible to notice the effects of integrated planning and management more rapidly than would be expected in the developed, continental situation. The size and nature of many small island states make the concept of integrated management a feasible one.

Over the years there have been a vast number of coastal management plans, including some of an integrated nature, prepared for (rarely by) small island developing states. The great majority of these plans have languished on shelves gathering dust or growing mould through either the lack of an appropriate process or simply because they were inappropriate. The development of appropriate plans for integrated coastal zone management (as proposed in this paper) will also suffer the same fate unless the next step – implementation – is taken.

6.3 Implementation needs

The two keys to any coastal management and planning process, including ICZM, are (i) implementation, and (ii) monitoring and evaluation. There are very few examples of effective implementation of coastal management plans, let alone ICZM, in the small island developing states. Successful implementation of integrated coastal zone management in small island developing states will require, at least: education and awareness programmes; capacity building (institutional and human); long term stability (funding and institutions); and appropriate methodologies.

Education and awareness are essential components for developing and implementing ICZM programmes anywhere. The initial targets should preferably be the

decision makers at all levels. It is this group that needs to fully understand the consequences of their actions and policy decisions on the coastal zone. In many small island developing states in the Pacific, the traditional decision makers tend to be very conservative and reluctant to adopt new or different ideas, especially at the local community level. Public awareness campaigns in formats appropriate to the country concerned will also be essential. It is with these campaigns that innovative approaches should be encouraged.

One of the main tenets of this paper is that 'appropriate' methodologies and approaches must be adopted and used for effective ICZM to occur in small island developing states. What is deemed appropriate will vary considerably between small island states. As for the development of integrated coastal zone management in small island developing states, it will be the *process* of implementation that is critical. For example, in the Pacific Islands region the decision-making processes involve a considerable number of meetings – both as a means to provide information, as well as the prime means to arrive at a consensus decision. This is reflected in the considerable emphasis on meetings and workshops in the regional ICZM project developed by SPREP. This is the 'Pacific Way', and may be inappropriate for other regions or small island developing states, but in any case it will be flexibility, not rigidity, in implementing integrated coastal zone management in SIDS that is required.

There has been much discussion of 'top-down' versus 'bottom-up' approaches to implementing integrated coastal zone management. This apparent dichotomy of strategies is rather misleading and unproductive. The 'bottom-up' approach that SPREP uses in the Pacific islands region also involves top level sanctioning. SPREP has found that it is essential to receive approval to proceed from the highest political level, particularly when operating at the 'grass roots' level. The implementation approach adopted will obviously vary from one small island developing state to another. For example, in Singapore it has been found that the 'top-down' approach is the most effective (Scura *et al.* 1992).

It has been well recognized that capacity building of both institutions and human resources is essential for effective implementation of integrated coastal zone management in small island developing states. At the national level this would include the establishment or strengthening of institutional, administrative and legislative arrangements for integrated coastal zone management. Capacity building for the planning and implementation of ICZM may also include the strengthening of regional and international networks, in particular, between SIDS; identifying ways of involving NGOs and other major groups in the ICZM process; and adequate resources for education and awareness as well as for the development of appropriate methodologies and tools referred to above.

As noted earlier in the paper, the majority of coastal management and planning activities to date have been funded by sources external to the small island states. This funding has more often than not been for a set period, usually of one to three years' duration. External sources of funding will be essential for developing and especially implementing integrated coastal zone management in most small island states. Herein

lies one of the key problems with ICZM implementation in small island developing states. As most external funding is for a finite period with no guarantee of renewal, once that funding stops then the country needs to be capable both financially and institutionally to carry on with the implementation and the evaluation and modification process. Essential to the development of ICZM programmes in small island states is the recognition of the need for long-term stability in the programme. Integrated coastal zone management is not a one-off project, it needs to be viewed as an integral part of long-term government procedures. It will obviously be important to look at means to generate income for long-term integrated coastal zone management, including such concepts as polluter/user pays.

In this paper we have provided an overview of some of the issues that need to be taken into account when developing integrated coastal zone management in small island states. It is by no means comprehensive, and the issues will vary in importance from state to state. The concept of integrated coastal zone management should be viewed as promoting the sustainable development of coastal resources. In the context of small island developing states, integrated coastal zone management is essentially synonymous with integrated island management. The following section sets out recommendations which we feel are important for promoting and establishing integrated coastal zone management in small island developing states.

7. Recommendations for future action

7.1 Role of the Barbados Conference

The Barbados Conference should:

- i) Promote the development of integrated coastal zone management appropriate for small island developing states as a matter of urgency;
- ii) Support the development of regional and sub-regional projects to assist small island developing states to carry out this task.

7.2 National and sub-national level

In initiating integrated coastal zone management the small island developing states should:

- i) Be carefully and deliberately tailored to the particular ecological, social, cultural and economic characteristics of small islands;
- ii) Be strongly oriented towards the process of achieving plans and strategies;
- iii) Initially aim to develop and implement integrated coastal zone management at the level of the most effective management unit;
- iv) Seek to assist and complement traditional or existing decision-making and management bodies rather than try from the outset to introduce new and alien structures or try to replace existing ones;

- v) Seek to define what human activities and intensities of use are sustainable in the coastal zone and provide strategies to achieve them;
- vi) Be broadly participatory and afford appropriate authority to local communities;
- vii) Take into account a broad definition of the coastal zone and include activities inland of the coastal areas by promoting less damaging development practices;
- viii) Deliver appropriate information material on climate change and other technical topics to decision makers and the public;
- ix) Encourage the early ratification or accession to the Framework Convention on Climate Change (FCCC) and develop appropriate protocols (e.g. carbon dioxide reduction protocol initiated by AOSIS) and become parties to other legal environmental agreements;
- x) Increase national scientific monitoring and research capabilities of climate change impacts, to support the adoption of appropriate adaptive measures and policies and development of response strategies to mitigate impacts of climate change and possible sea level rise;
- xi) Adopt the precautionary principle, especially in the context of climate change and sea level rise.

7.3 Regional level

Regional and sub-regional organizations should:

- i) Establish regional and sub-regional integrated coastal zone management programmes to promote and assist small island developing states to prepare and implement appropriate national or sub-national ICZM programmes;
- ii) Develop technical assistance programmes to assist small island developing states with integrated coastal zone management;
- iii) Develop public education and awareness information to assist SIDS to reach both decision makers and public/local communities with appropriate and innovative education and awareness programmes;
- iv) Develop networks to link small island developing states with each other and with other sources of relevant information;
- v) Develop and implement programmes for informing and persuading SIDS leaders to adopt ICZM approaches appropriate to their circumstances and to ensure government commitment to them;
- vi) Funding for the integrated coastal zone management of the small island developing states should be coordinated, where appropriate, via regional and sub-regional programmes to ensure that the most appropriate approaches are taken in individual small island states, and comprehensively supported in terms of technical advice, information and project funding.

- vii) Collect and disseminate information on climate change between small island developing states in order to improve understanding of present and potential impacts of climate changes;
- viii) Develop and enhance programmes and projects to monitor and improve the understanding of climate change, variability and sea level rise to assess the impacts of climate change on coastal areas and activities;
- ix) Provide technical assistance for ratification and develop appropriate protocols in the FCCC to meet their commitments.

7.4 International level

- i) To continue to advocate in international fora and with the international aid donor community, the special needs of integrated coastal zone management for small island developing states and the need for different approaches as proposed in this paper;
- ii) Recognize that integrated coastal zone management is a long-term process which will require continual monitoring, evaluation and modification, and therefore ongoing international support;
- iii) Encourage funding and other assistance that enables ICZM capacity building (both institutional and human resources) to ensure the long-term stability of ICZM programmes in small island developing states;
- iv) Support regional and sub-regional organizations to assist small island developing states in developing integrated coastal zone management and to cope effectively and creatively with climate change issues;
- v) Develop appropriate protocols for FCCC and immediately implement the convention;
- vi) Provide improved access to information from the activities carried out to reduce uncertainties of climate change and assist inter-island exchange of the information.

8. Acknowledgements

A number of people contributed to the development of this paper. They were: Vili Fuavao (Director, SPREP, Apia, Western Samoa); Andrew Smith (Coastal Management Officer, SPREP); Roger Cornforth (Environment Planning Advisor, Div. of Environment and Conservation, Dept of Lands, Survey and Environment, Apia, Western Samoa); Gerald Miles (Sustainable Development Officer, SPREP); and Chalapan Kaluwin (Climate Change Officer, SPREP).

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CASE STUDY V

A STUDY OF THE EARLY WARNING CAPABILITIES OF THE CARIBBEAN METEOROLOGICAL ORGANIZATION AND THE CARIBBEAN DISASTER EMERGENCY RESPONSE AGENCY

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1. Introduction

Because the scope of this study entailed only one visit to one country (Barbados) in the region, this survey cannot truly speak for each nation nor the entire region. Recognizing this limitation, this study does not represent itself as being comprehensive. It is, rather, an exploration of the institutional capacities of two principal regional coordinating bodies: the Caribbean Meteorological Organization (CMO) and the Caribbean Disaster Emergency Response Agency (CDERA). Where possible and appropriate, the study identifies opportunities to enlarge the base of collaborators which might be included in the planning process leading to the strengthening of the environmental and natural disaster warning capacities in the Caribbean.

In many respects, the objectives of Caribbean Meteorological Organization and Caribbean Disaster Emergency Response Agency can serve immediately as model objectives for other island regions of the world. As these institutions continue to develop their capacities, including both technical and human infrastructure, it is expected that this will continue to be the case. With specific regard to the Caribbean, strengthening the preparedness and response capacities of CMO and CDERA – and their national constituents – will lead to a sustained growth and measurable success in the ability to prevent, or mitigate the effects of, natural and environmental disasters that frequent the region with increasing regularity.

The scope of this study was to develop recommendations for the possible enhancement of a technical system for early warning in the Caribbean. The challenge in applying technology to emergency management, however, is not only a question of the suitability or availability of the technologies themselves, but it is also, importantly, the development of the relationships among the users of these technologies. In order for any information technology tool to be effective, it must operate in an environment of interpersonal and inter-institutional cooperation. Creating this environment requires attending to certain challenging non-technical concerns. These issues are substantive, procedural, and political/organizational. They are crucial to the success of this

¹ Paper written in cooperation with C.E. Berridge, Executive Director, Caribbean Meteorological Organization, Trinidad, and Jeremy Collymore, Regional Director, Caribbean Disaster Emergency Response Agency, Barbados.

enterprise. They must be developed and nurtured in concert with the development of technical systems.

2. Background

During recent years the frequency and magnitude of major disasters – of natural, technological, or ecological origin – have made the world community dramatically aware of the immense losses of human life and economic resources that are caused by such calamities. Particularly hard hit are developing countries. The magnitude of disasters frequently outstrips the ability of these societies to cope with them.

Of these societies, small island developing states are prone to extremely damaging natural disasters, especially in the form of cyclones, volcanic eruptions and earthquakes. For some of these island states, the range of disasters includes storm surges, landslides, extended droughts and extensive floods. A study by the United Nations Disaster Relief Organization (which has since become the United Nations Department of Humanitarian Affairs) identified 13 of the 25 most disaster-prone countries to be small island states. In part due to climate change, such events are perceived to be occurring with increasing frequency and intensity. These natural disasters are of especial concern to small island developing states because of their small size, narrow resource bases and the pervasive impact of such events on their economies. These catastrophes, of course, usually serve as an excuse for the loss of insurance coverage. For those persons and societies affected by these disasters, the economic, social and environmental consequences are long-lasting and the costs of rehabilitation as a percentage of gross natural product are high. Thus, the natural, and environmental, disasters are apt to be severe.

Throughout the Caribbean, disasters such as hurricanes and floods have through time a most destructive history. Though occurring less frequently than other natural phenomenon, volcanic eruptions, earthquakes, and tsunamis also represent a threat to this region.

A single hazardous event can destroy social and economic infrastructures that have taken years to develop and upon whose vitality local and national economies depend. Frequently it is the case in developing countries that the capacities of these infrastructures are strained to manage even the most basic of social and economic development programmes in normal times. A single disaster can severely disrupt the community lifelines that provide for food distribution, water supply, health care, waste disposal, and communication locally and with the rest of the world.

In order to develop to their fullest potential, countries in the Caribbean, and other island states throughout the world, need sustained periods of social and economic development. Major impediments to this development are disasters which often result in an affected country shifting its economic policies to the supply of basic goods required to cope with the disaster response and subsequent reconstruction. These shifts can exhaust scarce resources and intensify a country's financial imbalances.

In many cases these situations can be prevented. Frequently the difference between saving life and property is an effective warning of an impending disaster. Timely warning of a major natural hazard can reduce its consequences: at least, people may have enough time to save their lives; at most, they have an opportunity to relocate or otherwise protect their property.

Further, a disaster-resistant telecommunications network, and an associated campaign of public communications and awareness, can be vital to mitigation and relief operations for all rapid-onset hazards.

Similarly, access to timely information through a regional network also enhances preparedness and mitigation efforts for long-term hazards such as drought and insect infestation, and man-made hazards such oil spills and chemical accidents.

There are alternatives to periodic catastrophic disaster events. Research has shown that in some regions of the world there is a correlation between advanced planning and preparation and the saving of lives and property. The integration of terrestrial and space technologies into planning schemes has been an important key to this. Consider, for example, that between the 30-year period 1900-1929, hurricanes killed more than 10,000 persons in the United States. In the 30 years from 1945-1974, fewer than 2,000 persons died from such tropical storm activity. This impressive gain was achieved with the aid of better warning and forecasting systems and their effective integration into various phases of emergency planning.

At present most small islands have rudimentary environmental early warning facilities and are, as a consequence, seriously handicapped in their efforts at disaster preparedness, prevention and relief.

This has been the case in the Caribbean. There is evidence, however, that this situation is changing rapidly. This change has been made possible by a demonstrated willingness on the part of governments and institutions to cooperate on a regional basis. It is the belief of the team which undertook this study that a continuing programme of strengthening regional coordination and nurturing national capacities to prepare and respond will lead most rapidly to an effective environmental disaster early warning system.

To be most effective this regional 'system' should be viewed as a technical, institutional, and human infrastructure composed of national resources which have been forged, through collaborative planning, into a regional cooperative, thereby making the whole larger than the sum of its parts. Because this is the case – and while it is imperative that the sovereignty of each nation is respected – funding and political impetus for natural disaster and environmental warning programmes can be derived from a coalition of broad government, public, and private sector support and directed toward a programme of regional cooperation.

This study has focused on two such regional programmes in the Caribbean: the Caribbean Meteorological Organization (CMO) and the Caribbean Disaster Emergency Response Agency (CDERA). Each of these associations is a regional coordination mechanism made up of national institutions which both contribute to and benefit from regional collaboration.

In many respects, the objectives of these two organizations can serve immediately as models for other island regions of the world and that further strengthening the preparedness and response capacities of Caribbean Meteorological Organization and Caribbean Disaster Emergency Response Agency and their national constituents will lead to the sustained growth and measurable success in the ability to prevent or mitigate environmental disasters that regularly frequent the region.

3. Caribbean Meteorological Organization and the World Meteorological Organization

The Caribbean Meteorological Organization is an intergovernmental organization of the English-speaking governments of the Caribbean which has as its major responsibility to develop and promote meteorology, operational hydrology and allied sciences. CMO coordinates all the meteorology in the region to minimize unnecessary duplication of effort and to maximize the use of limited resources. One of its primary functions is to provide severe weather watch and warning for tropical cyclones and hurricanes. More regularly, Caribbean Meteorological Organization provides regional meteorological, aeronautical, and marine watch services.

CMO is governed by the Caribbean Meteorological Council of Ministers and is funded by the member-governments. Caribbean Meteorological Organization maintains its headquarters at Trinidad and a training institute for hydrology and meteorology, the Caribbean Meteorological and Hydrological Institute (CMHI), in Barbados. It plays an active part in World Meteorological Organization (WMO) affairs, particularly with regard to severe weather in the region, and is an important partner in the WMO Regional Association Hurricane Committee.

The responsibility for providing severe weather watch and warning services for member countries in the region and its territorial waters rests with the national meteorological service of that country. Within the English-speaking Caribbean these national MET services are members of CMO. Data collection, information management, and warnings are carried out by these national meteorological services within the framework of World Meteorological Organization's World Weather Watch (WWW) Programme.

NOAA's National Hurricane Center in Miami is designated as the specialized meteorological centre for Region IV. In this context it has the responsibility for providing advisory services on hurricane detection, monitoring, and forecasting to the national meteorological services of the Region IV, including the participating members of the Caribbean Meteorological Organization.

In fulfilment of this responsibility NOAA provides information from the National Weather Service (NWS) to Caribbean countries participating in the Antilles Meteorological Network (ANMET). Historically, the National Weather Service in Washington, DC has been connected to the participating ANMET station in San Juan, Puerto Rico via a multiplexed voice grade satellite circuit. From San Juan, however, the circuit is carried, less reliably and at low-speed (75 baud), via various terrestrial modes to other participating ANMET sites in the Eastern Caribbean.

Substantial progress has been made in the past decade in improving the hurricane warning services for each county through regional cooperation and coordination under the programme of the Region IV Hurricane Committee. The Committee is a regional body of the WMO's Tropical Cyclone Programme and a working group of Regional Association IV for North and Central America and the Caribbean.

The Hurricane Committee has annually reviewed the previous hurricane season and upgraded or updated its operational plan based on this review. However, while the organizational arrangements have attained a high level, and substantial progress has been made in areas such as training of staff of the national services, the rate of progress in implementing or upgrading facilities has been slow, mainly due to lack of resources. The committee identified meteorological telecommunications in the southern part of the Region as the weakest link in the chain. It unanimously decided that upgrading of the system using satellite communications and the associated introduction of micro-computer-based data handling in operational services should be the top priority item and a matter of urgency.

There are several factors which make the existing terrestrial telecommunications system vulnerable, including the susceptibility of the quality of performance to weather conditions, often deteriorating in bad weather conditions when it is most needed, and complete disruption that may be caused by a hurricane, as happened in 1989 while another hurricane threatened the area. Proven modern technology, which post-dates the installation of the present system, is available. Its use would circumvent nearly all existing shortcomings.

Additionally, it would permit further progress with the introduction, for the first time, of micro-computer (PC) based data handling, continuously updated database, data recall, processing and graphic display capabilities at each national centre to support the fullest use of the available products and forecast and warning services. The modernization of the operational meteorological services would greatly improve not only the seasonal hurricane warning service but also the whole range of meteorological activities. Their services include regularly issued weather forecasts, provision of severe weather and flash flood warnings, inputs to river flood forecasting, services to aviation, marine information, agriculture, and tourism. At the same time the flow of observational data from all parts of the region to the regional centre and to other parts of the world would improve.

To meet these goals the Hurricane Committee has proposed that the existing point-to-point terrestrial communication links be replaced with a satellite-based point-to-multipoint system and associated micro-computer-based data handling facilities at national centres. In March 1991 National Weather Service introduced a proposal for upgrading the ANMET network to a two-way Very Small Aperture Satellite (VSAT) system which will be called the Regional Meteorological Telecommunications Network.

VSAT technology permits use of small earth stations which, in a network consisting of several stations, can result in a system that is lower in cost and easier to maintain than its terrestrial equivalent. Further, and importantly, a VSAT network would be more reliable and resilient to conditions common during severe disasters. For example, if one site is damaged in a terrestrial network, it is typically the case that all sites in the chain from that point on are out of business too. Whereas in a VSAT network, if a site goes down other sites are not necessarily affected because of the casualty. Another advantage of a VSAT network is the ease with which additional sites can be added at any time.

The flexibility of a VSAT network also permits a 'mesh' network configuration where any site within the network can originate and receive transmissions at any time.

The point-to-multipoint distribution channel on the proposed VSAT network will be used for dissemination of the global and regional sets of observational data, processed information in digital form, as well as processed information in graphical form (coded digital facsimile), in accordance with a programme of transmission agreed upon between all national met centres concerned.

The receive/transmit satellite earth stations will be equipped with a relatively small size antenna and will be installed at participating national meteorological service premises. They will provide for direct reception of meteorological data and products from the World Meteorological Center and for global telecommunications system messages, including observational data, to the World Meteorological Center. The satellite earth station will be equipped with the ability to connect, through standardized means, with a variety of terminal equipment, including computers, printers, and digital facsimile.

The multipoint-to-point channel will be used by the World Meteorological Center to collect observational data from and for the reception, in Washington, of messages from the various national meteorological centres required for the efficient operation of the World Weather Watch system.

The proposed satellite-based regional meteorological telecommunications network will have the following capabilities, (thereby meeting the requirements of the global telecommunications system in Region IV):

- i) One main (hub) satellite earth station, controlled in Washington by the World Meteorological Center, providing for the distribution of data and products to

national meteorological centres and reception of data originating from national meteorological centres;

- ii) Satellite transponder capacity, leased from a commercial satellite covering the region, which provides for carriage of the distribution channel (4800 bps - 9600 bps) *to* national meteorological centres and the collection channel (1200 bps) *from* the national meteorological centres; and
- iii) Transmit and receive satellite earth stations located at a number of the region's national meteorological centres.

With some overlap in coverage by the Central American meteorological network (also a responsibility of Region IV), VSAT earth stations will be located at meteorological centres at Antigua, Bahamas, Barbados, Curacao, Dominican Republic, Jamaica, St. Martin, St. Lucia, Grenada, Trinidad, Haiti, Belize, Guadeloupe, Guyana, Martinique, and Cuba.

At this time, there are no firm costs for the VSAT earth stations nor for the satellite space segment, though bids from vendors are currently being received. NWS's estimate for the cost of the upgrade is, at a minimum, US\$ 130,000 (one-time) expenditure for each VSAT site. This cost will be supported by the World Meteorological Organization through its voluntary contribution programme. Each participating country will be expected to pay for the recurrent cost of the satellite time.

Because of cost, not all countries of the Caribbean will be two-way VSAT sites. Some of the centres which will be equipped with two-way VSAT capability will also serve as 'gateways' to nearby smaller counties. In these cases, it is anticipated that low-speed leased circuits will link larger systems with their smaller counterparts.

4. National disaster management and regional coordination

4.1 National disaster organizations (NDOs)

Although the heads of government of the Caribbean Community (CARICOM) recognize the value of regional cooperation in disaster preparedness and response, the principal of national sovereignty is honoured, and it is expected that each national government is ultimately responsible for its own disaster management. In this context, each participating state has been encouraged to undertake the following obligations:

- i) Establishing and maintaining national relief organizations capable of responding swiftly, effectively and in a coordinated manner to disasters in participating states;
- ii) Establishing emergency disaster planning groups and defining national policies and priorities in the event of disasters;

- iii) Providing national relief organizations with adequate support including named emergency coordinators, liaison officers with key ministries, emergency services, utilities, and the like;
- iv) Tasking the named agencies (including the emergency services, health and public works) and their coordinators with specific functions and responsibilities to ensure the development of an adequate response capability to support national disaster action;
- v) Defining the role and functions of key agencies such as security services, health and public works in disaster emergency response management and establishing a system for regular review of their procedures for coordinated response;
- vi) Establishing and equipping a suitable emergency operations centre capable of handling emergency telecommunications and coordinating emergency responses involving many services;
- vii) Developing and maintaining an emergency telecommunications system based on the most appropriate technology to ensure the coordination of emergency operations involving the emergency services mentioned above as well as voluntary private sector services;
- viii) Establishing and strengthening procedures for coping with major disaster threats and scenarios and reviewing systems for testing the procedures by drills and simulations;
- ix) Reviewing and rationalizing legal arrangements for disaster mitigation and emergency action;
- x) Reviewing and cataloguing past disaster events, listing credible future emergency event scenarios, identifying and mapping areas with special problems like floods and landslides;
- xi) Establishing databases of key resources, both human and material, and a system for keeping them current and computerizing and integrating them into an automated emergency information system;
- xii) Developing, in collaboration with competent government agencies, an emergency shelter policy and programme involving the full participation of local officials in community-based organizations;
- xiii) Developing and reviewing a system for community participation, local mobilization and counter-disaster action in the event of isolation;
- xiv) Developing strategies for loss reduction in the public and private sectors focusing on vital economic activities and life-line activities like water supply;
- xv) Developing a system and procedures for damage assessment in order to facilitate rapid and effective post-impact evaluation;
- xvi) Developing and implementing a comprehensive disaster public awareness, information and education programme involving media houses, schools, voluntary agencies and other institutions in order to ensure public participation and community involvement in the disaster management system; and

- xvii) Developing and implementing appropriate training programmes for persons involved in the disaster management system.

4.2 Caribbean Disaster Emergency Response Agency

Because of the perceived value of regional cooperation, and because of the frequency and intensification of natural disasters – particularly severe weather – affecting the region, CARICOM established the Caribbean Disaster Emergency Response Agency (CDERA) in 1991 to provide effective and coordinated relief assistance to affected countries. The Caribbean Disaster Emergency Response Agency has the following objectives:

- i) To make an immediate and coordinated response by means of emergency relief to an affected member state;
- ii) To secure, coordinate and channel to interested inter-governmental and non-governmental organizations reliable and comprehensive information on disasters affecting a member state;
- iii) To mobilize and coordinate disaster relief from governmental and intergovernmental organizations for affected member states;
- iv) To mitigate or eliminate, as far as practicable, the immediate consequences of natural disasters in member states; and
- v) To establish, enhance and maintain, on a sustainable basis, adequate disaster response capabilities among member states.

The regional disaster notification structure under which the Caribbean Disaster Emergency Response Agency operates calls for CDERA, in support of the affected country (and after having received warning from the national meteorological services, seismic research units, or airlines), to notify and maintain contact with the International Federation of Red Cross and Red Crescent Societies, the regional forces, the United Nations Department of Humanitarian Affairs/United Nations Development Programme, and relevant national and international airlines (each of these primary contact points has, in turn, the responsibility of contacting other institutions and organizations).

To accomplish these objectives CDERA requires the support of a clearly defined and reliable regional communications network. This 'network' must permit communications links, at a minimum, from the meteorological services, seismic units and airlines to CDERA, between Caribbean Disaster Emergency Response Agency and the national disaster organizations, and between Caribbean Disaster Emergency Response Agency and IFRC, regional forces, and DHA/UNDP. Further communications capabilities are required between CDERA and the support teams being used by CDERA to effect the regional response.

It is also necessary to ensure that each national disaster organization is capable of coordinating its own national effort, which will require the support of a similar communications network at a national level.

4.3 A review of national resources currently available to national disaster organizations

A March 1993 report of Caribbean Disaster Emergency Response Agency assessment mission to its member states reported the readiness capabilities of each national disaster organization to:

- i) Ensure the survival of its own communications control centre or relocate it if necessary;
- ii) Maintain communication with the national disaster organizations for quick restoration;
- iii) Provide alternate telecommunications facilities to critical agencies or to provide them with the necessary information; and
- iv) Ensure that information can be passed readily in both directions between the national disaster organizations and its various communities.

4.3.1 Survival of communications control centres (CCC)

Only four states had a dedicated communications control centre and only two of these appeared to have adequate equipment to perform effectively. The physical condition of all were reasonably good and appeared capable of surviving hurricane force winds and seemed safe against flooding. (This was not an expert opinion, and was based on observation only.)

All communications control centres were equipped with emergency power plants, however no one was able to give an estimate of the capacity of the fuel storage tank to support the plant at full load. (This is essential, and a two-week supply should be available).

There were no tools or hardware available to remount dislodged antennas. Nor were replacement whips available for temporary use. Two states were in the process of establishing dedicated communications control centres for which the above comments also appeared to be applicable.

Most states had no firm arrangement for an alternate communications control centre but all seemed ready to use the police radio room should the need arise. (This part of the plan was not detailed in the study.)

In general, the report identified the CCC capabilities as being inadequate for their intended use.

4.3.2 Ability to maintain communication

It is difficult to maintain regional communications even during normal situations. Although several high frequencies (HF) have been identified, these were either not used at all or not enough to permit 'capture' of the frequency. Since little, if any, useful traffic is passed on the net, it is not exercised enough and communications is only tested primarily in the mornings. Although scheduled roll calls take place, no follow-up action is taken if there is no response from a state.

A similar situation exists with the national emergency channel as far as scheduled roll calls are concerned. In many cases the radios are portables owned by another agency with that agency's emergency frequency programmed. In these cases, the radio is usually on the owner-agency's channel permanently. If the individual being called is not available, it is most difficult to get in touch with the agency by radio. It also appears that handhelds were not assigned spare batteries to ensure availability of a fully charged battery at all times. It was also noted that these portables have a very limited range without a repeater.

All national disaster organization networks are equipped with simplex capability which will allow limited coverage without the repeater, however, the capability to operate temporarily in a dispatch mode is not available.

Emergency power plants were not available at most of the national emergency operations centres and the Agencies' headquarters. In general, there was some measure of redundancy and security available to ensure radio contact with critical agencies.

4.3.3 Provision of alternate telecommunications facilities

It is essential that critical agencies maintain communications between their respective headquarters and sub-stations distributed within the country. In many cases communications with agencies is only available by telephone and, therefore, national disaster organizations must make provision for suitable facilities capable of satisfying their respective requirements. The health services and public works are two such organizations which regularly fall into this group. No details were available to indicate how these agencies will be accommodated.

It was also noted that shelters were not targeted for telecommunications facilities, even for the first seventy-two hours, and communities likely to be isolated have not been provided with facilities.

In most cases the national meteorological services have been provided with the capability of radio communications with their respective national disaster organization. However, there were no plans in place to allow the meteorological personnel access to weather data (raw or processed), should the normal methods of access fail. Some weather data is available 'off the air' and can be received with the assistance of a personal computer and printer.

4.3.4 Flow of information at the community level

The main resources available to adequately support community information are the broadcast radio stations, HAM radio operators, CB radio operators and, in some countries, operators of marine radios. Information these groups provide is vital and, in some cases, will only need one-way communications. These methods of communications were also identified as valuable for use by public broadcast radio stations which carry information on availability of shelters, warnings, (flooding, etc.) weather forecasts and other general information. The national disaster organization must be prepared to assist any station(s) for priority assistance to effect their recovery plan to put them back on the air as quickly as possible. A selected group of radio stations are all equipped with emergency power plants at both studios and transmitter sites.

Two-way communications between national disaster organizations and communities will include specific information from the field and associated institutions. This is primarily supported by HAM and CB radio operators. Although HAM operators are usually well organized, this is not typically the case with CB operators. A problem identified was that of providing reliable continuous power for both CB and HAM operators, especially when they are isolated in remote areas.

It was also considered possible to provide this level of communications from other networks such as fire and police departments, public utility companies, and private organizations. Although these would be more difficult to organize because they would be involved in their own normal activities, their availability for contingency plans is frequently overlooked.

Generally speaking, most resources existed in this area, however, a lack of detailed planning was evident.

5. Other sectors/regional organizations with responsibilities in the region

5.1 Marine pollution monitoring

Though planning has been underway for several years, at the present, environmental monitoring of marine pollution on a regional basis is in its infancy, and no operational system exists for regional environmental warning. The responsibility for this would come under the purview of another regional coordinating group, the Caribbean Environment Programme which is planning, under consultation with Caribbean Disaster Emergency Response Agency and the United Nations Environment Programme, to develop a 'regional marine pollution emergency information and training centre.' In the long term, the objectives of the centre will be to:

- i) Strengthen the national and regional preparedness and response capacity of the states and territories of the wider Caribbean region and to foster and facilitate cooperation and mutual assistance in cases of emergency in order to prevent,

control and combat major pollution incidents or cases in which there is grave or imminent danger of pollution to the marine and coastal environment;

- ii) Assist the states and territories of the wider Caribbean region – upon request – in the development of their own national capabilities to combat pollution from oil and hazardous materials and to facilitate information exchange, scientific and technological cooperation, and training and coordination for the provision of external government assistance from outside the region; and
- iii) Establish a computerized regional database to provide information on marine pollution accidents, and the nature of shortcomings, methods, techniques and resources available, for prevention, preparedness and response activities to facilitate regional cooperation in responding to pollution emergencies.

In the short term, the objectives of the Centre will be to:

- i) Collect and disseminate information on –
 - a) Inventories (both public and private) of national focal points, expertise, materials and emergency response equipment available in the states and territories of the wider Caribbean region for combating oil and hazardous materials spills;
 - b) Plans, methods and techniques used for combating pollution to assist the states and territories of the wider Caribbean region in the preparation of their national marine contingency plans; and
 - c) Sensitive areas in the states and territories of the wider Caribbean region vulnerable to pollution and recommended clean-up and disposal techniques which can be used with minimum environmental damage in such areas.
- ii) Provide technical assistance and advice in the preparation, exercising, periodic review and updating of national marine contingency plans, and updating of national marine contingency plans, in order to promote compatibility of those plans within the region, including the administration of the Caribbean Oil Pollution Preparedness and Response Cooperation Plan;
- iii) Develop and encourage technological cooperation and to assist in the development and publicizing of training courses and programmes for combating marine pollution from oil and hazardous material, including organizing the training of personnel;
- iv) Develop and maintain a communications and information system appropriate to the needs of the region being served by the Centre, including channelling of communications (i.e., pollution reports);
- v) Assist in strengthening the International Referral System by developing the capacity to serve as a regional focal point to collect and disseminate data on sources of information available in connection with pollution from oil and hazardous materials;

- vi) Develop and maintain close working relationships with other Caribbean regional activity centres as set out in the Caribbean Action Plan and to cooperate in all activities which are directed towards the prevention and reduction of marine pollution in the Caribbean;
- vii) Assist in the development of a memorandum of understanding (MOU) between the countries of the Caribbean region (at the ministerial level) to provide mutual assistance and communications to states and territories in a major pollution incident; and
- viii) Encourage states and territories of the region to develop mechanisms that would facilitate private commercial and non-profit oil spill response organizations in providing response services in the region.

5.2 Seismic research units

Throughout the states there are two major seismic research units, one in Trinidad and Tobago and the other in Jamaica. There is a local facility in St. Vincent capable of analyzing data on a limited basis.

In the Eastern Caribbean, data is gathered from the following states and analysed in Trinidad and Tobago: St. Kitts and Nevis, Antigua and Barbuda, Trinidad and Tobago, Dominica, Montserrat, St. Vincent and The Grenadines, St. Lucia, Barbados, and Grenada.

Information is communicated to Trinidad and Tobago via a combination of VHF radio links and the cable and wireless microwave network. Multiple sensors are located at most countries with spare units also in place. There are also redundant VHF links in place in some countries.

The Trinidad and Tobago station is equipped with a stand-by generator and a high speed switched battery back-up for computer operations. The cable and wireless links are considered fairly reliable but expensive. Investigations are currently being made to determine the feasibility of linking national stations via satellite. It is expected that this would improve the reliability and effectiveness of the system.

The seismic unit in Trinidad and Tobago is equipped with an HF radio link to the St. Vincent station and to meteorological offices in a number of countries.

5.3 National telephone companies of the region

CDERA reports that the level of participation in disaster planning by the local telephone companies is high, and that all national companies have a recovery plan and most have built in redundancy. During disasters such as hurricanes or flooding that typically stress terrestrial infrastructure the problem of service restoration is frequently complicated by the fact that the poles used by telephone companies to provide service to customers are, in most cases, owned by the power companies. This is a case where a

national post-disaster coordinating mechanism is valuable to prioritize restoration of service.

All states are now served by some level of cellular phone service, or will be in the near future. In some countries arrangements have been made to have cellular phones made available after a disaster (should the cell sites remain operational) but these sites are often some distance from the local exchanges and rely on microwave links (vulnerable during certain types of disasters) to carry the signal to the exchanges.

Where cable and wireless provides telephone service within a country, a single channel self-contained INMARSAT earth station is stored for use in emergencies. Presently, these terminals are not equipped for remote access (they are stand-alone units), but such capable would prove useful.

In all cases, the national telephone companies are equipped with emergency power plants and internal radio network links.

5.4 Role of broadcast media in early warning and disaster management

In addition to the reception and processing of information at MET centres, there is a need to transfer the warning to the public. The role of broadcast media in disaster management has expanded significantly in recent years reflecting both new advances in technology and an increasing openness on the part of many countries to share information with each other. CDERA has been working with the Caribbean Broadcast Union and the Caribbean Association of News Agencies to encourage collaboration with news agencies and to take best advantage of the broadcasting resources available in the region.

Early warning, preparation, onset coverage, and post-disaster response are areas where broadcast media plays a vital role in disaster management operations for all rapid-onset hazards including earthquakes, floods, landslides, tsunamis, hurricanes, tornadoes, volcanic eruptions, and wildfires. Reporting of accurate prediction and warning information can dramatically reduce the consequences of natural disasters, and relief operations also benefit from information disseminated via the media.

Mitigation efforts for long-term hazards, can also be enhanced by the process of collecting and reporting accurate information to areas affected and institutions capable of providing assistance.

Large segments of the region, and small island developing states in general, are vulnerable to rapid-onset disasters and survivable communications are not always available to most of these areas during the critical early phase of a disaster. This complicates the already difficult task of preparing a story by limiting the ability to share it.

There is also a growing realization that the relationships between media professionals and disaster managers, with respect to coordinated response plans and

disaster coverage, are inadequate to cope with the requirements of an increasingly interdependent world that is information hungry.

In cases where disasters can be predicted and warning is possible (hurricanes, for example), the public reads, listens to and/or watches information that is presented through, and by, various media. Before people respond, they process and interpret this information. The action then taken depends upon the relationship of the warning to them, personally; the perception of the veracity of the message; and the immediacy of the need to take action.

By design, or not, broadcasters play a crucial role in this process, and have enormous responsibility. Media professionals are also instrumental in providing information about the severity of a disaster, the extent of damage caused (and to whom), what support is required for the disaster's victims and how the public can appropriately respond to the needs of the victims.

5.5 National and regional security forces' telecommunications systems

All sections of the security forces are equipped with various types of radio networks which are part of local arrangements for managing emergencies. The CDERA survey reported two main regional networks available through the security forces. The CARICOM Disaster Relief Unit (CDRU), a regional response unit which utilizes military resources for managing relief supplies in CDERA member states stricken by disaster. A communications network to support the CDRU functions, including a link with Caribbean Disaster Emergency Response Agency and the relevant national disaster organization required. To accomplish this a communications pack is held in each of the following countries: Jamaica, Barbados, and Trinidad and Tobago. These packs consist of:

- 2 VHF solar power repeaters
- 24 VHF portable radios
- 2 HF radio base stations
- 4 Generators and 400 AA batteries.

This equipment is to be used only by the CDRU Team, to provide communications for their operating forces, and will not be available for use by the national disaster organization. Repeaters and radios are programmable, but there is no list of frequencies available for use in each country to ensure operation free from interference.

The Regional Security Services (RSS) also operate an HF network among the police forces of its member states. Each RSS member state is also equipped with a 1 kW repeater transmitter and a 375 watt radio which was intended to support a network capable of providing selective island calling from another member island. The network was not used regularly but operates during emergency situations.

6. Challenges and recommendations

There are several factors influencing effective use of the space technologies and their terrestrial counterparts for early warning and other phases of disaster management. These factors include:

- i) Capability and availability of technology;
- ii) Affordability of technology, relative to the intended application and other possible options that might accomplish similar objectives;
- iii) Institutional relationships and protocols required to facilitate optimal use of technologies by all users;
- iv) The need to develop training programmes in the application of existing technologies and education programmes that could lead to the development of indigenous capability and a regularity to the application of technologies;
- v) The need to undertake and support research in the development of ground systems and data management applications as a complement to development of space hardware;
- vi) National and international political or economic issues that may have negative impact on the acquisition and application of technology; and
- vii) National and international regulations that encourage or inhibit effective applications of technologies;

The scope of this study was to make recommendations for the possible enhancement of a technical system. The challenge in applying technology to emergency management, however, is not only a question of the suitability or availability of the technologies themselves, but the development of the relationships among the users. In order for any information technology tool to be effective, it must operate in a cooperative environment. Creating this environment requires attending to certain challenging non-technical concerns. These issues are substantive, procedural, and political/organizational. They are important – and challenging – and efforts must be taken parallel to the development of a technical system to resolve them.

Both Caribbean Disaster Emergency Response Agency and Caribbean Meteorological Organization regularly review and update their surveys of the capacities of member-states and, based on the results of these surveys, modify their protocols for preparedness and response. Since the March 1993 study referenced earlier, actions have been taken resulting in improvement of CDERA and national disaster organizations to respond to emergency needs. There are, however, areas where resources are required to improve the effectiveness of the system, and where institutional support would be valuable.

As identified by the Caribbean Disaster Emergency Response Agency, the region currently lacks a coherent system for collecting, managing and disseminating disaster-related information among national disaster organizations, regional and international

disaster management institutions, donor agencies and other interested parties. As a result, the many benefits that would be realized from increased sharing, both emergency and routine, are not realized. Recent advances in computing and telecommunications technologies, however, have made several options available for implementing such a network.

Tempting, though it may be to promote the procurement of technology as a first-line solution to preparedness and warning problems, the more appropriate and responsible earlier measure is to facilitate the interdisciplinary, inter-institutional, and intergovernmental dialogue that will lead to collaborative initiatives involving shared infrastructures, thus making expensive and valuable technology more affordable and more efficiently used. This being said, there are, however, some technological upgrades that would improve existing capabilities.

6.1 Support for Caribbean Meteorological Organization services

As has been recognized earlier in this study, the meteorological services of the Caribbean Meteorological Organization, in partnership with the World Meteorological Organization, have made great strides in recent years in increasing the capacity of the countries of the region to provide accurate and timely early warning for their respective countries and, cooperatively, for the region.

As stated above, the meteorological-related events are the dominant disaster-type of the region, and because the Caribbean Meteorological Organization MET services have demonstrated their credibility in their ability to collect, manage, and disseminate information it is reasonable to attach primary importance to ensuring the met services are adequately equipped and that there is a reliable capability to communicate disaster-related information from national meteorological centres to the respective national disaster organization and, simultaneously, to the Caribbean Disaster Emergency Response Agency as the regional coordinating institution.

It is a recommendation of this study that consideration be given to augmenting the planned ANMET/VSAT upgrade to include direct readout polar orbiting satellite and geostationary GOES satellite terminals for each meteorological centre receiving ANMET/VSAT facilities. This additional capability would cost approximately US\$ 45,000 per site and would permit more accurate tracking of tropical storms and hurricanes at a national level as well as additional imagery valuable for other marine and aeronautical applications. Communications by voice between VSAT stations would enhance coordination of warning services. Telephone connection is seen as the immediate solution to the existing 75 baud link which is currently the medium of information exchange. A method must be found, in cooperation with relevant national and international telecommunications authorities, to agree upon an affordable tariff for such communications, and future operating budgets for all national meteorological services must include funds for this purpose.

The Severe Weather Watch and Warning Service of the CMO has a network of 6 radar units. They improve the accuracy of the warnings when weather systems are

within range, and frequently make the difference between issuing warnings to many islands or being able to accurately target warnings to only those countries most likely to be affected.

The radar systems have been strategically located to provide an overlapping fence, but they have long outlived their expected lifetimes, and technological advances have made spares and replacement parts difficult to obtain. Two of the radar units are now out of service, and it is only a matter of time before the others suffer a similar fate. Therefore, these radar systems must be replaced, and an ongoing effort is now being undertaken by the Caribbean Meteorological Organization to seek technical assistance to do so. This effort must be supported.

6.2 Emergency information management

It is a recommendation of this study that consideration be given to funding and facilitating CDERA's proposed regional disaster information and communications network. The objectives of this project are:

- i) To develop a data communications network linking national disaster organizations in the region with each other and with regional disaster management agencies such as CDERA. This will also provide a link between the regional and international community;
- ii) To implement systems and procedures for identifying, collecting, storing, and disseminating relevant information; and
- iii) To provide training for disaster management officials so they can take full advantage of the facilities offered.

It is further recommended that the proposed Caribbean Regional Disaster Information and Communications Network be considered in the context and framework of the International Emergency Readiness and Response Information System (IERRIS) a recently introduced United Nations-sponsored initiative. The purpose of IERRIS is to bring together on a formal basis a steadily growing number of international disaster management organizations who agree to work with common and/or compatible information management standards and technologies; to collaborate in the development of new information systems to cover needs which are not met by existing systems; and to share and exchange with other participants emergency/disaster data collected by disaster managers for their respective institutional needs.

The immediate objective of the International Emergency Readiness and Response Information System can be seen as an identifiable point in time when the international community of disaster managers agree to work cooperatively to develop common procedures and standards for collecting and exchanging disaster mitigation and response information and data. The IERRIS initiative will permit – and encourage – disaster organizations to build their own information systems. An outcome of this

initiative would be that these independently developed systems would be compatible because they were built in compliance with these mutually agreed upon standards.

The information resource that will ultimately be created is envisioned to be a federation of independent systems that have, through self compliance, standardized their functions and their data. In this manner information would be available to disaster managers in the field at the disaster site, nationally, regionally, and internationally.

This system would permit a 'big picture' view for each disaster, including access to available predictive information, information about disaster onset (location and magnitude), post-disaster situation reports, and up-to-date information about which organizations are providing what products, services, personnel, or money.

6.3 Telecommunications links

With regard to the linkage between national meteorological services and CDERA and national disaster organizations – and respecting the cost of purchase, installation, and maintenance, of telecommunications technologies – it is not felt there is a need to develop dedicated systems for these communications. In advance of a predictable disaster, the likelihood is that the national and international telephone services can be relied upon and these should be the first line of communications. There is, therefore, a need to identify, country-by-country, the mechanism that will ensure this vital connection.

With regard to telecommunications services, there have been assessments of communications capabilities nationally and regionally. CDERA, among other groups, has recently identified availability of telecommunications resources (i.e., HF and VHF radios and INMARSAT terminals) owned and managed by the different disaster management groups in the region, as well as the infrastructure available through cable and wireless and national post, telegraph and telephone/telecommunications (PT&T).

Lesser strides have been toward an understanding of the protocols for access to available telecommunications services (including frequency allocations for regional emergency communications) and how agencies can be interlinked for the collective benefit of the various emergency preparedness and response groups.

It might be that the various disaster management agencies have not been successful in aggregating their emergency communications requirements and, collectively, putting forward a proposal for a tariff structure for telephone communications that could be considered reasonable to both the telecommunications companies and the disaster management groups. One recommendation of this study, therefore, is support, and possible international mediation of a focused effort to bring together representatives of the various relevant entities with this specific objective in mind.

Telephone services are available and reliable throughout the region. Bypassing them should not be the first course of action. There needs to be developed a philosophy

for payment of regular recurrent telephone bills. Though telephone charges are high, relative to the budgets of most disaster management groups, either tariffs must be changed to reflect the accepted vital role national disaster organizations and other emergency management agencies play in civil protection and preservation of economic development, or the budgets for these services must be increased by the national governments or international funding agencies.

7. Additional recommendations

7.1 University of the West Indies distance teaching experiment (UWIDITE)

The University of the West Indies distance teaching experiment (UWIDITE) currently connects, via telecommunications, campuses at 12 sites throughout the Eastern Caribbean. Most campuses have audio conferencing systems, some have slow-scan (still image) video capabilities, and some have computers with modems. The sites are: Antigua; Trinidad; Barbados; Dominica; Grenada; Jamaica, at Kingstown, Montigo Bay, Mandeville, and Port Antonio; St. Vincent; St. Lucia; and St. Kitts. In addition to a steady and growing fare of academic programming, the UWIDITE system carries a disaster studies unit whose programme originates from Jamaica. A recommendation of this study is encourage and support this form of training and information sharing and, specifically, to fund the installation and maintenance of additional regional sites not currently operating. These include Belize, Bahamas, and Guyana.

7.2 Geographical information systems (GIS)

GIS software can enable users to collect, manipulate, display and exchange critical data that traditionally resides on paper, in folders, or on maps on walls or in books.

GIS software will permit the display of geographically-referenced near-real-time information about emergency situations, people and property and natural resources at risk, and the resources available to aid or protect them. It does so with maps that are linked to both data and to one another. Use of GIS systems can allow users to readily move between different levels of maps showing different areas, scales and degrees of detail.

GIS maps begin with a base map, of the Caribbean region, for example. 'Beneath' each base map would be a progression of successively more detailed maps (and corresponding data screens) providing layer upon layer of detail as needed (and available).

Real-time information of storm direction and speed can be introduced into the system as a 'layer,' permitting storm tracking referenced to geography of the region.

UNDP is currently reviewing a project action plan for a 'disaster emergency response management system' that may employ geographical information systems for

regional disaster management but, thus far, there is no regional operational GIS system in place for such purposes.

It is the recommendation of this study that applications of GIS technology be approached carefully and with the understanding that successful operations take a sustained commitment to collect and maintain relevant information. Though some GIS applications require relatively modest capital investment, the investment of time is considerable. It is difficult to overemphasize this point, for there is the real possibility of ill-informed decisions being taken because of outdated or inaccurate information.

This caution having been made, it must be said that the potential for GIS applications in the region, with proper safeguards, is enormous, and should be pursued. One possibility that would stand a good likelihood of success would be a cooperative effort between the Caribbean Meteorological and Hydrological Institute and the Barbados Government's Coastal Conservation Unit. The Coastal Conservation Unit currently operates a GIS system (ArcCad/ArcView). They have mapped location of reefs, sand beds, shorelines, and flood levels. They also have composite hurricane data available over last 100 years, and spheres of influence of those severe weather systems, so they can run a model of result based on particular kinds of incidents based on historical evidence. The reason why this link would be valuable is that both institutions have professionally trained staff capable of maintaining GIS systems. Further, the meteorological and hydrological information that is currently available through the Caribbean Meteorological Organization would prove a valuable addition to the resources of the Coastal Conservation Unit.

7.3 Linkage between environmental and natural disaster warning

Historically there has not been a strong link between natural and environmental disaster management. There is, however, an increasing awareness of potential value in the linkage of these two fields, particularly within the context of sustainable development. There is an opportunity, now, with the development of the Regional Marine Pollution Emergency Information and Training Centre (in cooperation with the International Maritime Organization and the Caribbean Environment Programme), to link this regional institution with Caribbean Disaster Emergency Response Agency and Caribbean Meteorological Organization, to the advancement of the objectives of each organization by providing vital meteorological and hydrological information for warning and response efforts relative to environmental emergencies.

While meteorological disasters and oil spill emergencies frequently have a regional impact, coastal zone management tends to be a national consideration. Nevertheless there are similarities of coastal considerations within the region, and these institutions have the ability to work together to share information and to collect data so as not to duplicate effort and expenditure of their resources.

CASE STUDY VI

WASTE MANAGEMENT WITH PARTICULAR REFERENCE WATER POLLUTION IN SMALL ISLAND DEVELOPING STATES

Elizabeth Dowdeswell

1. Abstract

Small island developing states (SIDS) are not simply mini-continents surrounded by the sea, sharing characteristics and problems of continental land masses. Rather, SIDS have a number of unique, interrelated characteristics. These include high populated density, fragile ecosystems, small land area, isolation from the mainland and their neighbours, and limited natural resources. Taken together, these characteristics make SIDS significantly more vulnerable to environmental degradation and to human health problems resulting from inadequate waste management. The fresh water, land, marine and coastal resources are all critical to their sustainable development yet susceptible to degradation as a result of pollution from land-based activities.

This paper discusses the special problems of waste management in small island developing states. It highlights their island characteristics, resource utilization patterns and human activities, within the context of sustainable development. It argues that the integrated management of human activities and natural resources is at the core of effective strategies for waste management in SIDS and their coastal areas.

Wastes, the unwanted or unused by-products of human activities, have similar origins whether produced on continents or small island states. However, the unique characteristics of small island developing states require that approaches to waste management consider their special needs. The impact of domestic and industrial wastes can be especially stressful to their fragile ecosystems and fresh water, land and marine resources. The small population base, relative isolation and limited land area of SIDS greatly reduce the options for waste disposal. The difficulties of managing the large volumes of wastes that are generated during seasonal influxes of tourists is an especially significant problem in this context. Further, although many SIDS have a high population density, their typically small population base often results in reduced human resources capable of dealing with the technical and administrative aspects of waste management.

Small island developing states are also particularly vulnerable to natural disasters. The weak island infrastructure for waste management can be substantially damaged or destroyed by such events. Flooding and erosion often result in the transport of waste and the subsequent contamination of vital natural resources, including drinking water supplies and fisheries.

Because of their unique characteristics, a comprehensive, multi-disciplinary approach is required for effective waste management strategies for small island developing states. It must also be a key component of an integrated management framework for addressing the larger issues of environmental and resources protection, and sustainable development. Because traditional end-of-pipe solutions will not be adequate for SIDS, any waste management strategy must also promote changes in human and institutional behaviour in relation to resource utilization and waste production. Waste minimization, recycling, and innovative disposal methods are key means of addressing this serious and growing problem of the small island developing states. There is also an overriding need to develop local capabilities for technology innovation and adaptation, including building and retaining a critical mass of human resources needed for addressing effective waste management within the context of sustainable development.

2. Introduction

The term small island developing states (SIDS) defies precise definition. Small island developing states have many of the problems of other developing nations. However, they also have a number of unique, interrelated characteristics requiring a different approach to development planning and management. These include:

- i) Competition for limited natural resources;
- ii) Geographical isolation and small population base;
- iii) Environmental impacts of human activities on fragile ecosystems; and
- iv) Susceptibility to natural disasters.

Consequently, the production and management of wastes is therefore a critical issue in SIDS. This paper attempts to consider the main sources of waste-related pollution resulting from human activities and how a comprehensive approach to waste management in human settlements can reduce the consumption of natural resources and the production waste.

Very few data on waste management practices and pollution on small island developing states have been published, and still fewer studies have been carried out on environmental management related to waste in SIDS. This paper is based on information available for only a limited number of small island developing states and, therefore, must be considered in this light.

3. Waste production and current management practices

Wastes are generally regarded as those substances which have no further use and are discarded. They are produced from a variety of sources including domestic, industrial, commercial, agricultural and institutional activities. There are many different

ways to classify waste from these sources, including the media they pollute. This paper classifies waste according to its sources.

3.1 Domestic wastes

3.1.1 Liquid

Sewage collection is a basic problem in many small island developing states, especially in urban areas where the sewer reticulation is either inadequate or in a poor state of repair. In many rural and urban areas without piped sewers, septic tanks are widely used. The environmentally sound use of on-site disposal systems in SIDS is often unfeasible due to their special soil conditions and limited, fragile ground water resources.

Domestic waste water is generally composed of sullage or grey water produced from such activities as cooking, personal bathing and sewage. Sullage contains mainly organic matter and inorganic substances including grit and silt. Its microbiological quality is not critical but the organic and inorganic components may cause problems to the environment by depleting oxygen and deposition of silts. Sewage contains a wide range of pathogenic agents ranging from harmful bacteria, viruses and parasites, in addition to suspended and dissolved organic material. Water-borne off-site sewerage and on-site systems such as septic tanks and cesspools produce waste water or pathogenic sludges which require adequate disposal. Only a fraction of the waste water in SIDS is treated before being discharged to the surrounding land and coastal waters. Tourism amenities in the small island developing states, frequently sited at or near marine or estuarine locations, usually discharge their waste water directly into coastal waters without adequate treatment.

Efficient management approaches, as with other developing countries, are often lacking in the small island developing states and, although there are many examples of legislative efforts to control pollution, there is little enforcement. In addition, there is poor operation and a lack of maintenance of existing facilities for sewage treatment. Problems are apparent with both private and public utilities. Monitoring of effluent discharges is more often than not beyond the means of most municipal authorities.

3.1.2 Solid wastes

Domestic solid waste constitutes the highest proportion of solid wastes produced by SIDS but is often uncollected, dumped on vacant land or in a nearby river or coastal waters. The waste is infrequently disposed of to landfill or even open dumping sites. Some urban areas do have a regular collection service but the waste is disposed of in a haphazard manner with little control. Climatic conditions in SIDS sometimes can affect waste storage and collection. Typically the composition of solid wastes contain a large proportion of organic matter and recyclable material.

Incineration can offer another disposal option, but this is often rejected because the volumes and nature of waste (containing large quantities of incombustible organics) are unsuitable, and the high capital investment costs, and operation and maintenance requirements preclude its use. There are few reports of systematic efforts to apply

recycling practices, including inorganics and organics, as an alternative to other methods of disposal.

Some hazardous wastes from households and certain institutions are often disposed of in the domestic waste stream. This creates serious environmental problems for which conventional landfills and dumping sites are not suitable.

One of the most problematic areas of solid waste management is its ultimate disposal. Dump sites are often located in mangrove areas, which normally are easily accessible and abundant, resulting in large sections of mangrove forest being destroyed. Leachates can have a devastating effect on fresh water and marine ecosystems. There are also aesthetic problems with the location of dumping sites which could pose a threat to tourism.

On some SIDS where public waste management systems are relatively successful, a collection service is provided to residences and commercial establishments, particularly in high-income areas. The low-income areas are often underserved.

BOX 1

SOLID WASTE MANAGEMENT IN SIDS

In Mahe, Seychelles, waste from domestic bins along roadsides in residential areas is collected 6 days a week with 4 compacting trucks. Collection is also made from individual subscribers, such as hotels and restaurants. An estimated 6800 tons of domestic waste is collected per year by the local authority, and is disposed of at a dump site located on the East Coast land reclamation.

In the Republic of the Maldives a landfill site has been constructed on the Thila Fushi island. This isolated island is located west of Male at a distance of about 9 km. It is a submerged island with a crown of coral reef patches and the top edges of these patches are exposed during low tide. There is a large lagoon in the centre. Land has been reclaimed by solid waste landfilling in the north-eastern corner of this island. Waste is transported by trucks on a barge. The solid waste is laid in layers covered with limestone and sand of coral origin obtained from the same site. The depth of the landfill is approximately 5 metres. It was felt that a fully lined disposal site was not practical in the marine environment because of the serious risk of failure of the lining membrane due to tidal action, resulting in a catastrophic release of leachate into the sea. A lower risk would exist with an unlined site, where dilution of leachate is continuous. Tidal studies carried out showed that leachate during a falling tide would be washed into the Wadu Channel, where its effects would be relatively insignificant due to the very high dilution. There is evidence of discolouring of the surrounding water during low tide, but this clears at high tide. Little industrial waste is currently being disposed of at the site, so the leachate contains minimal amounts of toxic waste. It is recognized that some damage in the immediate vicinity of the landfill is inevitable and that more detailed assessments on the environmental impact of this type of disposal are required. However, Male benefits enormously from a clean environment.

An interesting initiative has been implemented by the German-based airline LTU which distributes bags to tourists to hold the rubbish they generate during their stay in the Maldives. LTU then flies the rubbish back to Germany – it is estimated that 200 tons of rubbish will be collected and returned in this way annually.

3.2 Industrial wastes

The current level of industrial development in SIDS (with few exceptions, such as Singapore) concentrate most of their industrial activities on the extraction and primary processing of natural resources (mining, fishing, petroleum), agro-industry (sugar and fruit), tourism and some manufacturing. Despite their relatively low level of industrial activity and production of industrial wastes, these normally contain large amounts of organic matter as well as non-biodegradable and toxic materials such as heavy metals, acids and other corrosive chemicals and synthetic organic compounds.

Materials which are also considered under the category of industrial wastes may be generated through activities which are not strictly industrial processes. For example, oil storage depots are the source of petroleum-based wastes in a number of South Pacific island countries.

Industries, normally clustered together in estates located in coastal areas or along riverbanks, and rural based agro-industries tend in many cases to dispose of their solid wastes in adjacent water bodies and vacant land, normally with very little pretreatment. This sometimes creates serious pollution problems. Industries which are situated in areas close to the coast, often discharge their wastes directly into the sea. Attempts to control pollution are frequently end-of-pipe solutions rather than efforts to reduce the production of waste.

There are a few industries that discharge their effluents to public sewerage systems, resulting in increased problems for treatment and disposal of domestic waste water. The coastal areas into which these wastes are discharged are almost invariably enclosed by land on one side and fringing coral reefs on the other, limiting water exchange with the open ocean and the dispersion of pollutants.

BOX 2

INDUSTRIAL WASTE WATER AND ITS DISPOSAL

In Western Samoa legislation for protection of the quality of the marine environment from industrial wastes is contained within Part VIII of the Lands, Survey and Environment Act 1989. Under this Act, it is an offence for a person, manufacturing establishment or mill of any kind to discharge into Western Samoan waters, refuse matter of any kind of description, or to deposit such material in places from where they can be washed into Western Samoan water causing pollution. No discharge of any oil, noxious liquid or solid substances is allowed except in case of emergency, endangering life or property or unavoidable accident or as otherwise permitted by regulations made under this Act.

In Singapore, industries that discharge their waste water into the sewerage network are required to ensure that the quality of the industrial waste water complies with the stipulated limits listed under the Trade Effluent Regulations of 1976. Otherwise they have to install treatment plants at their factories to pretreat effluents before discharging them into the sewer.

In Trinidad, industrial effluents are accepted in the sewers under certain conditions: no substances which are deleterious to the fabric of the sewerage system (sewers and plant) or to the operation of the sewage treatment plant; no substances likely to produce explosive vapours; and general discharge standards should be within these limits: BOD(5) at 20°C - 500.0 mg/l; pH - 6-10; maximum temperature - 45°C; and total suspended solids - 500.0 mg/l.

The main sources of industrial waste in SIDS are :

- i) Fish processing;
- ii) Toxic chemicals from productive processes;
- iii) Mining and quarrying;
- iv) Agro-industry.

A large volume of industrial waste originates from the fishing industry. Most fish waste is dumped at sea. This causes organic pollution and a further risk to swimmers and divers by attracting sharks. Some fish wastes are collected and processed into fish meal. However, wastes produced from the fish meal plants are normally disposed of directly into the sea. These wastes have a high organic content, thus creating zones of high turbidity in the area of discharge which, in some cases, can reach as far as the surrounding reef.

Mining and quarrying is considered a large scale industry in many small island developing states. Wastes from mining activities are not always held in tailing ponds prior to disposal. The marine waters are often used as a final disposal site for mining wastes.

3.3 Agricultural and agro-industry waste produced in small island developing states

Wastes from this sector can be categorized into three different areas. Firstly, slurry and dry wastes that are produced from animal farms, such as dairy, beef, pig and poultry. Secondly, effluent and solid wastes from industries that process crops, such as sugar cane. Lastly, non-point sources, such as run-off from farms containing pesticides and fertilizers.

Very few sugar mills in SIDS treat effluent waste waters. These effluents during the harvesting season contain substantial quantities of organic materials. The effluent which is discharged directly into the rivers and ocean could also contain caustic soda from washing equipment. More often than not, there are no effective regulations to control the quantities and nature of industrial waste discharged to water courses. When they exist, their effectiveness is seriously hampered by the lack of institutional capacity and will to apply them.

BOX 3

SUGAR INDUSTRY WASTE IN FIJI

The sugar industry is one of the largest agro-industries in Fiji where 700 square kilometres of land is under the production of sugar cane. Approximately 8-9 tons of cane are crushed to produce one ton of sugar. Effluent from the mills is primarily composed of soil and sugar, with some caustic soda from the washing of equipment. Poisoning of fish in the Ba River has been blamed on caustic soda leakage from the mills. Solid waste contains lime, nitrate and phosphate. After heavy rainfall, run-off of pesticides and fertilizers, now determined as wastes, are washed into nearby water courses. There is also the problem of disposal of disused chemical containers, with a lack of appropriate disposal sites.

In the majority of small island developing states little is known about the use and accumulation in the environment of agrochemicals. There is almost no legislation or control on import, registration, transportation, storage, sale, use and disposal of pesticides.

3.4 Hazardous wastes

A waste is considered hazardous if it exhibits certain characteristics, such as being inflammable, corrosive, radioactive or poisonous. Typical hazardous wastes in SIDS are agrochemicals, heavy metals, synthetic organic chemicals and hospital wastes. Storage facilities for existing hazardous substances are insufficient, and leakages are a common occurrence.

This paper does not consider radioactive wastes due to the lack of information available on this topic in SIDS. Possible sources of radioactive wastes in small island developing states are from hospital activities, such as isotopes from cancer treatment equipment.

The rate of generation of non-recyclable hazardous waste is expected to increase with the current economic growth and industrial technological progress. Presently, hazardous wastes are incinerated, buried at the site where they are generated, or more usually disposed off both legally and illegally to dump sites.

The Basel Convention is an attempt to control the transboundary movements of hazardous waste to reduce both the number of movements and the risks they pose. The Convention also aims to minimize hazardous waste generation by promoting low- or non-waste production techniques. The Convention controls transboundary movements of hazardous wastes through a system of prior notification and written consent. Both the exporting and importing State must agree in writing before any transportation of waste is made.

SIDS that have ratified or acceded to the Basel Convention include: Bahamas, Maldives, Seychelles, Mauritius and Cyprus.

As agreed on 25 March 1994, industrialized nations will cease dumping of toxic or hazardous waste on their developing world neighbours. The ban on exports for final disposal, incineration or burial was made effective immediately. Export of wastes for recycling, about 90% of toxic waste exports, will be illegal as of 31 December 1997.

BOX 4

SOURCES OF HAZARDOUS WASTE IN SIDS

Wastes identified in Western Samoa (Ogawa 1992) are:

- Pesticides – unspent pesticides and contaminated containers;
- Waste oil;
- Timber treatment chemicals – discarded in unauthorized places;
- Hospital wastes;
- Photo-processing chemicals;
- PCBs – old transformers; and
- Asbestos waste – packed into shipping containers and buried at the Tafaigata dump in the area designated for hazardous waste.

Hazardous substances accumulating in the Marshall Islands originate either as materials left in the Republic by various foreign agencies or as by-products of modern life. Foreign agency waste includes electrical transformers containing poly-chlorinated biphenyl contaminated oil which date back to the US Trust Territory Administration.

Fifty, 55-gallon drums containing cyclogen emulsifier, with carcinogenic properties, are stored unsheltered at the public works yard at Majuro in the Marshall Islands. The drums were donated to the Republic in 1986 by a foreign contractor, but use of the emulsifier for road repair only began in late 1991.

BOX 5

THE RESPONSE OF SIDS TO THE BASEL CONVENTION

A total of 18 countries, including Fiji and Trinidad and Tobago, have prepared a national waste management profile. The profiles assess the situation with regard to existing waste management practices and the assistance required to improve or complement such practices.

22 countries, including Bahamas prohibited the import of hazardous wastes for disposal. Trinidad and Tobago has already decided to prohibit the importation of hazardous wastes for disposal, but the implementation of that decision is not yet complete.

12 Parties, including Bahamas and Cyprus, notified the Secretariat that they had not entered into any bilateral, multilateral or regional agreements or arrangements regarding the transboundary movements of hazardous wastes or other wastes.

3.5 *Conclusions on current waste management practises*

From this brief overview of the waste management sector, it is possible to draw the following general conclusions:

- i) Many of the initiatives relating to waste management only attempt to provide end-of-pipe solutions which are expensive and require appropriate institutional arrangements (which are often lacking). There have been no attempts to develop a more comprehensive approach to waste management which includes minimization of waste production and waste recycling and reuse;
- ii) Although legislation does exist in many SIDS there is insufficient capacity to enforce it; and

- iii) The lack of institutional capacity has led to the failure to implement any successful cost recovery programmes for waste management. The application of the 'polluter pays' principle is not upheld.

4. The special environment in SIDS and its relation to waste management

4.1 Limited natural resources

With the exception of their marine assets, small island developing states have a limited base of natural resources.

4.1.1 Land

Islands represent a relatively unique environmental setting in a number of ways. They are often isolated land forms, located at considerable distances from mainland. Land mass is not abundant, directly limiting terrestrial and fresh water resources. Competition for land use is fierce due to its scarcity. Often small islands have high population densities, similar or higher than those found in Western European countries, but on land with a lower capacity to sustain agriculture and productive activities. Population growth and migration from other island states, or the mainland is a major problem SIDS have to contend with since it is accompanied by increasing demands on land for habitation. With a growth in population there is also an increase in residential areas, generation of waste, demand for fresh water and other natural resources.

Agriculture has always been a principal sector of many SIDS economies and remains the primary source of livelihood for a large majority of the population. The agro-industry requires large expanses of fertile land. Further competitors for land use are industries, including land hungry activities like mining and sand extraction. Sand extraction is carried out both on beaches and inland areas. Once extracted, rehabilitation rarely takes place, often rendering the land useless. The mining of sand from coastal areas usually causes erosion and further loss of land.

BOX 6

COMPETITION FOR LAND RESOURCES

In Mauritius, conflict arose when the government wanted to construct a landfill on fertile agricultural land. The planters were not willing to give up their land, and the government reacted by announcing it will institute compulsory purchase.

All land in the Marshall Islands is privately held in accordance with tradition, no public land-use scheme has been developed. There is a need to tailor management programmes to work hand-in-hand with traditional land property systems, so that environmental protection is achieved and the integrity of the land tenure system maintained simultaneously. In Micronesia, land is not a commodity to be sold or traded and under the FSM Constitution, ownership of land is restricted to citizens. Land may be leased to non-citizens. Attitudes are however gradually changing, especially near centres of development where potential riches from real estate deals are a strong influence.

Landfills also compete for land space. Often other sectors are considered a higher priority, and allocation of land to the development of adequate landfills never materializes. This situation leads to the formation of vast unmanaged dump sites, and dumping in areas that are not designated for waste disposal, thus further exacerbating the problems of land degradation and scarcity. Natural disasters to which SIDS are susceptible may exacerbate the problem.

4.1.2. Fresh water

Fresh water is a critical resource for small island developing states. In many SIDS the only source of potable water is a thin aquifer or 'lens' of fresh water perched on top of salt water. It is subject to rapid depletion, salt water intrusion and pollution. In addition to human consumption, water is also required by agriculture and industry. In many countries water supply for human consumption is being developed (and obviously takes priority), but little has been done so far to meet the demand from other categories. On some islands where there is a great shortage of fresh water resources, economic development is severely constrained.

BOX 7

WATER RESOURCES FOR SIDS

In urban areas in Nuku'alofa, Tonga, brackish ground water is used for washing and cleaning, while rainwater is used for drinking. In some areas rain is the only source of water. During 1987 there was a severe drought and the only source of potable liquid was from coconuts. Demand for water has risen due to a higher standard of living, and consumption has increased 10 fold in 10 years. In Nuku'alofa daily consumption is 80 litres per person. Daily consumption in the Seychelles is 140 litres per person.

The airport runway in Majuro, Marshall Islands, acts as a rain water catchment. It supplies roughly 75% of the public water. The water is stored in reservoirs, filtered and treated prior to entering the public water system of 11 miles of water mains. Demand is greater than supply, so rationing has been introduced, water is only available between 3 and 6 hours per day.

Tourism greatly increases the demand for fresh water. The Cook Islands received 50,000 tourists during 1992. The resident population is only 18,500. Tourists normally consume larger quantities than the resident population and many are oblivious of the fact that fresh water is a scarce commodity on small islands.

On Ebeye water supply is from a desalination plant fuelled by waste heat from the island's power plant. Production is approximately 200,000 gallons of water per day. This could be a solution for areas with little or no fresh water. However it is an expensive, technical option.

Demand for water also experiences sharp seasonal variations, particularly for agriculture and tourism. In certain cases, seasonal influxes of population can more than double the resident population. Excessive withdrawal of fresh water sources occurs easily when demands for water are so high, and supply is unable to meet it. Over extraction of ground water can lead to intrusion of sea water into the fresh water aquifer (salt water intrusion). Excessive extraction can also pull pollutants more readily from landfills and other pollutant sources into the ground water lens. Once ground water has been contaminated with salt water, it is no longer a potable source, and fresh water supply is decreased unnecessarily. Over extraction of underground sources can also have the detrimental effect of damaging the aquifer. This results in the lowering of the holding capacity of the aquifer, and also its replenishing capabilities. If surface water is

over extracted, dilution of effluents discharged into rivers is negligible thus creating severe pollution problems.

4.2 Geographical isolation

Some small island developing states consist of groups of islands often dispersed over a considerable area, thereby accentuating the difficulties of transportation, communication and administration. The geographical position of SIDS has an effect on the production of waste and on the strategies for its management.

Domestic markets are too small to provide economies of scale, so many of the products for domestic and commercial consumption, and industrial processes have to be imported. Such items range from food and vehicles to chemicals and fertilizer. SIDS are frequently located at great distances from the mainland. This creates problems with logistics and costs of transportation, communication, and packing. The ultimate disposal of waste materials from the imported items therefore becomes a major concern.

The materials that are produced locally have to compete with cheap imports that are often subsidized. This reduces the incentive of local industry development, and limits the opportunity for economic expansion. Tourism is a high consumption industry and in many tourist dependant Caribbean countries, out of every dollar earned, 70 cents is spent on importing food and services for tourists. Fifty per cent of the food imported for this industry is subsidized.

SIDS face stiff competition from overseas products in the export market because of added costs like transport. Due to the spread of islands, many are a great distance from any major international route and therefore depend on relatively high cost, infrequent and irregular transport. The relatively small volume of trade generated by such economies cannot support the large investments required to build and operate efficient modern air and sea terminals. The generally small-scale and often antiquated terminals lead to relatively high unit costs, causing delays and acting as a discouragement to foreign investment.

The costs of managing waste can also be quite high, especially if it is to be done in an environmentally sound manner. This is not unique to islands, but can be amplified because of the constraints to development opportunities posed by inherent economic disadvantages determined by geography, and their small and isolated markets for waste management technologies. Transportation can be a problem, both because of the logistics of moving large quantities of waste from its source to the place of disposal, as well as the associated costs. Refuse vehicles are usually imported, together with spare parts for maintenance. Where solid waste is deposited on another island, barge transport is an added cost.

Due to the size of the population and the economy of SIDS, current shortages of trained human resources restrict their environmental management capabilities. Training in the evaluation and management of marine resources, environmental impacts and solid and hazardous waste is desperately needed. Inadequate education at the primary and

secondary school levels results in a general lack of public awareness of environmental issues and, subsequently, a lack of support for environmental protection and management. Public education is therefore critical. There is also a great need to improve and place more emphasis on scientific education, mainly through teacher training and curriculum development. Rudimentary scientific principles are crucial for further training in environmental management.

4.3 Natural disasters

SIDS are vulnerable to various types of natural disasters, such as cyclones, tsunamis, earthquakes and sea-level rise as a result of climatic change due to global warming.

Although there is still much debate amongst scientists over sea-level rise, the threat of any appreciable sea-level increase is extreme when the island has a low land mass elevation. Some islands have a land elevation of only a few metres above sea level. Any rise would affect arable land, fresh water lenses, solid waste disposal sites and human settlements in general.

BOX 8

FLOODING IN SIDS

In Tonga, where mangrove forest is landfilled for housing sites, the land is rarely raised to a sufficient height to escape the danger of flooding during storms, or even from unusually high spring tides. As a result, in addition to property loss, sewerage is inadequate and severe health hazards can arise due to flooding of pit latrines and septic tanks.

The Maldives are likely to be very susceptible to sea-level rise. 1300 tiny islands stud the double chain of 26 atolls. The highest point on the chain is only 3.5 metres above sea level.

Hurricanes can also induce landslides of waste landfills and spoil heaps, causing further infrastructure damage and environmental problems. Unsatisfactory disposal of excreta is common immediately after natural disasters, and prompt sanitary measures are needed.

SIDS have limited capacity and lack preparation to cope with natural disasters. This is largely due to their small population base, geographical isolation and the fact that such events usually disrupt services throughout the entire country. Winds, rain and floods are almost inevitably followed by health emergencies, especially in countries poorly prepared to deal with disasters.

5. Environment and health risks of poor waste management

The ecosystems of SIDS are extremely fragile. They have a low capacity for absorption of pollutants, and therefore recovery and recuperation is slow, or irreversible. A polluted environment has an added negative effect on human health. Generally it is

the poorest members who bear the heaviest health burden because they are forced to live in areas most affected by pollution, often the only ones to which they have access.

The environment in many small island developing states is becoming increasingly polluted, especially in the area surrounding centres of population and industry. The underlying problem for these areas is the inability of infrastructure facilities and services to keep pace with population growth. If this rate continues, urban pollution will rapidly increase, and human and environmental health will deteriorate. The fate of pollutants is closely linked to the environment into which they are discharged.

Biodegradable pollutants consist of sewage, organic industrial waste and putrescible solid waste. Their pollution potential in the marine environment is dependent upon the degree of mixing and flushing of the receiving waters. The viruses and pathogens in sewage and solid waste have potential adverse effects on public health. As tourist developments increase around desirable waterfront locations, inadequate sewage treatment and solid waste management facilities destroy their recreational value (clean beaches, reefs and water).

BOX 9

HEALTH AND ENVIRONMENTAL RISKS FROM POOR SOLID WASTE MANAGEMENT

In Nuku'alofa, Tonga, solid waste disposal is recognized as a serious problem. The main garbage dump for household waste and other non-hazardous wastes, including septic sludge was for years a mangrove area immediately adjacent to the city at Popua. This refuse area became a squatter settlement for landless immigrants from the outer islands. The squalid surroundings, rats and disease risk are quite serious. In addition to the main refuse site, there are a number of official and unofficial sites, some so constructed that tip trucks can deposit their loads directly into the sea.

In Honiara, Solomon Islands, the existing Ranandi dump is poorly managed. This has resulted in obnoxious smells and swarms of flies. The household refuse is dumped in the open with an occasional covering of soil. The spread of vector-borne diseases is rife, and the leachate from solid waste dumps is contributing to eutrophication of coastal water, and the contamination of ground water.

Numerous water-borne diseases occur in the Marshall Islands (as in most other SIDS too), including typhoid, cholera and an array of debilitating bacterial and protozoan-caused diarrhoeal disorders. Contaminated water is the major source of such diseases. Ground water wells have been contaminated by poorly designed pit latrines and septic tanks. In Apia, Western Samoa, a borehole well was found to contain a faecal coliform count of 70 colonies per 100 ml of water. There is also evidence that several wells on Jaluit atoll contain exceptionally high levels of nitrates, possibly a result of the microbial contamination from nearby dump sites. Consumption of high nitrate content water has been shown to lead to severe health risks for infants, sometimes resulting in methemoglobinemia.

The activities of the concrete industry are contributing to the sediment load in coastal waters of Apia. The dredging is resulting in the re-suspension of sediments on the sea bed reducing the clarity of the water. High sediment loads restrict the penetration of light into the water column and sediments smother organisms living on the bottom.

A major indication as to the extent of these types of organic pollutants is the amount of oxygen that is required by bacteria to metabolize them. In well-flushed environments the oxygen demand can be readily assimilated with little ecological harm

because the oxygen content of the sea water is rapidly replenished by algal photosynthesis, mixing and circulation. The oxygen depletion occurs in estuaries and shallow embayments, making them more susceptible to impacts from pollution. There are also pollutants that are not readily biodegradable, but are not persistent in the marine environment. For instance, high or low pH waste water discharges and high temperature may have adverse ecological effects in the immediate vicinity of the discharge point. However, these effects disappear outside this limited zone.

Other categories of pollutants are non-biodegradable toxic and hazardous substances. Toxic substances do not always kill marine organisms, but affect growth rates, reproductivity, and increase susceptibility to disease or parasites. Accumulation of toxins in marine organisms leads to a detrimental effect on human health when seafood is consumed by the population.

BOX 10

INDUSTRIAL EFFLUENT AND ITS IMPACTS

Effluent from the Vailima Brewery in Apia, Western Samoa, consists of caustic soda (0.2%), sugar (0.5%) and 2500 kg of yeast daily. It is discharged directly into the sea via an outfall which extends approximately 50 metres from the shore. The effluent does pass through a small treatment chamber which is supposed to improve the quality. However the effluent continues to have a deleterious effect on the environment. The majority of the effluent is washed back to the shore. The decomposition of the organic residues has increased the nutrient levels in the water and brought about a profusion of algal growth. Algal blooms proliferate under the correct conditions and prevent the growth of slower growing corals.

A further source of eutrophication and pollution on reefs, adjacent to settlements, has been attributed to households lacking latrine facilities. Reef degradation is occurring in the Solomon Islands. One of the factors identified was pollution from sewage, attributed to latrine waste from households. Hotels and restaurants are also a major source of organic pollution to the marine environment. The sea water directly opposite a hotel was tested and had a coliform count of 300 colonies per 100 ml of water. Sewage effluent is also a cause of pollution in the Beau Vallon Bay area, Seychelles. This is a major tourist area where discharges are estimated at 900 m³/day. The coastal waters and submarine grounds have shown to be organically contaminated and there is deterioration of the coral reefs.

There is evidence from some households of SIDS that sewage has contaminated the soil. The incidence of algal growth along the foreshores and some watercourses indicates a high level of nutrients in the surface runoff from agricultural land.

Degradation of mangrove resources is also occurring as a result of siltation from onshore soil erosion due to agriculture and forestry activities, and landfill and coastal 'reclamation', particularly for waste dumps.

The effects of intensive animal production on ecosystems include ammonia emissions, which are toxic to neighbouring vegetation. Problems also arise from the storage and spreading of effluents, either by emission of acidic gases into the air or by the run-off and leaching of manure components into the soil and the waters. Soil contamination by heavy metals, chiefly copper and zinc which occur in animal feed and subsequently in manure, have been observed.

Agriculture also contributes to habitat loss through release of sediments, nutrients from fertilizers, and pesticides to the marine environment. Sediments are damaging to reefs and marine organisms, nutrients cause eutrophication, and pesticides are known to have a high level of toxicity and persistence in the environment.

Intensive use of pesticides leads to its transport into waterways and the marine environment, killing organisms through direct exposure. Once within the marine environment, pesticides can accumulate in marine organisms and thereby become a health risk to the population. Unwanted pesticides are also poured into drains and streams, becoming a constituent of sewage effluent, and directly contaminating fresh water and coastal systems.

A further vulnerability of SIDS to hazardous wastes is the transport from mainland of toxic wastes, and dumping in the sea nearby. Some small island developing states, not realizing the dangers, welcomed wastes being dumped on their land because it alleviated national debt and poverty. Oblivious of the long-term damaging effects, countries would accept wastes for a substantial payment to alleviate short-term economic needs.

5.1 Conclusions on environmental and health aspects of waste management

SIDS are subject to increasing population pressures, leading to impacts on their fragile ecosystems, due to human activities. The physical problems of development on ecologically fragile land forms, and the acute public health hazards resulting from poor sanitation and sewerage systems, lack of solid waste management and shortage of natural resources constitute major concerns for small island populations.

BOX 11

RISKS FROM HAZARDOUS WASTES AND TOXIC CHEMICALS

Fertilizer consumption in Mauritius is three times higher than the average rates of application on permanently cropped land in Western Europe, and sixty times the average rate in Africa. Average pesticide use per hectare is one of the highest in the world. The effects of such application rates on public health are potentially detrimental. An added environmental impact is the likely reduction in soil fertility.

Approximately 14,000 tons of waste, composed of garbage, fish wastes and oil, is produced per year by the commercial fishing fleet in Seychelles alone. Furthermore, brine, contaminated by fish waste and blood, is pumped into Seychelles water on a regular basis by commercial fishing vessels during the operation of cleaning holds. This should, by agreement, be carried out at sea and not close to land. Commercial fishing fleets are also a source of some 1 million litres of waste petroleum oil. This is dumped at sea annually because adequate facilities are not available in the Port of Victoria.

An estimated 450 million tons of oil per annum is transported from the Middle East around Southern Africa and the Cape. An additional 22 million tons transit the region en route to East and South Africa. This involves approximately 1,200 voyages by 200,000 ton crude carriers, and 4,000 voyages by 60,000 ton vessels each year in the Western Indian Ocean. By the law of averages, there is bound to be a major oil spill or numerous purely operational spills resulting in slicks and tar balls.

6. Overall conclusions

This study, which has focused on only a limited number of small island developing states, shows the need to undertake a more comprehensive review and increase our understanding of the environmental problems associated with waste management within the framework of human settlements development planning and management and its linkages to the management of natural resources. Conclusions that have been drawn in this paper must therefore be treated with caution.

6.1 Waste generation

In a large number of small island developing states, the tourist industry has a most profound effect on their economy. Development often takes place at the expense of the environment. Tourists produce larger per capita quantities of both solid waste, waste water and also hazardous clinical waste. It can reasonably be assumed that, in the absence of large-scale industries, tourism is often responsible for the vast majority of waste-related pollution. Domestic waste water in many SIDS receives only preliminary 'treatment', such as screening before discharge to a convenient water body. Although visibly improved, the pathogenic, toxic and oxygen-depleting capacity of the waste, which is responsible for the main environmental and health problems, is not significantly reduced and constitutes a very serious health risk.

Industrial pollution emanates from a variety of sources on SIDS but the main activities are centred around food and fish processing, with sugar refining contributing a substantial amount. The single most significant industry is mining and quarrying. There have been few attempts to introduce cleaner production technologies to industries to minimize waste production at source. Other industrial sectors, although not necessarily having a production capability, do produce wastes. Petroleum transportation and storage facilities and the transfer of petroleum products are good examples in this respect. On some small island developing states mining and quarrying contributes to the destruction of vast areas of land brought about by the need to find a source of locally-available building materials. Little effort is made to rehabilitate this land, creating more pressure on the already-limited land resources of SIDS.

The subject of hazardous waste production and disposal requires further investigation as little information is available on their generation and impact on small islands ecosystems. Recent studies have focused on the importation of hazardous waste from more developed countries. As a result of recent agreements between contracting parties in the Basel Convention, governing hazardous waste transportation and disposal, it would appear that importation of hazardous waste from developed countries will be reduced and perhaps eliminated in time. There is a more urgent need to collect information on the hazardous components of traditionally 'domestic' refuse as current trends indicate that the fraction present is increasing. Small-scale industry and small-scale sources of clinical waste also need to be considered in this respect.

The capacity to adsorb pollutants in SIDS is different compared to continental land masses in that the ecosystems are much smaller and more fragile. The pattern of

human settlements is often concentrated in one area and, as such, the populations are more susceptible to health and environment risks posed by poor waste management.

6.2 Water resources management

Adequate fresh water resources on small islands are frequently limited and directly affect development of human settlements, industry and agriculture. The situation is even more severe where small islands receive large numbers of tourists during particular seasons. The climate frequently dictates when tourists visit small islands and this nearly always coincides with periods when alternative sources of fresh water, such as rainwater, are limited. Large seasonal variations in service demand makes the design of adequate infrastructure for water supply difficult, and limits the application of demand management instruments. There is a high potential for contamination of scarce water resources from poor methods for on-site sanitation systems, inadequate sewage disposal and unsuitable solid waste disposal sites.

6.3 Land resources management

Land resources in small island developing states are often limited. There are competing demands for land between various social and economic sectors including housing, agriculture, industry, tourism and waste disposal. This competition frequently results in the selection of sites for waste disposal, such as low-lying areas or water-logged mangrove forests, which are suitable neither for waste disposal nor for any other immediate economic purpose. Dumping on sites which are inundated either permanently or intermittently results in contamination of the limited fresh water and coastal resources and/or the transport of contaminants to other parts of the environment.

SIDS are particularly prone to permanent sea-level rise resulting from global warming and temporary sea-level rise resulting from hurricanes and tsunamis. Waste disposal sites are often located in areas potentially at risk from inundation, flooding and erosion. In addition, natural disasters often destroy infrastructure services giving rise to the spread of pollution and the transmission of disease through waste sources. Infrastructure is often not designed with these special conditions in mind.

6.4 Institutional strengthening

Few SIDS have developed adequate strategies to integrate waste management concerns to the overall management of island development and resource utilization. An integrated approach combining resource and waste management, not only including fresh water and land but also coastal and marine ecosystems, was not evident in any of the islands considered in this study. The absence of strategies is also evident in the institutional structure designed to manage the various social and economic sectors in SIDS, and in inadequate coordination amongst institutions and sectors.

Little effort has been made to devise means of efficient cost-recovery which reflect the true cost of waste collection, treatment and disposal for all users of this service. There are not many experiences or attempts to introduce full cost recovery

policies accompanied by incentives to optimize resource utilization and waste minimization and cleaner production.

Human resources and professional skills are limited by the small indigenous population, and also by the increasing tendency for young persons to migrate for tertiary education. They are often reluctant to return after having experienced the salaries and life-styles offered in other countries. Skilled human resources for waste management are more often than not limited in SIDS. Local managers are often encouraged to implement possibly inappropriate methods and approaches from more developed countries rather than adapting and developing alternative approaches which are more sustainable to local conditions.

7. Recommendations

7.1 Waste minimization, cleaner production and resource management

Optimum resource utilization and waste minimization in SIDS should be considered as the principle strategy for waste management. This considers not only the promotion of public awareness to influence life-styles and reduce consumption patterns but also the careful management of solid waste and waste water.

Tourism should be targeted as a sector that should pay according to its economic capacity for infrastructure services including fresh water usage and waste disposal. This should be accompanied by programmes to raise awareness of the benefits of preserving SIDS resources and practising sustainable tourism. Novel schemes such as tourists returning to their domicile with the rubbish generated during their visit should be more thoroughly researched to gauge their effectiveness. Technologies, such as desalination as a source of potable water, can be expensive but if used for high revenue generating activities such as tourism then the cost can be passed on to the consumer.

Limited fresh water resources in SIDS will require the development of alternative or conjunctive uses. For example, promoting the use of rainwater for cooking and drinking, and the use of brackish and sea water for bathing and sanitation. Sea water can also be used for industrial cooling, for ice making (fishing industry), and even for fire-fighting. Effective measures to cope with the increased demand during tourist seasons should be investigated as this is a period when the limited ground water (often as fresh water 'lenses') is at risk from sea water intrusion due to high abstraction rates. Methods to conserve surface water runoff during periods of precipitation should be encouraged. Human-made catchment areas such as paved roads, airport runways and roofs on buildings should be considered, and storage facilities should be provided before the water is discharged into the ocean. Reuse of treated waste water should be considered as a way to reduce the requirement for fresh water.

Industry, as one of the main consumers of water resources, should be encouraged and provided with incentives to recycle industrial waste water within their production processes rather than discharge waste water or use new resources. Raising awareness

that improved resource management and cleaner production has the combined benefit of increasing production efficiency and reducing pollution penalty costs should be a key component of waste management policies for the industrial sector.

Waste minimization, cleaner production and pollution control at source is more sustainable than end-of-pipe solutions in SIDS. For industries whose processes produce toxic or hazardous chemicals, process substitution should be considered. In many cases pollution that results from the discharge of toxic substances is wasteful and more efficient processes are available. Small-scale industries could potentially be a source of many hazardous wastes and this should be investigated further.

7.2 Recycling and reuse

Waste recycling could provide a key component in reducing the requirement for final disposal in many small island developing states. Large quantities of inert and normally non-toxic material find their way into municipal landfills and rapidly reduce their capacity. It could also help the economy by reducing the requirement for imported products and the use of energy in industry. Many of the recycling activities in SIDS are not well documented and efforts should be considered to evaluate the contribution of recycling to overall waste management. The constraints to recycling and the markets for recycled products will have to be thoroughly investigated to ensure their economic viability.

In many SIDS soil types are poor, being sandy and of limited use for agriculture. Any recycling methods which apply waste organic residues to the soil will greatly contribute to improved agricultural productivity and food production. This could be achieved through intensive agriculture in urban and peri-urban areas. Sources of organic wastes include: domestic waste water and sludges, and food and agricultural wastes.

Reuse schemes, such as beverage bottles being returned for reuse, can also reduce the requirement for importation of disposable packaging. Such schemes should be evaluated for the local conditions in SIDS.

The potential for waste separation-at-source, at the household level, should be evaluated carefully in SIDS to stimulate the recycling possibilities and prevent recyclable fractions from being contaminated by hazardous substances. This activity should focus primarily on the development of community-based schemes that support more formal solid waste management systems by local authorities.

7.3 Environmentally sound disposal options

Solid waste and waste water should be disposed of using appropriate technologies. For example, conventional sewage treatment technologies, if available, do not eliminate the risk of faecal pollution from sewage effluent. Technologies that are frequently used in hot climates such as waste stabilization ponds face limitations for their application in SIDS as they require large extensions of land. Further research is needed on technology development which can, in a process intensive way, reduce the

pathogenic content of wastes. Wetlands or low-lying land unsuitable for other immediate economic activities could be used for environmentally sound waste water disposal. In Indonesia, for example, a research project on the use of marine-based waste stabilization ponds shows promise as a means of sewage treatment. A large circular floating boom with a flexible skirt moored off-shore will be evaluated as a means of treating domestic waste water.

In situations where on-site sanitation is a practical option, contamination of water resources should be considered carefully. Final disposal options, if carefully designed, can reduce the immediate environmental and health effects of waste water. For example, sea-outfalls if properly designed can effectively reduce contamination of bathing beaches and avoid damage to coral reefs. The discharge of wastes to enclosed or partially enclosed lagoons and other water-bodies should be strictly controlled as the potential for dilution and flushing by tidal flow or fresh water streams is limited.

Solid waste disposal, considering limited land availability, makes choosing a potential landfill site difficult. If strictly controlled, landfilling could be used in land reclamation schemes with little threat to the environment. Certain problematic wastes such as discarded vehicle tyres have been used to create artificial reefs and, in the correct location, can actually enhance marine life.

The discharge of industrial wastes, particularly those which are hazardous or persist in the environment, must be strictly controlled. Legislation must be introduced or, if available, must be enforced. The concept of zero discharge for particularly hazardous wastes could be introduced as possibilities for control are easier to enforce. In some cases, where industries are located together, a consortium approach to waste treatment could be adopted. This could substantially reduce the unit costs of waste treatment and disposal for a group of polluters. Longer-term solutions rest with developing cleaner production technologies.

7.4 Management improvement and institutional development

Current institutional arrangements for waste management have to be considered in an integrated manner. Approaches should be multi-sectoral and solid waste and waste water disposal considered within an overall strategy for the management of natural resources and human activities. A principal agency is needed to ensure that liquid, solid and hazardous waste are managed in an integrated manner. Such an agency could coordinate the scattered responsibilities and provide leadership, consolidating efforts by governments, NGOs and community groups, and individual citizens.

The lack of financial resources frequently limits SIDS' capacity for technological development and innovation. The transfer of technology on a regional basis could be provided through projects under a technical cooperation programme with the support of regional and international organizations.

Waste management institutions need to be financially viable and efficient as a condition to apply effective cost recovery policies. Involving the private sector and other

agents with capacity for waste management should be considered as a form of mobilizing local resources and increasing efficiency in service delivery.

Human resources development for waste management, and the creation of public awareness of the need for the integrated management of natural resources, human activities and waste, should be a key component of any strategy to improve waste management in small island developing states. This could be achieved and sustained through appropriate training of trainers on the application of these principles.

Preparedness should be enhanced to avoid long delays after natural disasters before services are resumed. Technologies should focus on services and infrastructure which are repairable with the minimum of work, and do not rely on large imported components.

7.5 Legislation and standards

The development of appropriate standards for waste treatment and disposal in SIDS should not necessarily follow the approaches of developed states but consider the local conditions. Discharge standards such as those based on the oxygen depleting capacity of wastes may be unrealistic, particularly when coastal discharge could enable the standards to be less stringent. A better understanding of these effects on SIDS ecosystems should be developed.

Effluent discharges from industries should be more strictly regulated, adopting where possible the 'polluter pays' principle accompanied by incentive mechanisms and pricing instruments. For new industrial establishments there should be legislation for mandatory Environmental Impact Assessment at the initial planning stage. This should also be extended to any development activity, including urban infrastructure and waste disposal sites. Planning procedures and authorizations should include mandatory technical appraisal by environmental scientists, health officials, engineers and planners. An emphasis should be on cleaner production to minimize production of waste.

Regulatory control does however have its limitations for water quality protection and enhancement. Despite compliance with discharge standards, cumulative pollutant loads from multiple sources may eventually exceed the assimilative capacity of rivers, other fresh water bodies and the marine environment. Water quality standards need further development and should be based on a review of existing water quality conditions.

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