UNEP

REPORT OF THE MEETING OF EXPERTS ON THE ENVIRONMENTAL VULNERABILITY INDEX

Valletta, Malta
29 November - 3 December 1999

Organised by the

Islands and Small States Institute,
Foundation for International Studies, University of Malta

in collaboration with

SOPAC
South Pacific Applied Geoscience Commission, Fiji

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1. INTRODUCTION

1.1 Date, Venue and Participants

The meeting on the Environmental Vulnerability Index (EVI) was held between 29th November and 3rd December 1999, at the Foundation for International of the University of Malta, Valletta, Malta. The meeting was attended by experts from small island developing states (SIDS) of the Pacific, Caribbean, Indian Ocean and Mediterranean regions. A participants' list is presented as Appendix 2.

1.2 Purpose of the Meeting

The purpose of the meeting was to:

1. Introduce the SOPAC model of the Environmental Vulnerability Index, and gain support for the Index, in the Caribbean and the IMA (Indian Ocean, Mediterranean and Atlantic) regions;
2. Examine the special environmental features of a sample of Small Island Developing States in the Caribbean and IMA regions, with a view to developing EVI indicators relating to these states;
3. Consult with experts from the Caribbean and IMA regions to identify the benefits they expect from the EVI;
4. Put forward recommendations as to how the EVI can be developed further and how data collection mechanisms might be set up within the Caribbean and IMA countries; and
5. Identify the process and devise an approach for obtaining the funding needed to globalise the EVI.

1.3 Structure

The meeting consisted of (1) presentations prepared by representatives of SOPAC and by the respective country representatives, (2) discussion on these presentations, and (3) further discussion on the future development of the EVI, culminating in a final statement. The sessions were chaired by Professor Lino Briguglio and Mr Craig Pratt.

1.4 Agenda

The agenda of the meeting consisted of the following items:

- Opening statements;
- Presentation and discussion on the EVI as developed todate;
- Discussion of concepts of Environment, Vulnerability/Resilience, Damage and Degradation.
- Presentation and discussion on the environmental characteristics of SIDS in the Caribbean and IMA regions;
- Consideration of the Individual Environmental Indicators;
- SWOT analysis relating to the EVI;
- Discussion on collection of data;

- Discussion on potential sources of funding for further development of the EVI
- Final Statement.

A detailed programme is presented as Appendix 1.

2. OPENING SPEECHES

2.1 Opening Statement by Chief Executive of the F.I.S.

Mr Leslie Agius, Chief Executive of the Foundation for International Studies, inaugurated the workshop. He said that he was pleased that the Foundation for International Studies was hosting such an important meeting, intended to facilitate the further development of the Environment Vulnerability Index and to gain support for the Index in the Caribbean and IMA regions. He welcomed the participants, and wished a pleasant stay to the non-Maltese participants many of whom travelled from distant areas in the Pacific, Caribbean and Indian Ocean.

Mr Agius said that the workshop could be instrumental in extending the EVI to the Caribbean and IMA regions and to devise an approach for obtaining the funding needed to globalise the scope of the EVI.

He said that Islands and Small States Institute, which was convening the meeting, had established itself as an international centre for research and information dissemination on small island states, working very closely with international organisations in this regard.

He thanked UNEP for funding the workshop and SOPAC for agreeing to collaborate with the Islands and Small States Institute in the organisation of the workshop. He also thanked the various other institutions that provided or facilitated the participation of experts for the workshop.

2.2 Address by Elizabeth Khaka, UNEP

Ms Khaka, speaking on behalf of UNEP, said that the workshop was one of the tasks undertaken by UNEP to carry out its mandate to facilitate implementation of the Barbados Programme of Action for the Sustainable Development of SIDS, in matters relating to the environment. She said that in November 1998, UNEP collaborated with the Islands and Small States Institute and the Government of Malta, by convening a Ministerial Meeting for SIDS in the Indian, Mediterranean and Atlantic Ocean where a new SIDS grouping, named IMA-SIDS, was formed. The meeting provided a forum for these SIDS, enabling them to provide an input to the process of reviewing the Barbados Programme of Action as a group. An important document that was produced during the November 1998 meeting was the "Valletta Declaration on the Sustainable Development of IMA-SIDS".

Ms Khaka said that the Barbados Programme of Action recognised the need for the development the Vulnerability Index, and this matter was also given a high profile in the Special Session of the UN General Assembly held in September 1999.

Ms Khaka thanked the Islands and Small States Institute and SOPAC for collaborating in this organisation of the workshop on the EVI.

2.3 Address by Prof. Lino Briguglio, Director, Islands and Small States Institute

Professor Briguglio, director of the Islands and Small States Institute, said that he was very pleased to be associated directly with the development of the EVI. He said that the Islands and Small States Institute was prepared to offer its services to extend the scope of the EVI to other small island states in the Indian Ocean, the Mediterranean and Atlantic (I.M.A.) and the Caribbean regions.

Prof. Briguglio explained how the idea of constructing an Economic Vulnerability Index to show that SIDS were more vulnerable than other states, was originally conceived by himself, within the University of Malta and gave a brief account of the developments in the conceptual framework and the statistical methods adopted for the construction of the vulnerability indices between 1992 and 1999.

Prof. Briguglio said that the Maltese Minister for the Environment, the Hon. Francis Zammit Dimech could not attend the opening session, as scheduled, but the Minister had sent a message to let the participants know that the Government of Malta was very much interested in the development of the Environmental Vulnerability Index.

Prof. Briguglio thanked UNEP for supporting this workshop and allocating funds for the development of the Environmental Vulnerability Index, and SOPAC for assisting in the organisation of this workshop. He also thanked the experts from Fiji, Tuvalu, Malta, Mauritius, Trinidad and Tobago, St Lucia and Jamaica for accepting to participate in this workshop

3. THE EVI: BACKGROUND INFORMATION AND DISCUSSION

3.1 Presentation by Dr Ursula Kaly

Dr Ursula Kaly's presentation dealt with the rationale, development and structure of the EVI. The following is a summary of her presentation. The full text is presented in Appendix 4.

Dr Kaly said that the index was initially developed by SOPAC[1] to provide an index for ranking countries in terms of environmental vulnerability, with a focus on the Pacific region. The work was carried out in response to a call made in the Programme of Action for the Sustainable Development of SIDS, adopted during the Barbados Global Conference in April-May 1994.[2] and an increasing awareness that small island developing states face disadvantages to their sustainable development associated with their remoteness, small size, dispersion, and economic constraints including limited natural resources.

She said that SOPAC started the programme on the development of the Environment Vulnerability Index (EVI) in August 1998, focusing on the Pacific SIDS. A total of 57 indicators of environmental vulnerability were selected for inclusion in the index. This included 39 indicators of risk (REI), 5 indicators of intrinsic resilience (IRI) and 13 indicators of environmental integrity or degradation (EDI), to represent extrinsic resilience. Many of the indicators were expressed as a ratio of area of land or coast rather than simply absolute numbers because it is risk density or proportion of area degraded that is of interest from an environmental perspective.

These indicators were evaluated for each country and scored on a 7 point scale, thus transforming observations to permit summation of the different components of the index. She explained that this allows for heterogeneous data (including qualitative data) to be represented along a common scale. Non-linearities were built-in by mapping the data on the assumption of a particular distribution along the seven point scale, which could be unique for a particular indicator.

Dr Kaly said that on the basis of the first attempt at constructing the EVI, it was concluded that it was possible to produce single-figure measures of environmental vulnerability for three countries, namely Australia, Fiji and Tuvalu. Following this first attempt at quantifying the index, SOPAC organised a Think Tank in September 1999 with the aim of (1) obtaining peer-review and commentary from experts in a range of fields relevant to the development of the EVI, (2) to render the EVI acceptable and/or operational in the international community and (3) to identify directions for future work. Following the Think Tank meeting, the number of

[1] See Kaly, U., Briguglio, L., McLeod, H., Schmall, S., Pratt, C. and Pal, R. (1999). *Environmental Vulnerability Index (EVI) to summarise National Environmental Vulnerability Profiles.* SOPAC Technical Report and Kaly, U., Briguglio, L., McLeod, H., Schmall, S., Pratt, C. and Pal, R. 1999. *Proceedings of the Environmental Vulnerability Index (EVI) Think Tank 7-10 September 1999.* SOPAC Technical Report.

[2] Article 113 of the Programme of Action states: "Small island developing States, in cooperation with national, regional and international organisations and research centres, should continue work on the development of vulnerability indices and other indicators that reflect the status of small island developing States and integrate ecological fragility and economic vulnerability. Consideration should be given to how such an index, as well as relevant studies undertaken on small island developing States by other international institutions, might be used in addition to other statistical measures as quantitative indicators of fragility". The Special Session of the UN General Assembly, held in September 1999, adopted a document, which contained three paragraphs (Section F, par. 39 to 41) dealing with the Vulnerability, and again stressing the need to compute a vulnerability index.

indicators was reduced to 47, and some modifications to the original set were introduced.

Dr. Kaly emphasised that the EVI, as proposed by SOPAC, deals with the vulnerability of the environment, on not of humans *per se*. But the underlying argument in SOPAC's EVI is that the "natural environment" is the basis of all human activities. She argued that poor environmental conditions mean fewer or poorer quality natural resources and poorer ecosystem services (such as attenuation of wastes and pollution).

She said that the Index has three components namely:

- the REI or Risk Exposure sub-Index;
- the IRI Intrinsic Resilience sub-Index; and
- the EDI, Environmental Degradation sub-Index.

Dr Kaly explained that the EVI requires further refinement. The progress so far relates to Phase I and a part of Phase II of the project, designed to determine whether it was possible to produce an EVI, and if so, expose it to peer review at the technical level. The next Phase is designed to start the process of globalising the index, enlist the support of SIDS from the IMA and Caribbean region, and find suitable funding for this purpose.

3.2 Presentation by Mr Craig Pratt on Data Collection

The following is a summary of Mr Pratt's presentation on data collection for the EVI. The full text of the presentation is carried in Appendix 5.

Mr Pratt said that availability of appropriate environmental vulnerability data is fundamental to both the development of the EVI and ultimately the final calculation of a country's EVI value. He said that the EVI, by its very essence, attempts to summarise a wide variety of environmental vulnerability data for a country. Much of these environmental data were only collected and compiled at the national level. Reporting and publication of these data internationally was not, until then, well-established as the reporting of country economic data.

Mr Pratt said that the criteria set for data collection, included that (a) data should preferably be already available or easily obtainable and that (b) data should measure change or be a proxy for change causing significant harm to the environment.

Mr Pratt said that the data that needed to be collected for the EVI includes meteorological data, fisheries data, land area, and natural hazards data. The very diverse and wide-ranging nature of these data means that their sources are widely dispersed and require considerable effort by a country to identify, collect and compile. Some of the indicators require information that could only be provided by the authorities or by experts in the respective country. Mr Pratt argued that it was therefore essential to have full government co-operation in the data gathering process to ensure success. This had been the case in the Pacific.

The first major issue that arose in the initial stages of trying to gather data for the EVI in the Pacific was the difficulty in creating an understanding of the data required to provide responses to EVI indicators, and the lack of capacity to compile the necessary data.

Mr Pratt discussed the problem of the lack of capacity - a common one throughout SIDS - referring to limited resources and few trained personnel, which often render data collection very difficult. Another issue that had arisen in the Pacific was that it had been difficult to create an adequate understanding in personnel of the specific data and information requirements needed for a response to indicator questions. This was due in part to a lack of understanding of the purpose of the EVI, and its mechanics and, more generally, the inadequate training of personnel in the identification, collection, analysis and manipulation of data.

Mr Pratt informed the participants that SOPAC was attempting to develop an alternative questionnaire approach to facilitate country environmental data gathering. He said that a help handbook would prove useful as a possible way to provide a detailed background to the EVI, its mechanics and specific instructions and assistance on how to identify and gather the required information. This is expected to reduce the need for continued assistance and support in the data gathering process.

3.3 Discussion on Dr Kaly's and Mr Pratt's Presentations

With regard to Dr Kaly's presentation, participants discussed the problem of comparing heterogeneous countries using a single yardstick. It was argued that the EVI might be more meaningful for small countries, where climatic and environmental conditions did not vary much within territorial boundaries, as compared to large countries, where environmental conditions varied drastically between one region and another. It was noted that this problem occurs also in the case of economic comparisons between countries, e.g. when comparing GNP per capita. In spite of this concern, the GNP per capita index is used widely in comparisons of economic development among countries.

Another item of discussion related to the applicability of the index to areas within national boundaries. Dr Kaly pointed out that the EVI was intended for entire states, but has the flexibility to be used within countries.

Comments and queries were made regarding the general criteria for the selection of indicators for the EVI after Mr. Pratt's presentation. It was argued that ease of collection should not be set as a criterion, since if an event harms the environment of a given country, its impact should be considered even if data for it is difficult to obtain. Otherwise, the index would only reflect part of the environmental damage. This comment provoked considerable discussion. It was noted amongst other things, that an "all or nothing" approach for data availability would defeat the whole exercise, and that whatever index is chosen, the problem of data limitations will occur. It was argued that sometimes proxy variables could fill the gaps, when data for a particular event is difficult or impossible to obtain.

4. DISCUSSION OF BASIC CONCEPTS

Participants discussed the concepts of "environment", "vulnerability", "resilience", "damage" and "degradation" for the purposes of the EVI.

The discussion was introduced by Dr Ursula Kaly who stressed that the development of the index depended on clear and precise definitions of the underlying notions, in particular the concepts of "environment", "vulnerability", "resilience", "damage" and "degradation".

4.1 Adoption of Definitions

Following discussion, the group adopted the following definitions:

The natural environment was defined as those biophysical systems that are capable of being autonomously sustained without human inputs.

Vulnerability was defined as proneness of the natural environment to damage and degradation.

Resilience was defined as the potential for a system to minimise or absorb the effects of damage.

Damage was defined as the reduction of diversity, extent, quality and function of natural environments, which may be reversible.

Degradation was defined as irreversible damage.

4.2 The Impact on Human Systems

The discussion also dealt with the question of whether the definition of environment excluded human systems (e.g. agriculture).

Dr Kaly explained that the concept of vulnerability, as applied to the EVI, excluded human systems, and considered the natural environment. However the underlying assumption was that the health of the natural environment had ramifications for human welfare.

Following discussion, participants agreed with Dr Kaly's explanation.

4.3 New Name for the Index

Participants considered the problems that might arise because of the different definitions of the term "environment". It was suggested that to avoid confusion, the name for the Environmental Vulnerability Index (EVI) be changed to the Vulnerability Index for the Natural Environment (VINE). It was agreed that this suggestion was to be transmitted to SOPAC for further consideration.

5. ENVIRONMENTAL CHARACTERISTICS OF SIDS IN THE CARIBBEAN AND IMA REGIONS

5.1 Presentation of Country Papers

The representatives of Malta and Mauritius (IMA-SIDS) and of Trinidad and Tobago, St Lucia and Jamaica (Caribbean-SIDS) made presentations relating to their respective small island states.

5.2 Malta

Dr. Adriana Vella said that the more important environmental characteristics of the Maltese Islands, relate to (1) water and land shortages (2) coastal zone management and soil erosion (3) pollution (4) waste management (5) limitations, over-exploitation and degradation of natural resources and (6) loss of wildlife and genetic erosion. The following is a brief overview of these characteristics.

5.2.1 Water shortages

Natural water resources in Malta are totally dependent on rainwater, which percolates through the rocks and forms aquifers. Because of the low rate of precipitation, exacerbated by high rainwater runoff rates, natural freshwater is a scarce commodity in Malta. Such scarcity has traditionally had direct impact on human health and general well being, on agricultural production, and in recent years on tourism and certain manufacturing industries. At present about 60% of water demand in Malta is supplied by desalination plants (reverse osmosis) - a very costly method of water production. Water tariffs are heavily subsidised in Malta and do not therefore reflect the cost of production, and this may be conducive towards lack of incentives for saving water.

5.2.2 Coastal zone management

The coastal area of the Maltese islands has played a very important role in the social and economic development of the country, with a large proportion of economic activity and of the resident population occurring on the coast. The natural harbours of the islands are extensively used for commerce and for tourism related activities. Urban settlements, new industrial and tourist infrastructures and other buildings are mushrooming along the coast, leading, as expected to increase waste generation and sewage pollution.

The coastal area is also important from an ecological point of view, since it contains habitats, including sand dunes and saline marshlands, which in turn support a number of endemic plant and animal species.

The coastal area has, up to recently, been considered to consist only of the restricted strip of land or rock between the sea and the human habitations. The importance of seriously considering the coastal sea areas and the vulnerability of this marine strip to the increasing local exploitation and development has been brought forward through scientific research on specific natural resources, such as local endangered marine species.

5.2.3 Soil and coastal erosion

Soil erosion in Malta is on the increase mainly as a result of abandoned agricultural land and limited tree cover. The building sprawl has substantially decreased the number of catchment areas, thus resulting in greater rainwater run off. Local climatic conditions and the increased over exposure of areas with soil have definitely contributed to its loss. The lack of trees and shrubs together with the loss of rubble walls further exacerbate this problem.

5.2.4 Waste Management

In small islands, waste management tends to be more problematic than in larger territories, due to the limited land area. In Malta the very high population density and rapid economic growth accentuate this problem. The added load of the tourist population during different seasons of the year but in particular during the summer months is not to be underestimated.

5.2.5 Pollution

The most important considerations in this regard relate to air and marine pollution. In Malta certain environmental damage and health risks are directly associated with elevated concentrations of air pollutants. Examples of typical pollutants are sulphur dioxide, nitrogen oxides, particulate matter and dusts, ozone, carbon monoxide, benzene, polyaromatic hydrocarbons, and heavy metals (e.g. lead, mercury and cadmium). A recent scientific study has actually found strong associations between particulate air concentrations and an increasing local health problem. Such study is also starting to shed light on the dominant relationships between different weather conditions and increased presence and effects of the pollution.

As for marine pollution, the most important concern relates to solid and liquid waste disposal. A positive development in this regard is that Malta is a party to the Barcelona Convention on the Protection of the Mediterranean Sea against Pollution and its Protocols and collaborates actively in MEDPOL and there is legislation in place to control waste disposal into the sea.

5.2.6 Other environmental concerns

Limitations, over-exploitation and degradation of natural resources. The initial limitations of space and biodiversity richness has imposed local limitations on the abundance of natural resources available for exploitation. This same limitation has imposed restrictions on the diversity and abundance of natural resources on and around the Maltese Islands. To avoid eradication of these natural resources serious assessment and planning of future sustainable developments and exploitations is necessary.

Loss of wildlife and biodiversity. In Malta the institutional and legal set-ups for nature conservation and protection of endemic and indigenous species are rather underdeveloped, and not adequately enforced. In addition, agricultural practices in Malta have led to a drastic reduction of forest-cover. There is also the negative impact caused by grazing goats, sheep, cattle and wild rabbits, which has led to further reduction of forest cover. Uncontrolled exploitation of natural resources is still a norm and though local expertise to undertake proper wildlife conservation assessment and monitoring exist locally the government's will and assistance to undertake conservation monitoring and management is still very poor. Specific conservation research projects have been undertaken with the goal to highlight this

requirement. The awareness to consider the need for sustainable development and the conservation of natural and genetic resources in a scientific and professional manner is only recently developing. The need to preserve the variety of local genetic resources is increasingly becoming a requirement at both national and international level. Thus assessing the genetic variation of natural resources needs to become synonymous with resource assessment for long-term management and conservation. A local high human population density in itself creates a considerable stress on natural habitats and their biota. Local wildlife has also been exploited since time immemorial, and in most cases the rate at which individual organisms are removed from their population is well above the rate at which they are replaced, leading to loss of populations, species and biodiversity.

Lack of institutional and policy co-ordination. Over the past decade, Malta has experienced a number of improvements in environmental legislation and management. One major shortcoming at present is that environmental legislation is somewhat fragmented with different lines of command leading to inefficient enforcement and sometimes contradictory signals. There is therefore a dire need for a national strategy for co-ordinating legislation and policies.

5.2.7 Malta and the EVI

Dr. Adriana Vella said that Malta was likely to record very high risk exposure and degradation scores, and low resilience scores on the EVI with regard to indicators related to islandness (indicator number 11)[3], land area (indicator 10), water shortages and droughts (indicators no. 3 and 41), natural resource monitoring and protection (indicators 16 to 24) (indicators 44, 45 & 47), soil degradation (indicator no. 40), coastal zone (indictor no. 25); tourism (indicator no. 29) removal of natural vegetation (indicators no. 22 & 28); high population density (indicator no. 26); waste generation (indicators nos. 30 and 32) and other indicators associated with economic development (indicators no. 35, 23, 18).

Dr. Vella argued that the EVI, as currently constructed, requires some refinements to the indicators to take into account vulnerability associated with water shortage and water salinity in states like Malta which experience this reality.

Also important is the emphasis on making sure that the EVI would be a reflection of the dynamic change of the environment apart from a descriptor of the static status. This would give the EVI a greater practical value over the State of the Environment Report.

5.3 Mauritius

Dr Deolall Daby said that the terrestrial, aquatic and marine environments of Mauritius are being degraded due to the socio-economic driving forces and unsustainable resource use. These problems are exacerbated by climate change and its associated impacts as well as natural disasters. The main areas of concern are (1) deforestation (2) loss of biodiversity and (3) climate change and extreme weather events. The following is a summary of Dr Daby's presentation.

5.3.1 Deforestation and the land use

Although 31% of the total land area is under forest, woodland and scrub, only 1% of native forest remains due to three centuries of deforestation and exploitation. Approximately 45% of the total land area (90% of arable land) is under sugar cane. The forests, nature reserves and coastal Pas Geometriques (public land constituting 10% of total) is under increasing pressure from competing uses (hotel, recreation and conservation). Encroachment on environmentally sensitive areas (coastal ecosystems, forested areas, hills and mountain slopes, nature reserves and catchment areas) is also increasing.

5.3.2 Bio-diversity

Mauritius is ranked second in the world for having the highest percentage of its native plants threatened globally (39%) and nationally (71%). Natural vegetation has been largely destroyed due to clearing land for agriculture, settlements, road infrastructure, farming and pastures. Many endemic species have already become extinct. Modification of aquatic habitats (draining, pollution, competition for water), introduced species and commercial exploitation are the principal causes of decline of the freshwater fish species.

5.3.3 Climate change and extreme weather events

Mauritius is at high risk from the effects of global climate change and its associated impacts. These include sea level rise and enhanced frequency of extreme weather events such as temperature and precipitation extremes and natural disasters (10-12 annual cyclones, floods, droughts, storm surges and landslides). The changes due to these calamities represent additional stresses on the environmental systems that are already under intense and growing pressure.

5.3.4 Other areas of environmental concern

Urbanization. The rate of growth of the urban population has been 1.1% over the period 1975-1995 and this is projected to increase to 1.9% by 2015. Currently just over 40% of the population is urban and by 2025 this will increase to 60%. The environmental problems associated with urbanisation include habitat and biodiversity loss, unplanned and haphazard development, pollution of surface, underground and coastal waters, and social problems.

Fresh water. Mauritius is classified as a water poor nation by the UNDP, and further demand and consumption by the growing population with a rising standard of living may hamper economic development. Mauritius is coming under increasing water stress, defined as an annual water supply of between 1100-1700 m^3 in 1995 to 1485 m^3 by 2025. During the second half of 1998 and most of 1999, Mauritius faced the most severe water stress situation in the last 20 years, impacting heavily on the economy and environment. About 75% of water withdrawals are used for agriculture, 16% for domestic use and the remaining for industrial and commercial uses. These sectors of consumption are also the main polluters of both the terrestrial and coastal marine water bodies. Further, salt water intrusions into bore holes are evident.

Agriculture. Soil fertility is probably being maintained by the high rate of fertiliser application (600kg/ha/yr) and crop production maintained by intensive pesticide use (44 kg/ha/yr). Much of such applications run-off with red soil into inland water bodies and

lagoons causing hypernutrification and eutrophication problems. Enhanced soil erosion occurs in cleared areas not under sugar cane and causes siltation problems in lagoons after heavy rainfall.

Tourism. Tourism is a major earner of income for the country. It is mainly marine-based and tourist arrivals continue to increase (600,000 annually). Mauritius has invested heavily in coastal infrastructure development to accommodate the escalating tourist populations. However, such development has occurred without appropriate planning and preventive measures, and damage to coastal ecosystems (erosion, physical damage to habitats, pollution) is already evident. Expansion in the sector is often in the form of encroachment on non-tourist space.

Pollution. Oil pollution is a major source of concern in Mauritius. Oil spills can cause catastrophic effects on tourism, fisheries, coastal ecosystems and recreational activities. The region is the main transportation route of more than 475 million tonnes annually of oil from the Middle East to Europe and America. This constitutes a constant threat and at present no country in the region has the capability to deal with oil spill disasters.

Air pollution, though still low by international standards, is increasing as energy use rises. Gas emissions are particularly severe in urban centres, and dust and air pollution problems occur in areas surrounding sugar mills, from burning cane fields, emissions from boilers and release of flyash. Other sources include stone crushers, brick making plants, lime kilns, chemical processing factories, hot asphalt plants, odours from agricultural wastes, waste dump sites, coal burning for electricity and steam raising in textile industries.

Coastal zone. The intensive urbanisation of the coastal zone is a major cause for concern because of unplanned construction, land reclamation, and increasing demographic pressure. Coastal habitat degradation occurs as a result of over-fishing above the MSY level, swimming, recreation and tourism activities, siltation of lagoons, mining, quarrying, dredging, nitrogen loading and recurrent HABs. Microbial contamination of coastal waters occurs from raw sewage disposal and increasing hot spots of marine pollution result from industrial effluents, high BOD load from sugar processing and run-off of agrochemicals. Inshore fishing is detrimental in various ways such as use of undersized nets, coral breakage by poling and anchoring of boats, overfishing of aquarium fish from coral reef areas, and poor enforcement of fisheries legislation.

5.3.5 Mauritius and the EVI

Dr Daby said that Mauritius was likely to register relatively high scores in terms of risks, degradation and lack of resilience, with regard to the following aspects: sea surface temperature (indicator no. 1) cyclones (indicator no. 2), droughts (indicator no. 3), degradation of coral reefs (indicator nos. 24, 25) loss of critical coastal and terrestrial habitats and biodiversity (indicator nos. 20, 22), land area, soil degradation (indicator no. 40), decreasing fish catches (indicator no.28), coastal erosion and marine pollution (indicator no. 33) ecotoxicology (indicator 31), waste management (indicators nos. 32) and fresh water shortage and contamination (indicator no. 41).

Dr Daby argued that the EVI, as currently constructed, required some additional indicators or modification to existing ones, to take into account vulnerability associated with fresh water shortage and contamination in states, which, like Mauritius experience this reality.

5.4 Jamaica

Mr. Learie Miller said that the major environmental concerns in Jamaica are related to agriculture, mining and quarrying, tourism and fisheries.

5.4.1 Agriculture and forestry

The main problems associated with agriculture in Jamaica are excessive land clearing and soil erosion. There is an adverse effect on water quality and quantity of agricultural production. In addition, agriculture gives rise to a number of hazards associated with the use of chemicals, uncontrolled use of fire, loss of biodiversity and wildlife habitat, excessive siltation and risk of downstream flooding. In the case of forestry, the major concerns relate to land clearing for cultivation and fuelwood/charcoal production.

5.4.2 Mining and quarrying

Bauxite mining has resulted in a disposal problem specifically of red mud from the refining process. Air pollution from wind driven dust is common for both mining and quarrying activities. In addition, there is loss of aesthetic value of hillsides due to scarification associated with limestone quarrying and inadequate rehabilitation of mined out areas. Some beach erosion occurs due to illegal sand mining.

5.4.3 Tourism

The Jamaican representative said that tourism in Jamaica is spatially concentrated on the north coast of the island. Wetlands have been used for dumping and been filled, and beaches have been mined for sand, coastal structures such as groynes, piers and marinas established. The impact of tourism on coral reefs and sea grass beds due to poor sewage disposal and tourism associated recreational activities such as bathing and boating have been significant.

5.4.4 Fisheries

Fishing in Jamaica gives rise to considerable environmental harm especially because of over-fishing, the use of dynamite, the destruction of breeding ground such as wetland areas and sea grass beds, pollution of harbours and near-shore water bodies, use of fine mesh nets and traps and dragline methods of fishing. Furthermore there is no practice to return juvenile fish to the wild.

5.4.5 Other areas of environmental concerns

Water resources. Water resource in Jamaica are affected by red mud pollution, saline intrusion where there is an over abstraction of water from some coastal aquifers, chemical, sewage pollution and sedimentation.

Energy. The bulk of the country's energy supply is obtained from imported fuel. Depending on the sulphur content combustion can result in the production of sulphur dioxide. Charcoal and fuel wood usage is still common and usually causes deforestation and habitat destruction. Historically, the use of leaded gasoline has resulted in high leads levels in some locations.

Air quality. This is associated with motor vehicle exhaust, stack gases, and the burning of domestic and municipal garbage.

Solid, liquid and hazardous waste. There is no sanitary landfill in Jamaica and open dumping is widespread, with known attendant problems of leachates, open burning, flies, vermin and unpleasant smells. A small percentage of the country is sewered and where sewage plants occur they often malfunction. There is no hazardous waste facility to deal with PCBs, asbestos, waste oils, lead and pecholorcthylene (Perc) among others.

Other concerns. Other concerns relate to oil spills, chemical accidents, transboundary movement of hazardous waste, climate change and attendant sea level rises.

5.4.6 Jamaica and the EVI

The Environmental Vulnerability Index would have some applicability to Jamaica based on a review of the indicators. While information may not be available on all the indicators it is likely that the meteorological and geological data can be obtained. Information may not exist for some of the anthropogenic indicators such as no. 36 which deals with Max 24 hour SO_2 concentration and nos. 37 and 38 which seek to determine fertilizer and pesticide usage over the last five years respectively.

The indicators seem to be deficient in evaluating water quality and quantity and this resource is being adversely affected by development in many countries. Indicator no. 47 recognises the importance of water but it seems as if work so far has not yet identified the specific parameter for which data must be sought.

Indicator no.43 requires careful weighting considering the impact that mining and quarrying can have on a small island state such as Jamaica which has extensive bauxite deposits and where limestone constitute more than 66% of the rock material.

5.5 Saint Lucia

Ms Valerie Isaac St Hill said that the most important environmental concerns in Saint Lucia related to (1) deforestation (2) coastal and marine degradation (3) unsustainable land use and (4) occurrence of natural hazards. The following is a summary of Ms Isaac St Hill's presentation.

5.5.1 Deforestation and soil erosion

The historical pattern of land ownership and the concentration of large tracts of prime agricultural land in the hand of relatively few owners, has resulted in small farmers encroachment on forests and reserves and steep slopes unsuitable for agricultural purposes. The result has been extensive deforestation, soil erosion and siltation of inland and coastal waters and the contamination of inland water courses and coastal waters by runoff from agricultural land.

5.5.2 Coastal and marine degradation

The entire island mass of St Lucia must be considered a holistic system because natural and anthropogenic events no matter how far inland, impact on the shore and marine environment

within a very short time frame of occurrence. The aggressive development policy being pursued, particularly in tourism and agricultural sectors, has placed many of the coastal resources under stress. This is made evident by the coastal degradation occurring particularly along the Northwest coast of the island in the form of erosion, poor coast water quality, reef degradation and the loss of marine habitat.

5.5.3 Land use

The problems associated with land use are characterised by conflicts between competing uses such as forestry and agriculture, recreation and tourism, environment and tourism, and agricultural and urban environment. These pressures on land have placed all natural areas under severe pressure. The last decade has seen progressive loss of vast tracts of the central forests, almost total destruction of the remaining west coat mangroves, the loss of most areas of natural marshlands and the destruction of several sand beaches.

5.5.4 Natural hazards

Natural hazards in Saint Lucia are primarily associated with tropical cyclones, earthquakes, volcanic activity, land and rock slides and wave action. Tropical cyclones are the most common and damaging natural disasters with potential for severe impacts.

5.5.5 Other areas of environmental concern

Solid and liquid waste management. Solid waste management and the disposal of refuse is one of the most serious environmental issues facing Saint Lucia. Despite improvements in the garbage collection system, serious problems remain from poor solid waste management practices, and illegal disposal of solid wastes along roadsides, in rivers and in other sensitive habitats. In addition to the unpleasant sight and health risks posed by these practices, there is a threat to the ecology of the rivers and the mangroves, and contamination of the water supply and near shore marine eco-system. The human population residing in the coastal areas of Saint Lucia has grown over the years and is still growing, thus increasing the amounts of poorly treated or untreated sewage waste waters being discharged into the coast environment.

Use of chemicals. The intensification of agricultural activities, primarily the banana industry, has led to the increasing use of agro-chemicals to control pests and improve productivity. The regular use of these chemicals, particularly on land with relatively steep slopes, provide the potential for the contamination of streams and rivers which supply the country with drinking water.

5.5.6 Saint Lucia and the EVI

Ms Isaac St Hill said that Saint Lucia was likely to record relatively high scores in the EVI with regard to a number of indicators, in particular those referring to land use and deforestation (indicator nos. 22, 28) soil erosion and coastal misuse (indicator no. 11, 25), tourism (indicator no. 29), natural hazards (indicator nos.2, 7, 8) waste (indicator no. 30, 32) and chemicals (indicator nos. 37, 38).

She argued that the EVI, as presently constructed, required additional indicators or refinement of existing one, to take into account environmental vulnerability associated with ship based pollution, especially that associated with cruise tourism for countries, which like Saint Lucia, experience this reality.

5.6 Trinidad and Tobago

Dr John Agard said that the most important environmental problems in Trinidad and Tobago are: (1) pollution and (2) deforestation. The following is a summary of Dr Agard's presentation.

5.6.1 Pollution

Rapid population increase and industrial development fuelled by a petroleum based economy in a small island setting have led to pronounced pollution effects on the natural environment. Although new environmental and planning regulations are being put in place, many developments have taken place without the benefit of adequate physical planning or environmental impact assessments. In the built environment there is widespread pollution of land due to improper disposal of solid and toxic wastes from industry and households. Emissions from motor vehicles and industry contribute to deteriorating air quality not only in industrial areas, but also along major roads due to the presence of the largest vehicle population per capita in Latin America and the Caribbean. Industrial effluents and malfunctioning sewage plants (especially in Tobago) have contributed to the degradation of the lower courses of rivers and nearshore coastal waters.

5.6.2 Deforestation

There has been extensive deforestation in critical watersheds, associated with shifting cultivation, hillside slash and burn agriculture, inappropriate and illegal logging, and sand and gravel extraction. These activities cause siltation in watercourses and lead to flooding. About 31.4% of Trinidad and Tobago consists of natural forests. Deforestation averaged 2600 ha per annum (or about 0.5%/yr) from 1990 - 1995. Of critical importance to the conservation of forest resources is the annual fire problem, which occurs during the dry season. Of the total of 44,850 ha of forests burnt in the ten-year period 1987 – 1996, only 230 ha or 0.5% have been replanted.

5.6.3 Other environmental issues

Coastal resources. Pelagic fisheries and shrimp are the main living resources on the continental shelf around Trinidad and Tobago. Expansion of fisheries exploitation has traditionally been hindered by over-fishing of near-coastal waters by trawlers as well as subsistence and other small scale fishers. Tobago has well developed coral reefs, which are coming under increasing pressure from coastal tourism infrastructure developments.

Disaster Proneness. Fortunately, Trinidad and Tobago is on the southern fringe of the hurricane belt. During this century, 1900 – 1998, only on seven occasions did a tropical storm or hurricane directly affect the country. Five of the tropical cyclones caused no more than torrential showers and strong gusty winds throughout Trinidad and Tobago. The remaining two attained hurricane status but only one, Hurricane Flora did substantial damage to Tobago on September 30, 1963. Trinidad and Tobago have no volcanoes. Trinidad and Tobago are on the edge of the Caribbean Plate and as such are subjected to daily minor earthquake tremors. No extensive earthquake damage has been recorded however. Even so extensive waterfront development on filled land in Port of Spain, Trinidad may make it vulnerable to earthquake induced ground failure.

5.6.4 Trinidad and Tobago and the EVI

Dr Agard said that Trinidad and Tobago is likely to record very high exposure to environmental risks, degradation and lack of resilience, and therefore likely to register high scores with respect to pollution (indicator nos. 30, 31, 32, 33, 34, 35, 36, 43), and the removal of natural vegetation (indicator nos. 22, 28).

He argued that that the EVI, as presently constructed, required additional indicators or refinement of existing one, to take into account environmental vulnerability associated with oil exploration and production of petroleum products, for countries, which like Trinidad, experience this reality.

6. DISCUSSION ON THE INDICATORS

The purpose of the discussion was to review all indicators to assess their suitability for SIDS in the Caribbean and IMA regions, and to suggest new indicators to take into account the special circumstances of these regions

Dr Ursula Kaly and Professor Briguglio gave some background information regarding the set of indicators that were being presented for discussion. It was pointed out that initially 57 indicators were selected, but after the Think Tank meeting of September 1999 (see Appendix 3), some of the original indicators were reformulated and their number was reduced to 47. Participants were asked to consider each indicator in turn, to assess its suitability, and to suggest changes. They were also asked to ensure that each indicator has a clear rationale to facilitate an understanding of why it was chosen and what it represents.

The participants then organised themselves into two groups, with one group focusing on Caribbean SIDS and the other on IMA-SIDS.

Group 1 for IMA Region
Chair: A. Vella.
Members: D. Daby, K. Mercieca, U. Kaly, J. Sammut, P. Gatt, A. Mallia, D. Duca, M. Tabone, L. Micallef, M. Cassar, M. Camilleri

Group 2 for Caribbean Region
Chair: J. Agard.
Members: V. Isaac St Hill, L. Miller, C. Pratt, L. Grima, C. Attard

Following extensive deliberations, the two groups reconvened in plenary and put forward the suggestions on which there was broad agreement within each group. The participants recommended that SOPAC takes cognisance of these suggestions.

The suggestions are reported below, and are grouped under two headings (1) general and (2) relating to specific indicators.

6.1 General Suggestions

Participants suggested that:

- There was a need for an additional column of keywords with every indicator to help the respondent understand better what the indicator is measuring and to highlight the linkages between the different indicators.
- Some of the environmental data that are derived from national sources are not properly audited and standardised for international comparisons, and additional care should be taken to reduce the dangers of comparing like with unlike.
- The indicators should be accompanied by some coefficient indicating the level of confidence in the data.
- The EVI needs to be further legitimised in a peer-reviewed international journal.
- In the narrative describing the index, more emphasis should be made on the association between environmental vulnerability and costs and benefits to human systems and welfare
- In the same narrative, the policy implications associated with anthropogenic indicators

should be given importance;
- The indicators should be calculated over a span of time, so that rates of change can be calculated so as to be used as a dynamic tool towards natural environmental assessment and management

6.2 Comments on Individual Indicators

The participants considered the 47 indicators which were adopted following the Think Tank meeting held in Fiji in September 1999, and suggested changes where they thought appropriate, as follows:

Indicator 1 relating to deviation in surface sea temperature

No change was suggested to this indicator. It was noted that there was a discrepancy between data compiled by the National Oceanic Atmospheric Agency (NOAA) and data collected locally by different countries. It was pointed out that since NOAA data is more widely available, it should be used for the purpose of this indicator.

Indicator 2 relating to wind speed
Indicator 3 relating to monthly rainfall less than or equal to the 100 year low rainfall event
Indicator 4 relating to monthly rainfall greater than or equal to the 100 year high rainfall event
Indicator 5 relating to temperature greater than or equal to the 100 year high temperature event
Indicator 6 relating to temperature smaller than or equal to the 100 year low temperature event

Both groups agreed that using a 100 year event to capture the long term trend, could very likely create data problems. Following discussion it was agreed that the benchmark of a once in 100 year event would be changed to deviations from a 30 year average.

Indicator 7 relating to number of volcanoes with potential for eruption
Indicator 8 relating to earthquake energy
Indicator 9 relating to number of tsunamis or storm surges
Indicator 10 relating to land area
Indicator 11 relating to the ratio of the shoreline to land area

No significant changes were suggested for these indicators.

Indicator 12 relating to distance to nearest continent
There was some discussion relating to the definition of "continent". It was agreed that the term "continent" could be interpreted in different ways and that in the notes for respondents, the term should be defined as precisely as possible for consistency purposes.

Indicator 13 relating to altitude range (highest point - lowest point in country)
Indicator 14 relating to percent of land area below 10m above sealevel

No significant changes were suggested for these indicators

Indicator 15 relating to the percent of land area composed of unconsolidated sediments

It was suggested that the wording be changed to "Percentage of land area less than 10m elevation within 2km of coast composed of unconsolidated sediments (exclude coral reefs and ice)".

It was noted that this indicator is somewhat difficult to measure.

Indicator 16 relating to number of known endemic species per 10,000 sq. km land area

No significant changes were suggested for this indicator.

Indicator 17 relating to the number of reported organism outbreaks

It was suggested that the word "catastrophic" be replaced by "reported and verified by appropriate authorities".

It was noted that this indicator is too open to interpretation especially regarding the terms "outbreak" and "appropriate authorities".

Indicator 18 relating to total tonnage of freight imported annually

No significant changes were suggested for this indicator.

Indicator 19 relating to the number of all introduced species since 1900
Indicator 20 relating to the number of endangered and threatened species
Indicator 21 relating to the number species which have become extinct since 1900

No significant changes were suggested for these indicators.

There was some discussion on whether the new IUCN definitions should be adopted regarding the status of species. Although it was generally understood that this would refer to the most recent definitions, it was agreed that this point should be made clearer to the respondents in the questionnaire.

Indicator 22 relating to percentage of natural and regrowth vegetation remaining

No significant changes was suggested for this indicator.

Indicator 23 relating to tonnage of intensively-farmed animal products

It was suggested that the question should clearly indicate that intensive farming should include aquaculture.

Indicator 24 relating to percent of fisheries stocks overfished
Indicator 25 relating to density of people living in coastal settlements
Indicator 26 relating to total human population density in the country
Indicator 27 relating to annual human population growth
Indicator 28 relating to the removal of natural vegetation

No significant changes were suggested for these indicators.

Indicator 29 relating to annual number of international tourists

It was agreed that the denominator should be changed from 100 sq. km to land area.

Indicator 30 relating to untreated industrial and domestic wastewater discharged

It was noted that this indicator requires measurement by length of coast and rivers. This could create data problems for countries like Jamaica where rivers go underground.

Indicator 31 relating to generated toxic, hazardous and municipal wastes

There was some discussion relating to the difference of toxicity between domestic and industrial waste. It was agreed that allowance was to be made for this difference by having two separate indicators instead of one.

It was agreed that the indicators should include imported toxic and hazardous materials.

Indicator 32 relating to mean percent of waste effectively managed or treated

There was discussion relating to the meaning of managed and treated waste. It was suggested that the term "Effective management" would be more appropriate referring to the following strategies: composting; reusing; recycling; controlled incineration (including temperature control, retention time control and control of emissions); and controlled landfill (involving treatment of leachate, containment, gas management, aftercare and rehabilitation i.e. recovery, planting, and post management).

Another suggestion was to change "mean percent of waste" to "cumulative percent of effectively managed waste" … per year. The term cumulative refers to total percentage of wastes managed . It was noted that this information may be very difficult to obtain.

Indicator 33 relating to number spills of oil and hazardous substances

It was noted that spills of oil and hazardous substances are not confined to the coastal areas. It was therefore suggested to change the indicator to refer to the number of spills of oil and hazardous substances greater than 1,000 litres during the last 5 years on land, in rivers or territorial waters.

Indicator 34 relating to industrial facilities that could cause significant damage

Following discussion it was agreed that the denominator should include territorial waters as well as land area. With this new denominator, industrial facilities would therefore include such structures as oil rigs.

Indicator 35 relating to number of cars / land area

It was agreed that the term "vehicles" should be used instead of cars, as per World Bank Definition. There was some discussion on whether to use density of vehicles on roads rather than total land area. It was noted that this may not be appropriate, since the former is used as a measure of congestion, rather than of the ability of land to attenuate pollution emitted by vehicles.

Indicator 36 relating to Max 24 hour SO_2 concentration
Indicator 37 relating to Tonnes of N,P,K fertilizers used on agricultural land
Indicator 38 relating to Tonnes of pesticides used on agricultural land

No significant changes were suggested for these indicators.

Indicator 39 relating to the number of new fisheries stocks added

There was discussion regarding the term "new fisheries species added". It was pointed that (a) new fisheries does not take into account added effort or new technology (b) a threshold of at least 20% in increase in catches should be set (c) the way the question was formulated could be misleading because it focuses on species rather than on stocks.

It was suggested that the wording of this indicator be changed as follows:
"Number of new fisheries stocks and added effort exploited by countries over the last 5 years"

It was also agreed to develop this indicator further to incorporate points (a) and (b).

Indicator 40 relating to percentage of land area degraded since 1950

It was noted that data for this indicator could be difficult to obtain. It was agreed that there needs to be a clear rationale to show that the indicator captures erosion, salination and desertification and that this indicator should exclude urban areas.

Indicator 41 relating to annual internal renewable water resources per capita

A properly specified indicator was required to capture quantity and quality of freshwater separately.

It was suggested that an indicator to capture quantity would be the following:
"Annual internal renewable water resources per capita." This would be measured by average annual runoff and recharge of groundwater from endogenous precipitation.
The rationale for measuring the renewable water supply per capita was that lower availability per head would create higher pressures on natural ecosystems (i.e. water for people is considered to have a higher priority than for ecosystem conservation)

It was noted that the issue of water quality has been covered by indicators 30, 33, 37 and 38.

Indicator 42 relating to kilotonnes of mining material (ore + tailings) extracted

No significant changes were suggested for this indicator.

Indicator 43 relating to land, rivers and coastal zone affected by mining & quarrying

It was suggested that sea area should not be included in this indicator. The indicator should therefore read as follows:
"Percentage of land, rivers and coastal zone affected by mining and quarrying"
It was noted that "coastal zone" needs to be defined more precisely

.

Indicator 44 relating to percent of terrestrial zone set aside as reserves
Indicator 45 relating to percent of marine zone set aside as reserves
Indicator 46 relating to number of war or civil strife years over the last 50 years

No significant changes were suggested for these indicators.

Indicator 47 relating to environmental legislation

There was considerable discussion regarding this indicator and its usefulness. It was suggested that this indicator be dropped, because aspects of environmental management are covered by other indicators.

6.3 Suggested Possible New Indicators

Participants agreed to suggest the following indicators for possible inclusion in the EVI for further consideration by SOPAC's experts.

Reported mass mortalities of organisms, including strandings

Basically this indicator would relate to possible imbalances in the environment

.

The number of ships/tonnage of hazardous substances carried/transiting within 100km of a country per year (averaged over the last 5 years)

This indicator was considered to be significantly different from Indicator 18

Pollution coming in currents of air or sea or rivers from outside the territory

This would require a yes/no response when a country is or is not downstream by air or water from a major pollution source, within 1,000 km. It was noted that this indicator would require further development and refinement.

It was noted that this indicator could possibly be captured by indicators 26, 33 and 34.

Total tonnage of chemicals and hazardous material imported and in transit within the country.

It was noted that this indicator could add useful information to indicator 31, since this indicator deals only with waste.

6.4 Possible Indicators for the Subsidiary List

Participants identified a list of important environmental issues for which indicators could eventually be developed, but could not be included now due to data limitations. These were:

Marine and forest productivity

Salination of groundwater – it was pointed out that this may be captured by indicator 40

Hail and glacial melt

6.5 Possible Weighting Schemes

Participants discussed the weighting procedures that could be adopted for the indicators to underscore their importance in terms of their contribution to the overall index.

Dr. Ursula Kaly said that in the original EVI, six of the 57 indicators were assigned a weighting factor of 5, while the remaining indicators were given the default weighting of 1.

She said that at the Think Tank, the 47 indicators were rated in terms of the importance attached to them by the experts, on a scale ranging from 0 to 4, with zero indicating no importance and 4 indicating the highest importance. The values thus obtained were averaged over all of the Think Tank experts and the final score for each indicator used to assign a low, medium or high weighting to each. High importance (weight) was assigned to 15 indicators and low importance to 14 indicators out of a total of 47. The remaining 18 indicators were assigned medium importance.[3]

Participants agreed that it is not possible to use weights derived on the basis of ecological criteria alone, and that a measure of subjectivity would have to be employed in this regard

Participants therefore agreed that the indicators would be weighted in terms of their perceived importance by the experts associated with the compilation of the index. This was the same conclusion arrived at during the Think Tank meeting.

It was also agreed that ultimately it will be the responsibility of the experts compiling the index to choose appropriate weighting, based on plausible criteria and following extensive consultation.

Participants agreed that the issue of weighting required further study and debate.[4]

[3] See Appendix 3 for more details.

[4] The participants at the Malta meeting were also asked to rank the indicators in order of importance. The results are reported in Appendix 3.

7. STRENGTHS, WEAKNESSES, OPPORTUNITIES & THREATS

The participants discussed the strengths, weaknesses, opportunities and threats facing the EVI. The following are the major conclusions reached by participants.

7.1 Strengths

Education . The EVI could be a useful instrument in the hands of governments, organisations and individuals to foster education about the environment. Even lack of data could be educational. For example if a country fails to collect data relating to SO_2 levels in urban areas, the index will have a data gap which gives an important signal in itself. In other words, the index helps countries to find out what they do and do not know about their environment.

Information and visibility. The indicators could render environmental problems more visible, since all the indicators relate to major areas of environmental concern. They could also help governments to prioritise certain environmental problems.

Corrective measures. The index could allow governments to apply corrective measures to rehabilitate the environment, in line with the level of harm detected by the indicators. It could also serve as a useful guide for technology requirements, capacity building and development assistance. If the EVI is measured over time (say over five years), it could also produce information on whether the corrective measures are yielding positive results.

Linkages. The indicators could be used to highlight linkages. For example, tourism and agriculture could lead to undesirable levels of environmental harm. Water production, which requires electricity, which in turn is oil produced, may lead to undesirable levels of pollution. It was pointed out that these linkages may not appear clearly in the indicators themselves, and should therefore be given a high profile in the narrative accompanying the index.

Non-linearities and qualitative data. The indicators, as structured, allow the combination of quantitative and qualitative data. They also permit non-linear environmental data to be amalgamated in a form that could potentially be grasped by decision-makers. In other words, the EVI could be instrumental in simplifying complicated events into a form that is relatively easy to grasp. This appeals to decision-makers, although it may be a difficult task for those collecting and mapping the data.

Capacity building in data collection. The EVI has the potential of strengthening the process of data collection. The questionnaire itself could assist the statistical division of the Ministries for the Environment to identify statistical gaps and to try to fill them. It was pointed out that a manual on the data required would be useful in this regard.

International comparisons - fulfilling a mandate. The EVI allows comparisons within and between countries, as requested by the global community in the Barbados Programme of Action (1994) and the Special Session of the UN General Assembly (1999).

7.2 Weaknesses

Indirect measures. Many of the indicators are measured by proxy variables and not directly. This could lead to errors, since a proxy variable may capture factors not associated with the true variable which the indicator attempts to measure. If many such proxies are used, this could lead to cumulative errors. It was pointed out however that this weakness is not specific to the EVI, since it frequently occurs in compilation of indices and in quantitative estimations in general.

Weighting. The EVI is itself vulnerable to arbitrary weighting. Different weighting schemes could lead to different answers.

Lack of feedback mechanisms. The calculation method used in the EVI does not cater for feedback mechanisms or synergistic effects of one indicator to another.

Hides variation. Averaging and summarising data may hide important variations. This may lead to complacency when, for example, a positive score for one indicator cancels out a negative score for another indicator.

Comparing like with unlike. The index tries to compare large countries like Canada and Australia, with small countries like Tuvalu. The validity of such comparisons may be questioned. It was noted that this problem occurs also in the case of economic comparisons between countries.

7.3 Opportunities

Various advantages. The advantages listed in section 7.1 of this report with regard to education, information and capacity building, were also cited as opportunities.

Demand at the international level. The construction of the EVI provides an opportunity for responding to the call for such an index in various documents, including the Barbados Programme of Action (1994) and the final document of the Special Session of the UN General Assembly (September 1999).

Awareness and support by regional organisations. There was increasing awareness by regional organisations of the benefits of constructing the EVI. The Pacific regional organisations, the Indian Ocean Commission and the OECS were mentioned in this regard. There is therefore the opportunity of enlisting the support of these organisations for the further development of this index.

The National level. Some countries are interested in the construction of the EVI because, amongst other considerations, the index could help them support their claim for special status.

7.4 Threats

Lack of acceptance by Governments. Participants expressed concern about the possibility that the EVI might not be accepted by some governments because the single number which the index returns for a particular country might conceal the many facets of environmental vulnerability. It was pointed out that in the Pacific region, some countries have already expressed their preference for a vulnerability profile report, rather than a vulnerability index. It was stressed however the reporting of the results of the EVI will include both an index and profile formats, so that areas of concern can be easily identified.

Problems with academic acceptance. The EVI may not be accepted on scientific grounds because if viewed from the perspective of a specific discipline, say, biology, it may lack rigour. Participants agreed that this threat would be reduced if a paper on the EVI is published in a scientific journal.

Participants suggested that Dr. Ursula Kaly, Mr. Craig Pratt and Prof. Lino Briguglio should try to publish a paper in the EVI in a suitable journal. Many possible journals were suggested, including the following journals: *Environmental Management; International Environmental Management*; *Our Planet; Environmental Monitoring & Assessment*; *Ambio.* It was also suggested that specialist studies could be published on the sub-indices in more specific journals, such as *Conservation Ecology*, *Environmental Conservation,* or *Nature.*

Funding. There is the threat that the further development of the EVI may be stalled due to lack of funding. The problems with procuring funds may be due to various factors, including the perception that the exercise will not produce meaningful results for policy and decision making, and the fact that other projects competing for funding may be given higher priority. To combat such a threat, participants agreed that the narrative accompanying the questionnaire should highlight the benefits of the index for decision-making.

8. FRAMEWORK FOR PROCUREMENT OF DATA

Dr Ursula Kaly and Mr Craig Pratt opened the discussion by giving some information about the manner in which data was to be collected. They said that SOPAC had prepared data sheets, to be filled by respondents, with a whole page assigned for each indicator. Space was provided for the response, the source of the data, and other information.[5] The discussion which followed focused on the roles of governments, regional organisations and other institutions in data collection.

8.1 The Role of Governments

Participants agreed that the EVI development process will require formal endorsement/ approval by governments, and that some government institution should be involved officially in the procurement of the data. This would be spread across different ministries, therefore the respondent might need to approach the Prime Minister's Office, or some high level environmental authority, to facilitate collection of data.

8.2 The Role of International Organisations

Some data would be easier to obtain from international organisations such as WMO, UNDP or UNEP. These organisations base their data on statistics provided by member countries. It was noted in this regard that (1) often data provided by international organisations has important gaps, notably with respect to small states and (2) some of the environmental data required for the EVI is not likely to be collected by international organisations. It was argued however that international organisations could act as catalysts for data procurement.

8.3 The Role of Regional Organisations

It was pointed out that in the Pacific, where the whole exercise started, SOPAC found useful backing from regional organisations, in particular the Pacific Islands Forum and the national governments. The Indian Ocean Commission and the IMA-SIDS Centre for Sustainable Development could be asked to facilitate data collection in the IMA region, while the OECS Caricom and the Association of Caribbean States (ACS) could do the same in the Caribbean region. However, national government endorsement will remains essential, even if regional organisations are willing to cooperate in data collection.

8.4 The Role of Universities and Research Institutions

It was pointed out that considerable research takes place within Universities and that some of the data required for the EVI has to be "researched". It was agreed that Universities have an

[5] Each response sheet will contain five sections as follows: (1) the text of the indicator; (2) information for the respondent regarding what the indicator represents and possible data sources; (c) a formatted space for the respondent to enter the data; (4) comments by the respondent regarding data quality and data source/s; and (5) details about the respondent and stamp of authority verifying the data.

important role to play, especially by collaborating with the Ministries of the environment for evaluating the quality of the data.

8.5 The Role of Private Organisations

Data could also be produced by private firms. There are advantages associated with such an arrangement. The product is likely to be more efficiently produced and will not depend on political exigencies. On the other hand there is the danger that the data will not be properly audited.

9. POSSIBLE AVENUES FOR FUNDING

9.1 Funding at the International level

Prof. Briguglio introduced the discussion by explaining that the initial funding for the EVI came mostly from New Zealand. He explained that the fact that the current workshop was being funded by UNEP indicates that the interest in the index has taken a global dimension. He said that there was the need to find further funding for globalising the scope of the EVI.

He said that UNEP had already indicated that it supported the EVI process by providing funds for the Malta workshop and assistance for the SOPAC Think Tank meeting. He asked whether UNEP will be prepared to provide further funding.

Ms Khaka said that there UNEP was interested in funding the further development of the EVI, as it was in line with the decision of UNEP's Governing Council. However, this was subject to the availability of funds.

The discussion which followed dealt with a number of issues, the most important of which dealt with the possible roles of UNEP and SOPAC in the future development of the Index.

The question was raised as to whether or not, in the event that UNEP funds the further development of the index, SOPAC would still have the veto regarding possible changes in the EVI.

Participants agreed that there should be a line of continuity in the work that has been done in Fiji, before and during the SOPAC Think Tank meeting of September 1999 and that SOPAC should therefore keep the intellectual "ownership" of the development of the EVI for the next 2 years, meaning that SOPAC should remain the final arbiter of how the index is to be developed, even at the global level. After 2002, the index could be managed by some global organisation.

Participants considered the possibility that the work done by SOPAC be eventually passed into wider UNEP context, thereby anchoring the EVI within UNEP to establish a formal framework, applicable to all countries of the world. It was agreed that (1) such an arrangement would enhance the acceptance of the index at the global level and (2) before this arrangement be effected, the work related to the further development of the EVI should proceed within SOPAC to enable the experts who initiated the process to continue with the initial phases of the EVI development, and (3) that the arrangement could come into effect by the end of 2002.

9.2 At the Regional Level

Participants discussed the involvement of the Caribbean and IMA regions in the further development of the EVI.

It was pointed out that there were various regional organisations that could be instrumental in obtaining funding for the further development of the EVI in the IMA and Caribbean regions. Amongst these the following were mentioned.

IMA regions

- The Indian Ocean Commission
- The IMA-SIDS Centre for Sustainable Development
- The Mediterranean Action Plan

Caribbean Region

- The Organisation of East Caribbean States (OECS)
- The Association of Caribbean States (ACS)
- Caricom

9.3 At the National Level

It was noted that funding by individual SIDS is not likely. However funding could be sought from certain donor countries, such as New Zealand, Australia, Canada, Norway and others that have an interest in the sustainable development in SIDS. It was agreed that donor countries be called upon to assist in the process of further developing the EVI.

10. ADOPTION OF FINAL STATEMENT

Participants adopted the following statement during the final session of the meeting.

" The participants at the Workshop on the Environment Vulnerability Index held in Malta between November 29 and December 3, 1999:

Agree:

(a) That an appropriate structure for the development of the EVI would be the following:
   (i) A suitable international organisation, such as UNEP, takes the role of international co-ordinating body for globalising the scope of the EVI; and
   (ii) Regional bodies, such as Association of Caribbean States, Caricom, the IMA SIDS Centre for Sustainable Development and SOPAC, act as co-ordinating centres for the development of the EVI at the regional level.

(b) That SOPAC should continue to develop the EVI at the technical level until such a task can be effectively transferred to a suitable international organisation, such as UNEP, preferably by the first quarter of the year 2002.

(c) That the appropriate national co-ordinating institution should be the respective governments, since the EVI requires endorsement by the respective governments and the government is normally the depository of most of the data required.

(d) That in countries where there is a functional environmental authority such as the EMA in Trinidad and the NRCA in Jamaica, the co-ordination at country level could be placed under the auspices of these authorities.

(e) That where appropriate, the private sector and Universities should be involved in the process.

(f) That funding should be sought to invite six additional countries from the IMA and Caribbean regions to participate directly in the procurement of data for constructing the EVI for these countries, and that such data should be collected by the end of year 2000.

(g) That by the end of 2001, data should be collected for 15 other countries to represent all country possibilities (small and large, arctic, temperate and tropic, developed and developing, etc.) to enable the carrying out of various tests on the indicators, including redundancy tests.

(h) That funding should be sought for follow-up expert meeting to be held in the Caribbean region sometime in 2001 to review progress in the development of the EVI.

(i) That a manual relating to the EVI should be written so as to give information about the purpose and usefulness of the index, the manner in which the data is to be collected and standardised, and other matters associated with the indicators.

Call upon:

(a) UNEP, to continue to support and facilitate funding for the development of the EVI according to its mandate by its Governing Council and in line with the Barbados Programme of Action and its review carried out at UNGASS (September, 1999).

(b) AOSIS, to support the development of the EVI and encourage its member governments to collaborate in the process, especially by providing data and facilitating data collection.

(c) Appropriate regional organisations, to promote interest and assistance for the development and utilisation of the index in the countries of their region.

(d) Governments, to provide the necessary data and to facilitate the collection of data for the construction of the EVI.

(e) Donor countries and organisations, to support the further development of the EVI, in line with the Barbados Programme of Action and its review carried out at UNGASS (September, 1999).

Express their gratitude to:

(a) UNEP, for supporting the development of the EVI, by providing funding for the current workshop, and for supporting participation in the Think Tank meeting organised by SOPAC in September 1999.

(b) SOPAC, for the leading role it has taken in the development of the EVI and for agreeing to collaborate with UNEP and the ISSI in the organisation of the present workshop.

(c) ISSI, for organising the workshop and facilitating further development of the EVI.

(d) The OECS, the University of Mauritius, the University of the West Indies (St Augustine Campus), University of Malta, the Malta Environment Protection Department of the Ministry for the Environment, the Malta Planning Authority, Lino Bianco and Associates, Eco-Standards Services Limited, the Centre for Insular Coastal Dynamics (Malta), the International Environment Institute (Malta) and the Institute for Environment Studies (University of Toronto) for providing expertise for this workshop. ”

APPENDIX 1

AGENDA AND PROGRAMME

of the UNEP Meeting of Experts on
the Environmental Vulnerability Index
held in Malta between 29 November and 3 December 1999
at the Foundation for International Studies, Valletta, Malta
organised by the Islands and Small States Institute (Malta)
in collaboration with the
South Pacific Applied Geoscience Commission (SOPAC)

UNEP MEETING OF EXPERTS ON THE ENVIRONMENTAL VULNERABILITY INDEX

AGENDA AND PROGRAMME

MONDAY 29 NOVEMBER

0930 -0940	Inauguration by Mr. Leslie Agius, Chief Executive of the Foundation for International Studies
0940 - 0950	Opening speech by Ms Elizabeth Khaka, on behalf UNEP
0950 - 1000	Address by Prof. Lino Briguglio on behalf of the Islands and Small States Institute and on behalf of Dr. Francis Zammit Dimech, Maltese Minister for the Environment.
1000 - 1100	Presentation by Dr. Ursula Kaly: "The Development of the EVI: Background Information"
1100 - 1115	Coffee Break
1115 - 1300	Presentation by Mr. Craig Pratt: "Recommendations from the Fiji Think Tank Experts regarding the EVI"
1300 - 1430	LUNCH
1430 - 1530	Discussion on Dr. Kaly and Mr. Pratt's presentations.
1530 - 1545	Coffee Break
1545 - 1700	Discussion on basic concepts: "Environment, Vulnerability, Resilience, Damage and Degradation"
1900	Reception

TUESDAY 30 NOVEMBER

0930 - 1015	Special characteristics of SIDS in the Indian Ocean, Mediterranean and Atlantic (IMA) regions: Country statements by Malta, Mauritius and Cape Verde.
1015 - 1100	Special characteristics of SIDS in the Caribbean region: Country statements by St Lucia, Trinidad and Tobago and Jamaica
1100 - 1115	Coffee Break
1115 - 1300	Break-out in two working groups: Group 1: Indicators for the IMA regions Group 2: Indicators for the Caribbean region
1300 - 1430	LUNCH
1430 - 1600	Continuation of work in two groups
1600 - 1615	Coffee break
1615 - 1800	Continuation of work in two groups

WEDNESDAY 1 DECEMBER

0930 - 1100	Report of the two working groups.
1100 - 1115	Coffee break
1115 - 1300	Discussion on the Individual EVI indicators.
1300 - 1430	LUNCH
1430 - 1600	Discussion on the Individual EVI indicators (continued).
1600 - 1615	Coffee break
1615 - 1800	Discussion on the Individual EVI indicators (continued).

THURSDAY 2 DECEMBER

0930 - 1100	Discussion on "Strengths, Weakness. Opportunities and Threats relating to the EVI (SWOT Analysis)"
1100- 1115	Coffee break
1115 - 1300	SWOT analysis of the Model (continued)
1430 – 1530	Discussion "Framework for Procurement of Data"
1430 - 1630	Discussion "Possible Avenues for Funding"

FRIDAY 3 DECEMBER

0930 - 1100	Presentation and discussion on the structure of the report of the meeting
1100 - 1115	Coffee break
1115 - 1145	Presentation and discussion on Final Statement
1145 - 1200	Adoption of Final Statement
1200 - 1215	Closure

APPENDIX 2

LIST OF PARTICIPANTS

at the UNEP Meeting of Experts on
the Environmental Vulnerability Index
held in Malta between 29 November and 3 December 1999
at the Foundation for International Studies, Valletta, Malta
organised by the Islands and Small States Institute (Malta)
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South Pacific Applied Geoscience Commission (SOPAC)

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APPENDIX 3

LIST OF INDICATORS FOR THE ENVIRONMENTAL VULNERABILITY INDEX

UNEP Meeting of Experts on the Environmental Vulerability Index
organised by the Islands and Small States Institute, Malta
in collaboration with SOPAC, Fiji,
held at the Foundation for International Studies, Valletta, Malta
29 November – 3 December 1999

LIST OF INDICATORS FOR THE ENVIRONMENTAL VULNERABILITY INDEX

This Appendix contains two sets of indicators, the first relates to the list compiled following the suggestions put forward during the SOPAC Think Tank meeting held in Fiji between 7 and 10 September 1999, and the second contains a modified list as proposed during the meeting of experts held in Malta between 29 November and 3 December 1999.

BACKGROUND

The process of developing the EVI started by a team of consultants appointed by SOPAC in 1998 and the first set of indicators were published in early 1999. The Think Tank meeting was convened in September 1999, with the objective of bringing together a group of experts from a range of disciplines central to the EVI, to subject the Index to critical peer review. The experts considered the structure of the model, the indicators used, procedures for mathematical testing and future directions for development of the Index. The assembled group of experts generally accepted the EVI approach, as originally proposed by the SOPAC team of consultants, but suggested changes to the indicators.[6] The changes have been accepted by SOPAC in principle, and incorporated in the indicator questionnaire. The final list of indicators included 47 questions - 10 fewer that the original EVI, is presented below.

CLASSIFICATION OF THE INDICATORS

The indicators are classified into 5 categories:
M = Meteorological;
G = Geological;
B = Biological;
C = Country Characteristics; and
A = Anthropogenic.

These indicators can be grouped into three sub-indices namely:
REI = Exposure to natural or human risks / hazards
EDI = Environmental Degradation Index. This measures present status of the 'health' of the environment It is based on the assumption that past impacts affect the ability of the environment to tolerate new impacts.
IRI = Intrinsic resilience index

MAPPING OF RESPONSE

The response to each question is mapped on a 1 to 7 scale, with 1 referring to the lowest possible impact and 7 to the highest. After adjustment for weighting[7], the scores are averaged to produce a summation taking the value of between 1 and 7. This summation is reported for the EVI and for its sub-indices.

Where data for a particular question are unavailable, the relevant indicator will be omitted from the average, so that it makes no contribution to the mean. At least 80% of the indicator questions have to be answered for a valid EVI to be calculated for a particular country.

[6] A full report of the Think Tank meeting is given in Kaly, U., Briguglio, L., McLeod, H., Schmall, S., Pratt, C. and Pal, R. (1999). *Proceedings of the Environmental Vulnerability Index (EVI) Think Tank 7-10 September 1999.* SOPAC Technical Report.

[7] Originally the SOPAC team assigned a weight of 1 to 51 of the original 57 indicators and a weight of 5 to the remaining six indicators, on the assumption that the latter had a much higher impact on the environment than the former. This approach was very tentative, and it was recognised that some guidance was necessary from the Think Tank experts. However, no broad agreement was forthcoming regarding this matter from the Think Tank meeting, although it was stressed that appropriate weighting of the EVI indicators was a very important requisite. At the Think Tank meeting, the 47 indicators ere rated in terms of relative importance by participants and a simple weighting scale involving 5 categories was suggested.

THE EVI INDICATORS
LIST COMPILED FOLLOWING THE SUGGESTIONS PUT FORWARD DURING THE SOPAC THINK TANK MEETING HELD IN FIJI BETWEEN 7 AND 10 SEPTEMBER 1999

				Importance Assigned[8]		
Indicator Number	Sub-Index	Category	Indicator	Mean Score[9]	SD[10]	f(0)[11]
1	REI	M	Greatest average annual deviation in Surface Sea Temperature in last 5 years from long term mean (30 years) (more work required to finalise form) (Centralised database)	2.48	1.12	1
2	REI	M	% of reference climatological stations experiencing >= 1/100 yr. 3 second wind gusts in a 5 year period / land area	2.48	1.25	1
3	REI	M	% of reference climatological stations experiencing <= 1/100 yr. minimum annual rainfall in a 5 year period / land area	2.35	1.18	1
4	REI	M	Cumulative number of 24 hr periods over all reference climatological stations over last 5 years during which rainfall is >= 1/100 yr. event / stations	2.14	1.15	1
5	REI	M	% of reference climatological stations experiencing >= 1/100n yr. daily max temp in a 5 year period	2.10	1.18	1
6	REI	M	% of reference climatological stations experiencing <= 1/100 daily min temp in a 5 year period / land area	2.05	1.16	1
7	REI	G	Number of volcanoes with potential for eruption >= VEI 4 (Volcano explosivity Index) within 100km of country land boundary / area of land	2.10	1.18	1
8	REI	G	Earthquake energy within 100km of country land boundaries / land area with ML >=6.0 and <=15km depth per 5 years	1.95	1.32	2
9	REI	G	Number of tsunamis or storm surges with run-up >2m above MHWS / 100km coastline since 1900	1.95	1.24	2
10	IRI	C	Total land area (sq. km)	2.71	1.45	2
11	IRI	C	Ratio of length of ocean shoreline : total land area	2.62	1.32	1
12	IRI	C	Distance to nearest continent (km)	1.90	1.09	0
13	IRI	C	Altitude range (Highest point – lowest point in country)	2.19	1.08	1
14	IRI	C	Percent of land area <10m above sea-level	2.57	1.16	0
15	IRI	C	Land area below 10m elevation with unimpeded access to the coast composed of unconsolidated sediments (excluding coral reefs and ice) / land area (%)	2.00	1.22	2
16	IRI	C	Number of known endemic species / 10,000 sq. km land area	2.52	1.17	1
17	REI	B	Number of catastrophic organism outbreaks over the last 5 years / land area (pathogens, blooms, plagues etc)	2.29	1.10	0
18	REI	B	Total tonnage of freight imported / year	2.05	1.20	1
19	EDI	B	Number of all introduced species / 10,000 sq. km land area since 1900	2.14	1.42	3
20	EDI	B	Number of endangered & threatened species / 10,000 sq. km of land area (IUCN definitions)	2.76	1.18	1
21	EDI	B	Number species which have become extinct since 1900 / 10,000 sq. km land area (IUCN definitions)	2.71	0.85	0
22	EDI	B	Percentage of natural & regrowth vegetation remaining (e.g. forests, mangroves, saltmarshes, prairies, savannah, desert, tundra)	2.67	1.43	2
23	EDI	B	Tonnage of intensively-farmed animal products / yr. / land area	1.81	1.08	2
24	EDI	B	Percent of fisheries stocks overfished (FAO)	2.6	1.03	0
25	EDI	A	Density of people living in coastal settlements (define area)	2.6	1.12	1
26	REI	A	Total human population density (per sq. km land area)	3.6	0.75	0
27	REI	A	Annual human population growth rate (average over last 5 years)	2.9	0.94	0

[8] Perceived importance by 21 experts present at the Think Tank Meeting, who were asked to rank the 47 indicator in terms of the importance attached on a scale ranging from 0 to 4, with zero indicating no importance (to be discarded) and 4 indicating the highest importance.
[9] This represents the mean of the scores assigned by the Think Tank experts.
[10] Standard Deviation associated with the mean.
[11] f(0) refers to the number of times that a 0 was assigned to the indicator.

Indicator Number	Sub-Index	Category	Indicator	Importance Assigned[8]		
				Mean Score[9]	SD[10]	f(0)[11]
28	REI	A	Net percentage of land area changed by the removal of natural vegetation over last 5 years	3.0	1.14	1
29	REI	A	Annual number of international tourists * average days stay / 365 / 100 sq. km (last 5 years)	2.1	1.16	1
30	REI	A	Megalitres of untreated industrial and domestic wastewater discharged to aquatic system / 1,000 km aquatic ecosystems (length coast + length rivers)	2.6	1.28	1
31	REI	A	Total tonnage of generated and net imported toxic, hazardous & municipal wastes/ 10,000 sq. km land area / year (average last 10 years)	2.0	1.14	0
32	REI	A	Mean percent of industrial and municipal waste managed or treated / yr.	2.0	1.16	2
33	REI	A	Number spills of oil and hazardous substances >1,000 litres during last 5 years within territorial waters	1.7	0.85	0
34	REI	A	Number of nuclear, chemical and other major industrial facilities that could cause significant damage / 10,000 sq. km land area	1.7	0.96	0
35	REI	A	Number of cars / land area	2.4	0.97	0
36	REI	A	Max 24 hour SO_2 concentration (micro g /cubic m) (average over last 5 years)	2.3	0.86	0
37	REI	A	Tonnes of N,P,K fertilisers used / 10,000 sq. km agricultural land area / year (average last 5 yr.)	1.9	0.82	0
38	REI	A	Tonnes of pesticides used / 10,000 sq. km of agricultural land / year (average last 5 years)	1.9	0.84	0
39	REI	A	Number of new fisheries species added to country over last 5 years (within territory)	1.6	1.02	2
40	EDI	A	% Land area degraded since 1950	3.1	1.14	1
41	EDI	A	Question on importance of water…?	2.6	1.35	1
42	REI	A	Kilotonnes of mining material (ore + tailings) extracted / 10,000 sq. km land area / year (average last 5 years)	1.3	0.64	1
43	EDI	A	Land and sea area affected by mining & quarrying / land area	1.7	1.10	2
44	EDI	A	Percent of terrestrial zone set aside as reserves	2.3	1.10	0
45	EDI	A	Percent of marine zone set aside as reserves (mean high tide to continental shelf)	1.9	1.22	2
46	EDI	A	Number of war or civil strife years over the last 50 years within the territory	2.1	1.20	3
47	REI	A	Environmentally related legislation with regulations	na	na	na

THE EVI INDICATORS
LIST COMPILED FOLLOWING THE SUGGESTIONS PUT FORWARD DURING THE MALTA MEETING BETWEEN 29 NOVEMBER AND 3 DECEMBER 1999[12]

				Importance Assigned[13]		
Indicator Number	Sub-Index	Category	Indicator	Mean Score[14]	SD[15]	f(0)[16]
1	REI	M	Greatest average annual deviation in surface sea temperature during last 5 years, from long term average (use a 30 year average).[17]	2.9	1.07	0
2	REI	M	Number of days over the last 5 years during which the maximum recorded wind speed (3 sec gusts) was at least 20% higher than the average maximum for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).	2.4	1.22	1
3	REI	M	Number of months over the last 5 years during which rainfall was at least 20% lower than the 30 year average for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).	3.1	0.83	0
4	REI	Met	Number of months over the last 5 years during which rainfall was at least 20% higher than the 30 year average for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).	2.9	0.86	0
5	REI	M	Number of days over the last 5 years during which the maximum temperature was at least 5^0C higher than the mean monthly maximum for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).	3.1	0.86	0
6	REI	M	Number of days over the last 5 years during which the minimum temperature was at least 5^0C lower than the mean monthly minimum for that month (use a 30 year average for each month as reference, and average the results over all reference climate stations).	2.9	0.92	0
7	REI	G	Number of volcanos (with potential for eruption) having a Volcano Explosivity Index equal or greater than 4. The result to be expressed as a ratio of land area. (Volcanos situated 100 km of country land boundary).	2.9	1.03	0
8	REI	G	Earthquake energy with ML >=6.0 and <=15km depth per 5 years. (The earthquake energy occurring 100 km of country land boundaries). The result to be expressed as a ratio of land area.	3.1	1.00	0
9	REI	G	Number of tsunamis or storm surges per 100 km of coastline, with run-up greater than 2m above MHWS since 1900.	2.9	0.95	0
10	IRI	C	Total land area (km^2)	3.4	0.93	0
11	IRI	C	Length of ocean shoreline (km) expressed as a ratio of total land area	3.1	1.17	0
12	IRI	C	Distance to nearest continent (km).[18]	2.0	0.88	1
13	IRI	C	Altitude range measured as the difference between the highest point and the lowest point in country.	2.3	0.99	0
14	IRI	C	Percent of land area which is lower than 10 meters above sea-level.	3.2	0.89	0
15	IRI	C	Percentage of land area, composed of unconsolidated sediments, which is lower than 10 meters elevation, situated within 2 km of the coast (exclude coral reefs and ice).[19]	2.8	0.80	0
16	IRI	C	Number of known endemic species per 10,000 km^2 land area.	2.9	1.38	1
17	REI	B	Number of reported (and verified by appropriate authorities) organism outbreaks over the last 5 years (pathogens, blooms, plagues) expressed as a ratio of land area.[20]	2.7	0.75	0
18	REI	B	Total tonnage of freight imported annually during the last five years, expressed as a ratio of land area.	2.2	0.97	1
19	EDI	B	Number of all species introduced in the country since 1900, per 10,000 km^2 land area.	2.3	0.61	0
20	EDI	B	Number of endangered and threatened species per 10,000 km^2 of land area (use IUCN definitions).	3.3	0.73	0

[12] The EVI indicators were discussed, one by one, by the participants in the Malta meeting, and a number of changes were suggested, as detailed in Section 5.2 of the main report. The list which appears here was approved by participants. It should be noted that some of the indicators require further refinement. This task was left for completion by the SOPAC team of consultants.
[13] Perceived importance by 15 experts present at the Malta Meeting, who were asked to rank the 47 indicator in terms of the importance, on a scale ranging from 0 to 4, with zero indicating no importance (to be discarded) and 4 indicating the highest importance.
[14] This represents the mean of the scores assigned by the Malta meeting experts. In general the Maltese experts assigned higher scores to the indicators than the Think Tank experts (the mean difference being 22% higher).
[15] Standard Deviation associated with the mean.
[16] f(0) refers to the number of times that a 0 was assigned to the indicator.
[17] This indicator requires further work.
[18] Addition work is need regarding the definition of continent.
[19] This indicator may be somewhat difficult to measure.
[20] The terms verified needs further definition.

Indicator Number	Sub-Index	Category	Indicator	Importance Assigned[13]		
				Mean Score[14]	SD[15]	f(0)[16]
21	EDI	B	Number species which have become extinct since 1900 per 10,000 km^2 land area (use IUCN definitions).	2.9	0.86	0
22	EDI	B	Percentage of natural and regrowth vegetation remaining (such as: forests, mangroves, saltmarshes, prairies, savannah, desert, tundra).	3.5	0.65	0
23	EDI	B	Tonnage of intensively-farmed animal products over the last five years expressed as a ratio of land area (includes acquaculture, pigs, chickens).	2.5	0.94	0
24	EDI	B	Percent of fisheries stocks overfished (use FAO definitions).[21]	3.1	0.73	0
25	EDI	A	Density of people living in coastal settlements expressed as a ratio of land area.[22]	3.4	0.63	0
26	REI	A	Total human population density expressed as a ratio of land area.	3.5	0.65	0
27	REI	A	Annual human population growth rate, averaged over the last 5 years.	3.5	0.85	0
28	REI	A	Net percentage of land area changed by the removal of natural vegetation over the last 5 years	3.2	0.80	0
29	REI	A	Annual number of international tourists, multiplied by the number of nights stayed, expressed as a ratio of land area, over the last 5 years.	2.9	0.73	0
30	REI	A	Megalitres of untreated industrial and domestic wastewater discharged to aquatic system expressed per 1,000 km aquatic ecosystems (length of coast plus length of rivers) over the last 5 years.[23]	3.3	0.91	0
31	REI	A	Total tonnage of generated and net imported toxic, hazardous and municipal wastes expressed per 10,000 km^2 land area, expressed as an annual average over the last 5 years.	3.4	0.84	0
32	REI	A	Percent of hazardous, toxic and municipal waste effectively managed or treated over the last five years.[24]	3.4	0.84	0
33	REI	A	Number of spills of oil and hazardous substances greater than 1,000 litres during last 5 years on land, in rivers or within territorial waters, expressed as a ratio of land area.	3.0	1.11	1
34	REI	A	Number of nuclear, chemical and other major industrial facilities that could cause significant damage, per 10,000 km^2 land area and territorial waters.[25]	3.4	1.01	0
35	REI	A	Number of vehicles (as per World Bank definition) expressed as a percentage of land area during the last year .	3.0	0.88	0
36	REI	A	Maximum 24 hour SO_2 concentration (micro g /cubic m) annual average over the last 5 years.	2.8	0.90	0
37	REI	A	Tonnes of N,P,K fertilizers used per 10,000 km^2 of agricultural land area, annual average over the last 5 years.	2.9	0.66	0
38	REI	A	Tonnes of pesticides used per 10,000 km^2 of agricultural land area, annual average over the last 5 years.	2.8	0.70	0
39	REI	A	Number of new fisheries stocks or expanded fisheries efforts (measured as at least 20% increase in catches) added within the territorial area of the country over last 5 years.[26]	2.4	0.85	0
40	EDI	A	Percentage of land area (excluding urban areas) degraded since 1950 (includes salinisation and desertification).[27]	3.6	0.74	0
41	EDI	A	Annual internal renewable water resources (average annual runoff plus recharge of groundwater from endogenous precipitation) per capita, over the last five years.	3.2	0.97	0
42	REI	A	Kilotonnes of mining material (ore and tailings) extracted per 10,000 km^2 land area. Annual average over the last 5 years.	2.5	0.97	1
43	EDI	A	Percentage of land, rivers and offshore coastal zone (1 kilometre outside shore) affected by mining and quarrying.	2.5	0.65	0

[21] Requires further work.
[22] This indicator requires further work to refine the denominator.
[23] Requires further work to define length of rivers.
[24] This indicator requires further work to define the concepts "managed" and "treated".
[25] This indicator requires further work to refine the denominator, which could be "territorial area".
[26] This indicator requires further refinement.
[27] This indicator may be somewhat difficult to measure.

				Importance Assigned[13]		
Indicator Number	Sub-Index	Category	Indicator	Mean Score[14]	SD[15]	f(0)[16]
44	EDI	A	Percent of terrestrial area set aside as reserves.	3.0	0.78	0
45	EDI	A	Percent of marine zone set aside as reserves (mean high tide to continental shelf)	3.0	0.78	0
46	EDI	A	Number of years of war or civil strife over the last 50 years within the country territory.[28]	2.7	1.14	0
47	EDI	A	Percentage of population with access to safe sanitation (use WHO definitions).[29]	2.7	0.63	0

[28] This indicator requires further work to define the concepts of "war" and "civil strife"
[29] This index requires further refinement.

APPENDIX 4

EXTENDING SOPAC'S ENVIRONMENTAL VULNERABILITY INDEX TO THE IMA AND CARIBBEAN REGIONS

Background paper prepared by

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held at the Foundation for International Studies, Valletta, Malta
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CONTENTS

1. INTRODUCTION

1.1 Background

During the nineties, there has been a growing interest in Small Island Developing States (SIDS), with special attention being given to their economic and environmental vulnerabilities. Two main events took place in this connection, namely the 1994 Global Conference on the Sustainable Development of SIDS and the 1999 Special Session of the United Nations General Assembly. In the Barbados Programme of Action there is a call for the development of an index that expresses vulnerability[30], while in the UNGASS final statement, this call was further elaborated.[31] The benefits of producing a Vulnerability Index include that it can attract attention to the plight of vulnerable states and that it attempts to quantify the extent to which some states are more vulnerable than others. The index could also provide a useful tool for environmental authorities and managers of vulnerable states. Several studies have been produced on the economic vulnerability and, more recently, on environmental vulnerability.[32]

1.2 The SOPAC study

The SOPAC programme on the development of the Environment Vulnerability Index (EVI) started in August 1998, focussing on the Pacific SIDS. The study attempted to develop a logical framework and methods of calculating and index for environmental vulnerability (EVI) and to identify and collect data to calculate the index. The result of this first attempt are reproduced on the Internet site http://www.unep.ch/islands/devi.htm (see also Kaly *et al* 1999a). A total of 57 indicators of environmental vulnerability were finally selected for inclusion in the index. This included 39 indicators of risk (REI), 5 indicators of resilience (IRI) and 13 indicators of environmental integrity or degradation (EDI). Many of the indicators were expressed as a ratio of area of land or coast rather than simply absolute numbers because it is risk density or proportion of area degraded that is of interest from an environmental perspective.

On the basis of the first attempt at constructing the EVI, it was concluded that it was possible to produce single-figure measures of environmental vulnerability across three countries[33], although it was stressed that the results were tentative and preliminary because there was insufficient time to collect all of the data required for these three countries and there were some problems with reliability of the data.

Following this first attempt at quantifying the index, SOPAC organized a Think Tank in September 1999 with the aim of obtaining a peer-review and commentary from experts in a range of fields relevant to the development of the EVI and to render the EVI acceptable and/or operational in the international community (see Kaly *et al*, 1999b). The meeting also attempted to set criteria that would need to be met to ensure that the EVI will be internationally applicable to all regions of the world and to identify directions for future work. Following the Think Tank meeting, the number of indicators was reduced to 47 and the context of the index was shifted to global.

[30] Article 113 of the Programme of Action states: "Small island developing States, in cooperation with national, regional and international organizations and research centres, should continue work on the development of vulnerability indices and other indicators that reflect the status of small island developing States and integrate ecological fragility and economic vulnerability. Consideration should be given to how such an index, as well as relevant studies undertaken on small island developing States by other international institutions, might be used in addition to other statistical measures as quantitative indicators of fragility".

[31] Three paragraphs (Section F, para. 39 to 41) dealt with the Vulnerability Index in the document adopted by the Special Session of the UN General Assembly (September 1999), wherein the need to compute a vulnerability index was again stressed.

[32] A list of studies on the Vulneranbility Index is given in the references section. See also section 2.1 of this report.

[33] The three countries were Tuvalu, Fiji and Australia.

1.3 The present report

This present report is in the context of a project initiated and funded by UNEP to extend the SOPAC's EVI and assess the applicability of the model for the Caribbean, Indian Ocean, Mediterranean and Atlantic regions. It also puts forward preliminary recommendations as to how these regions can be involved in the process of further developing the EVI. One of the main activities of the project is an expert workshop in Malta, which the Islands and Small States Institute of the University of Malta was entrusted to organize. The Island and Small States institute was also assigned the task of producing this report, on the basis of inputs by Dr Ursula Kaly and Prof Lino Briguglio, assisted by Mr Craig Pratt.

This report is organised as follows. Section 2, which follows this introduction gives the background of the Environmental Vulnerability Index and the work done so far in the development of this index. Second 3, contains an overview of the SIDS in the IMA[34] and Caribbean regions, since the focus of this study is on these SIDS. Section 4 zooms in on six SIDS in these regions, namely Cape Verde, Jamaica, Malta, Mauritus, St Lucia and Trinidad and Tobago. These small states were chosen on an experimental basis to extend the SOPAC experiment to other regions. Section 4 also discusses possible additional indicators which may be required to take into account the special circumstances in the six SIDS in the IMA and Pacific regions. Section 5 concludes the study.

[34] IMA stands for Indian Ocean, Mediterranean and Atlantic Ocean

2. CURRENT STATUS OF THE EVI

This section describes the current status of the development of the Environment Vulnerability Index. This Index, which has been developed to simplify what would otherwise be a long and complex process of assessment, produces a single-figure to express the relative environmental vulnerability of entire country. This expression of vulnerability could be used as part of the argument for the ranking of countries and for assigning some special status to countries which are shown to be more vulnerable than others. It could also be used to provide estimates of the resilience of countries to particular events of concern, such as natural hazards, geological events, and particular kinds of hazards such as a volcanic eruption.

For a particular country, the EVI could be used to identify areas of weakness to particular risks and of high environmental degradation, giving the governments of that country useful information for environmental management.

2.1 Background: purpose and history

A range of indices have been developed over the past decade which attempt to describe, in a single expression, the vulnerabilities of different aspects of states to a range of internal and external stressors. The central purpose of constructing an EVI is to simplify the task of categorising countries according to their relative environmental vulnerabilities. If personnel, funding and time were unlimited, this could be done by sending several independent teams of scientists to each country and commissioning them to carry out a vulnerability assessment for each. The replicate assessments for each country could then be used to classify countries in terms of their vulnerability. This exercise would of course be extremely expensive and it is one of the purposes of the EVI to simplify this process.

Studies of vulnerability are necessarily concerned with two groups of variables. These are the "risks" which may cause unacceptable change to human and natural systems (e.g. cyclones, anthropogenic impacts), and "responders", those human and natural systems affected by the risks (e.g. economies, ecosystems).

Some studies on vulnerability indices base the index in relation to the risks involved and not the responders to those risks. For example, Pantin's (1997) Ecological Vulnerability Index was concerned with effects of natural disasters on human systems. This index was therefore more of a "Human Vulnerability Index" since after all, it is the human systems which were deemed vulnerable, not the natural disasters themselves. The EVI, as proposed by SOPAC deals with the impact on the environment, on not on humans *per se*.

Attempts have been made to provide indices for economic systems (Briguglio, 1992, 1993, 1995, 1997; Wells, 1996, 1997; Atkins *et al*. 1998; Chander, 1996; Crowards, 1998), climate change and sea-level rise (IPCC, 1991, 1992; Pernetta, 1990; Downing, 1992; Formel, 1996), ENSO phenomena (NOAA, 1997), human impacts on the environment (Ehrlich & Ehrlich, 1991, UNEP, 1998; Eurostat, 1998), and the effect of natural disasters on human systems (Albala-Bertrand, 1993; Pantin, 1997).

Prior to the development of the SOPAC EVI, the number of different vulnerability indices developed to examine the relative vulnerabilities of states in terms of these risks and responders totaled at least fifteen (see Kaly *et al*. 1999a). The risks of concern varied among studies. Anthropogenic risks were considered in 11 of the fifteen studies, and 6 studies focused on climate change and sea-level rise and 6 studies considered natural disasters. In terms of responders, thirteen of the indices were concerned with risks to human economic and social systems, while only 5 attempted to include effects on the natural environment. Only 1 study specifically examined the effects of both humans and natural hazards on the environment.

The underlying argument in SOPAC's EVI is that the "[physical] environment" is the basis of all human activities. Poor environmental conditions mean fewer or poorer quality natural resources and poorer ecosystem services (such as attenuation of wastes and pollution). Concern for the quality of the [physical] environment is therefore well-founded because neither economic systems, quality of human life, nor human development will thrive without it. It is the object of this EVI to shift the focus of vulnerability indices off human systems and onto the foundations on which they are built. The SOPAC EVI is a true environmental vulnerability index, based on a wide array of environmental indicators which examines both natural and anthropogenic risks to environmental health (Kaly *et al*. 1999a,b).

2.2 Approach and progress on the EVI

The SOPAC EVI (Kaly *et al*. 1999a,b) was developed in response to a call made in the Barbados Programme of Action, and an increasing awareness that small island developing states face disadvantages to their development associated with their remoteness, small size, dispersion, economic conditions and limited natural resources. It was initially developed with a focus on the Small Island Developing States (SIDS) of the Pacific Region (Kaly *et al*., 1999a) and later peer reviewed and expanded to more global relevance during a Think Tank which utilised relevant experts from around the world (Kaly *et al*., 1999b).

The EVI was constructed on a theoretical framework that identified two main aspects of vulnerability, risks and resilience, that could be further broken down into a total of three distinct aspects:

- risks or hazards to the environment (natural and anthropogenic);
- intrinsic resilience; and
- extrinsic resilience.

Intrinsic resilience is the innate ability of the environment to cope with hazards (expressed as good recovery rates, high productivity or natural resistance to damage) and extrinsic resilience is related to ecosystem health (the amount of degradation of the environment as a result of past impacts determines the ability of ecosystems to cope with future stresses).

These three aspects correspond to three sub-indices,

- the REI or Risk Exposure sub-Index, and
- the IRI Intrinsic Resilience sub-Index; and
- the EDI (Environmental Degradation sub-Index).

The IRI and the EDI together form the RI, or Resilience sub-Index.

A total of 47 indicators of environmental risk and resilience was assembled, 27 for the REI, 7 for the IRI and 13 for the EDI (Kaly et al*., 1999b). These indicators are to be evaluated for each country and scored in the range of 1-7 in order to allow for heterogeneous data on different scales to be accumulated on a single linear scale (thus transforming them to permit summation of the different components of the index).*

Each sub-index (or component) for a particular country is to be calculated as an average of scores obtained and the final EVI calculated as an average across all indicators, regardless of the sub-index to which they belong. Although weighting schemes were applied to the EVI, a final system for weighting the indicators awaits the results of more rigorous mathematical testing. It is intended that data would be collected every five years to provide an update on the vulnerability status of each country.

To ensure that the final EVI values calculated are able to identify differences in vulnerability among countries and provide an unbiased assessment for each, a series of criteria were used during their selection (Table 1).

Table 1
Criteria for the selection of indicators for the EVI

1	The data should be available or easily obtainable
2	The indicators should measure change or be a proxy for change which would do significant harm to the environment
3	A particular indicator could weighted to reflect the probability of change to the environment and the amount of damage which might be done
4	The indicators should be relatively easy for users to understand
5	Be as uncorrelated with other indicators as possible to limit redundancy
6	Be suitable for international comparisons across countries

2.3 Current status

The EVI developed by SOPAC has come a long way but requires further refinement. The progress described above constituted Phase I and some of Phase II of the project, and was designed to determine whether it was possible to produce an EVI, and if so, expose it to peer review at the technical level.

A preliminary test of the EVI based on the initial model developed by Kaly *et al.*, (1999a) was promising and produced single figure indices for Australia, Fiji and Tuvalu that highlighted known differences in the levels of environmental degradation. That initial model and indicators have now been superseded (see Kaly *et al.*, 1999b). A new list of proposed indicators, shown in Table 2, is awaiting complete definition, setting of the scoring scale and testing for redundancies, a process which will require data from a range of test countries. The work (and funding) remaining for Phase II is to collect data for at least 5 Pacific states for initial testing. Full testing will require a larger sample of countries from around the globe.

The methodology selected in the computation of the index appears to produce results which are expected to have operational usefulness for identifying the environmental vulnerabilities of countries. Data for the new SOPAC EVI have already been collected for Tuvalu with relative ease (one person-week of work in-country). There now remains the large task of fully globalising the model and its indicators before final testing can be completed.

Table 2
List of the indicators selected by the Think Tank group for inclusion in the EVI

Indicator Number	Sub-Index	Category	Indicator	Weight Proposed
1	REI	Met	Greatest average annual deviation in Surface Sea Temperature in last 5 years from long term mean (30 years) (more work required to finalise form) (Centralised database)	M
2	REI	Met	% of reference climatological stations experiencing >= 1/100 yr 3 second wind gusts in a 5 year period / land area	M
3	REI	Met	% of reference climatological stations experiencing <= 1/100 yr minimum annual rainfall in a 5 year period / land area	M
4	REI	Met	Cum # of 24 hr periods over all Reference Climate Stations over last 5 years during which rainfall is >= 1/100 yr (1/50, 1/20 ?? Less?) event / stations	M
5	REI	Met	% of reference climatological stations experiencing >= 1/100n yr daily max temp in a 5 year period	M
6	REI	Met	% of reference climatological stations experiencing <= 1/100 daily min temp in a 5 year period / land area	M
7	REI	G	Number of volcanos with potential for eruption >= VEI 4 (Volcano explosivity Index) within 100km of country land boundary / area of land	M
8	REI	G	Earthquake energy within 100km of country land boundaries / land area with ML >=6.0 and <=15km depth per 5 years	L

9	REI	G	Number of tsunamis or storm surges with run-up >2m above MHWS / 100km coastline since 1900	L
10	IRI	CC	Total land area (sq km)	H
11	IRI	CC	Ratio of length of ocean shoreline : total land area	H
12	IRI	CC	Distance to nearest continent (km)	L
13	IRI	CC	Altitude range (Highest point - lowest point in country)	M
14	IRI	CC	Percent of land area <10m above sealevel	H
15	IRI	CC	Land area below 10m elevation with unimpeded access to the coast composed of unconsolidated sediments (excluding coral reefs and ice) / land area (%)	M
16	IRI	CC	Number of known endemic species / 10,000 sq km land area	H
17	REI	B	Number of catastrophic organism outbreaks over the last 5 years / land area (pathogens, blooms, plagues etc)	M
18	REI	B	Total tonnage of freight imported / year	M
19	EDI	B	Number of all introduced species / 10,000 sq km land area since 1900	M
20	EDI	B	Number of endangered & threatened species / 10,000 sq km of land area (IUCN definitions)	H
21	EDI	B	Number species which have become extinct since 1900 / 10,000 sq km land area (IUCN definitions)	H
22	EDI	B	Percentage of natural & regrowth vegetation remaining (e.g. forests, mangroves, saltmarshes, prairies, savannah, desert, tundra)	H
23	EDI	B	Tonnage of intensively-farmed animal products / yr / land area	L
24	EDI	B	Percent of fisheries stocks overfished (FAO)	H
25	EDI	A	Density of people living in coastal settlements (define area)	H
26	REI	A	Total human population density (per sq km land area)	H
27	REI	A	Annual human population growth rate (average over last 5 years)	H
28	REI	A	Net percentage of land area changed by the removal of natural vegetation over last 5 years	H
29	REI	A	Annual number of international tourists * average days stay / 365 / 100 sq km (last 5 years)	M
30	REI	A	Megalitres of untreated industrial and domestic wastewater discharged to aquatic system / 1,000 km aquatic ecosystems (length coast+length rivers)	H
31	REI	A	Total tonnage of generated and net imported toxic, hazardous & municipal wastes/ 10,000 sq km land area / year (avaerge last 10 years)	M
32	REI	A	Mean percent of industrial and municipal waste managed or treated / yr	L
33	REI	A	Number spills of oil and hazardous substances >1,000 litres during last 5 years within territorial waters	L
34	REI	A	Number of nuclear, chemical and other major industrial facilities that could cause significant damage / 10,000 sq km land area	L
35	REI	A	Number of cars / land area	M
36	REI	A	Max 24 hour SO2 concentration (micro g /cubic m) (average over last 5 years)	M
37	REI	A	Tonnes of N,P,K fertilizers used / 10,000 sq km agricultural land area / year (average last 5 yrs)	L
38	REI	A	Tonnes of pesticides used / 10,000 sq km of agricultural land / year (average last 5 years)	L
39	REI	A	Number of new fisheries species added to country over last 5 years (within territory)	L
40	EDI	A	% Land area degraded since 1950	H
41	EDI	A	Question on importance of water (to be developed)	H
42	REI	A	Kilotonnes of mining material (ore + tailings) extracted / 10,000 sq km land area / year (average last 5 years)	L
43	EDI	A	Land and sea area affected by mining & quarrying / land area	L
44	EDI	A	Percent of terrestrial zone set aside as reserves	M
45	EDI	A	Percent of marine zone set aside as reserves (mean high tide to continental shelf)	L

46	EDI	A	Number of war or civil strife years over the last 50 years within the territory	M
47	REI	A	Environmentally related legislation with regulations	L

The indicators are classified into 5 categories (Met = Meteorological, G = Geological, B = Biological, CC = Country Characteristics and A = Anthropogenic).. The final list of indicators were categorised by the Think Tank participants in terms of their perceived importance so that preliminary weightings could be assigned. Participants were asked to score each indicator with a value of between 0 and 4, where 0 showed the lowest level of importance (to be discarded) and 4 the highest. The results of this weighting exercise are shown in the last column of the table; as suggested weighting (L = low, M = Medium, H = High). Data were collected from 21 Think Tank participants.

2.4 Extending the SOPAC EVI Model for the Caribbean and IMA Regions

To extend the EVI to the Caribbean and IMA small island states, it will be necessary to adapt the indicators, their scoring scales and weights. The mechanics of calculating the EVI (framework or model) and other inherent features of the index will remain the same, regardless of the region of the world for which they are applied. The main considerations will be to determine what the particular environmental concerns relevant for the IMA and Caribbean SIDS are, to adapt the existing indicators and/or develop new indicators which cater to these needs, collect the data necessary for setting the new levels of all indicators and develop a plan of action for making data collection part of the normal reporting of each country.

The first step in adapting the EVI to include and be relevant to Caribbean and IMA regions is to select a small sample of countries from which to draw relevant indicators. It will be necessary to preface this investigation with a consideration of the explicit requirements of these countries for an environmental vulnerability index. The SOPAC EVI is specifically designed for natural environments and takes a snap-shot of the likelihood of damage from hazards, and the ability of that country as a whole to tolerate those hazards. It is envisaged that the same would be required by the other regions. To change this approach would be to eliminate the possibility of comparisons among states or regions.

A consideration of the special environmental concerns for Caribbean and IMA SIDS would require identification and discussion on all of the main natural and anthropogenic risks occurring in a range of countries from those regions. A similar process would need to occur for the questions of intrinsic resilience, expressed as permanent characteristics of a country that predispose it to environmental vulnerability and extrinsic resilience, expressed as environmental degradation. Many of the concerns will already have been incorporated into the SOPAC EVI and will not require new indicators. It is expected, however, that some new indicators will be required.

2.5 Adapting the existing indicators and developing new indicators

To explore the possibilities of adapting the existing indicators to regions other than the Pacific, SOPAC has agreed to collaborate with the Islands and Small States Institute in the convening of a UNEP workshop in Malta, between 29 November and 3 December 1999. The workshop will examine the possibility of obtaining data for six SIDS in the IMA and Caribbean regions, which are Cape Verde, Jamaica, Malta, Mauritius, St Lucia and Trinidad and Tobago. This will be a pilot experiment which could eventually be extended to include other states, in preparation for the globalisation of the index.

Once the special circumstances of these six SIDS have been fully identified, and if the existing indicators do not reflect these special circumstances it will be necessary to incorporate new indicators in the EVI.

The most important requisite will be to revise and extend the mapping of heterogeneous data onto the 1-7 scale in such a way that SIDS from the three main regions (Pacific, IMA and Caribbean) may be completely incorporated. This process is complex because for each indicator it will be necessary not only to determine the upper and lower limits of values, but also whether the mapping should be on a linear, non-linear, discontinuous, truncated or on a yes/no scale. If the scaling of an indicator is to be non-linear, it would then be necessary to determine what the assumed shape of the underlying

function might be. Although this process has been done for a sample of Pacific countries for many of the SOPAC indicators, it is likely to require reevaluation to take on board countries in the IMA and Caribbean regions. This process may take some time before it is completed.

In the case where new indicators would be required, these will need to be designed so that they meet the criteria in Table 1 above. New indicators would be incorporated on the basis of a need to take into account a signal which is likely to be important to the Caribbean and IMA SIDS and which is not included in any of the other indicators.

2.6 Extending the EVI to six new states

The objective of the Malta meeting is to attempt to apply the EVI, on an experimental basis, for six SIDS situated in the Caribbean and IMA regions. Testing of the EVI requires the collection of data from a range of countries worldwide.

In addition the Malta meeting will serve to introduce the concepts and gain support for the SOPAC EVI in the Caribbean and IMA SIDS and to consult with experts from the Caribbean and IMA regions in identifying their needs and the functions and benefits they expect from the EVI.

Another objective is to determine what the special considerations for the Caribbean and IMA SIDS are in relation to the EVI and attempt to extend the indicators of the EVI model, as developed by SOPAC for the Pacific region, to the Caribbean and IMA SIDS as part of the process of globalising the index.

One of the major inputs of the meeting is to put forward recommendations as to how the IMA and Caribbean regions can be involved, together with the Pacific region, in the process of further developing the EVI and to put forward recommendations on how data collection mechanisms might be set up within Caribbean and IMA countries, and in relation to global data-collection mechanisms.

A long term objective is to identify the process and devise an approach for obtaining the funding needed to complete the global EVI.

Collecting the data is outside of the scope of this meeting, although an attempt will be made to assess the difficulties of procuring suitable information relating countries in these regions. The meeting will however try to identify the probable sources of data for deriving indicators for countries in these regions.

The Malta meeting will explore how best to approach the task of presenting the indicators to the countries. This includes practical considerations of which departments to approach, requirements for capacity-building, translation of the documentation and identification of outside sources of data. It will also be necessary to finds means to incorporate the collection of data for the EVI into normal mechanisms in each country in anticipation of updating the EVI every five years.

2.7 Globalising the EVI

Globalisation of the EVI will require expanding the above processes described for the Caribbean and IMA SIDS to countries with widely differing characteristics across the world. This is a longer term goal of the EVI project and will require the cooperation of a wide variety of countries ranging from the large industrialised countries to the small developing ones, from those occupying large continental masses to those which are, highly-fragmented; and from those situated in tropical regions to others exposed to cold climates. This would ensure that the full range of environmental hazards and conditions across the globe are incorporated into the EVI. The most important aspect of this work will, once again, be the scoring onto the 1-7 scale and weighting of indicators.

2.8 Testing the EVI

Testing of the EVI can begin once the data have been collected for a sufficiently large number of countries which are considered to be a sufficiently good sample of all countries of the world. It is envisaged that about 15 countries will be sufficient in this regard.

Three tests will be performed for the purposes of determining when the EVI would be sufficiently statistically sound for operation. These are summarised in Table 3.

Table 3
Testing required to complete the globalised EVI

Test 1:	When redundant indicators are eliminated. This will be tested using standard statistical tests.
Test 2:	When the spread in EVI values among the 15 test countries occupies much of the 1-7 range expected and countries considered a priori to be 'similar' cluster closer together than 'dissimilar' countries.
Test 3:	When the difference between the value obtained by the EVI and the mean of the assessment provided for a country by several independent experts is about the same or less than the spread for a country found among the experts. (this should be done for around 5 countries).

Redundancies. The first test is of redundancy among indicators. A correlation matrix would be produced using the data for each indicator and country and assessed using a suitable statistical procedures. Any indicator with a high correlation with one or more other indicators would at this stage be dropped or merged. The final list of indicators would then only consist of those which bring significantly new information into the EVI value. The final weighting of indicators can only occur after redundancies in the model have been limited.

Spread. The second test is an analysis of the ability of the EVI model to distinguish between and provide spread among countries. This means that the final EVI scores would need to be evaluated for the test 15 countries. The EVI should be able to cluster similar countries together and provide spread among countries which are considered *a priori* to be very different. The 1-7 mapping scales for each of the indicators (which is the mechanism in the EVI which provides the spread) can be finalised when these data are available.

Validation. The purpose of constructing an EVI is to simplify the task of categorising countries according to their relative environmental vulnerabilities. The only independent means of assessing the effectiveness of the EVI in carrying out this task in a simplified way, is to compare the results of the EVI with a full assessment for a small number of, say 5, countries. Several teams of experts would have to be mobilised in each of the test countries to provide a 'mean assessment' for each. The consultants involved should be independent and must not use the EVI approach to ensure that they do not unintentionally bring bias into the results. These assessments could then be compared with the EVI scores obtained.

3. SIDS IN THE IMA AND CARIBBEAN REGIONS

This section will give an overview of the SIDS in the IMA (Indian Ocean / Mediterranean / Atlantic)[35] and Caribbean[36] regions. As explained in section 2 of this report, it is envisaged that the EVI will be extended to cover these regions, and new indicators may be developed to cater for the special conditions in these SIDS.

3.1 The Economies of the IMA and Caribbean SIDS

The economies of the SIDS considered in this study varied according to various factors, including geographical location of the state and the structure of its economy. Summarised data in this regard is presented in Tables 4 to 7.

Table 4 shows that the highest GDP per capita were registered in Singapore, Bahamas, Cyprus, Malta and Bahrain, four of which are in the IMA-region. However, the countries with the lowest GDP per capita are also IMA-SIDS, namely Guinea Bissau, Comoros, Madagascar and Sao Tome/Principe. The Caribbean SIDS exhibited more homogeneity in their GNP per capita with Haiti and Guyana occupying the lowest levels. A closer look at the structure of the economies of the SIDS in question would show that those SIDS with the highest dependency on the agriculture sector tended to register the lowest GDP per capita. Also the countries which are proximate to main centres of Commerce (Singapore. Malta, Cyprus, and most Caribbean SIDS) tended to register the highest GDP per capita.

Table 5, which deals with the structure of merchandise structure, shows that most SIDS in the regions under consideration, with the exception of Bahrain and Trinidad and Tobago, tend to depend on exports of primary products or light industry . The table also shows that most SIDS depend on a very narrow range of exports.

A common characteristic of small island states is heavy dependence on tourism for income generation and foreign exchange inflows. Table 6 shows that many of the IMA and Caribbean SIDS fall into this category, with the Maldives, Antigua/Barbuda, St Lucia, Bahamas, Barbados, St Kitts/Nevis, Grenada, Jamaica, St Vincent, Malta, Cyprus and Seychelles registering the highest dependence in this regard.

A common feature of SIDS relates to their economic openness, which coupled with their high export concentration, render these states as very vulnerable to economic forces outside their control. Table 7 shows that most SIDS in the regions under consideration have very high dependence on imports and exports. Almost all of them are very much dependent on energy imports, and experience a negative resource balance (the difference between exports and imports of goods and services).

[35] The IMA- SIDS group, as considered in this report, contains one country Guinea-Bissau, which is not an island. This country is included with this group because it forms part of AOSIS (the alliance of small island states), and because it is a coastal state, sharing many of the coastal problems faced by island states. The group also contains two islands which cannot be called small, namely Madagascar and Sri Lanka, but which were considered to share many features of small island states.

[36] Again here the country grouping includes 3 states which are not islands, namely Guyana, Suriname and Belize, which are members of AOSIS and share many features of islands. The group also includes two island states which are not very small, namely Cuba and Dominican Republic which have often associated themselves with small island states in the past

Table 4
The GDP of SIDS in the IMA and Caribbean Regions

			Sectoral Composition of GDP (%) 1994			
	GDP (Million US$ 1995)	GDP per capita (US$) 1995	Agriculture and Fishing	Industrial Production Total	Manufacturing	Private and Government Services
IMA SIDS						
Bahrain	5060	9085	1	43	21	56
Cape Verde	324	862	13	15	5	72
Comoros	227	271	38	13	6	49
Cyprus	8788	11797	5	24	13	71
Guinea Bissau	257	240	45	19	7	37
Madagascar	3160	312	39	13	12	48
Maldives	271	1065	na	na	na	na
Malta	3205	8744	3	39	27	58
Mauritius	3290	2511	9	33	23	58
Sao Tome	46	342	na	na	na	na
Seychelles	474	6493	4	17	na	79
Singapore	83700	25156	-	36	27	64
Sri Lanka	12900	720	24	25	15	52
Caribbean SIDS						
Antigua and Barbuda	493	7585	4	17	2	79
Bahamas	3460	12409	na	na	na	na
Barbados	1740	6678	5	16	7	79
Belize	587	2753	22	27	16	29
Cuba	17827	1638	na	na	na	na
Dominica	227	3197	21	21	8	59
Dominican Rep.	11810	1510	15	22	15	64
Grenada	276	3000	11	19	6	70
Guyana	595	717	36	37	11	27
Haiti	2040	286	44	12	9	44
Jamaica	4410	1787	9	38	18	53
St Kitts and Nevis	225	5488	6	25	11	69
St Lucia	556	3915	11	21	7	68
St Vincent & Grenadines	256	2286	11	22	na	67
Trinidad & Tobago	5330	4141	2	44	9	5

Source: UNCTAD. Tables 6.1 and 6.3

Table 5
Export Structure (1994-95)

	Major Exported Item	Second Major Item	Third major Item	10 major Export items As % of Total Exports	Number of Exported Items*	Concen-tration Index**
IMA SIDS						
Bahrain	Petroleum	Aluminium	Gas	93%	117	0.629
Cape Verde	na	na	na	na	na	na
Comoros	na	na	na	na	na	na
Cyprus	Fruit/veg	Garments	Pharm. Prdcts	65%	96	0.228
Guinea Bissau	na	na	na	na	na	na
Madagascar	Coffee	Spices	Shellfish	76%	58	0.284
Maldives	Fish	Garments	Animal feed	93%	19	0.356
Malta	Electronic comp.	Clothing	Ships & boats	79%	130	0.499
Mauritius	Sugar	Garments	Fish	85%	111	0.313
Sao Tome	na	na	na	na	na	na
Seychelles	Fish	Spices	Animal feed	98%	11	0.677
Singapore	Data processing	Electronic comp.	Petroleum	61%	229	0.211
Sri Lanka	Garments	Tea	Prec. Stones	69%	152	0.218
Caribbean SIDS						
Antigua and Barbuda	na	na	na	na	na	na
Bahamas	na	na	na	na	na	na
Barbados	Sugar	Switchgear	Paper	65%	56	0.190
Belize	Fruit	Sugar	Garments	98%	14	0.572
Cuba	Sugar	Metal Ores	Pharm. Prdcts	92%	na	0.461
Dominica	Fruit	Soap	Pigments	94%	48	0.426
Dominican Rep.	Garments	Pig iron	Med. Instrmnts	62%	108	0.209
Grenada	Spices	Fruit	Cocoa	83%	26	0.326
Guyana	Sugar	Gold	Metal ores	73%	53	0.350
Haiti	Garments	Coffee	Oils/perfumes	73%	38	0.223
Jamaica	Metal ores	Garments	Sugar	89%	112	0.502
St Kitts and Nevis	na	na	na	na	na	na
St Lucia	Fruit	Garments	Paper	93%	32	0.595
St Vincent & Grenadines	na	na	na	na	na	na
Trinidad and Tobago	Petroleum	Oxides etc	Gas	88%	127	0.361

Source UNCTAD. Table 4.3 and 4.5

Note:

* Number of exported items at the 3 digit SITC and having a value greater than $100,000 in 1995 or more than 0.3% of the countries exports.

** The UNCTAD Export concentration takes a value of between 0 and 1, where 1 is maximum concentration. In general the concentration index for small states tends to be higher than that of large states.

Table 6
Tourism Inflows and Incomes

	Revenue from Tourism. (Million US$, 1995)	Number of Tourists (thousand)	Revenue from Tourism as % of GDP	Tourism Revenue as % of Exports of Goods and Services
IMA SIDS				
Bahrain	25	1950	5%	5%
Cape Verde	10	28	3%	12%
Comoros	21	23	10%	46%
Cyprus	1797	2100	21%	43%
Guinea Bissau	-	-	-	-
Madagascar	58	75	2%	8%
Maldives	210	315	78%	66%
Malta	659	1116	20%	22%
Mauritius	430	422	11%	18%
Sao Tome (1990)	2	2	5%	na
Seychelles	129	121	21%	40%
Singapore	8337	6422	10%	6%
Sri Lanka	225	403	2%	5%
Caribbean SIDS				
Antigua and Barbuda	247	212	50%	99%
Bahamas	1346	1598	39%	98%
Barbados	662	442	38%	58%
Belize	77	131	13%	26%
Cuba	977	742	5%	na
Dominica	34	60	15%	33%
Dominican Rep.	186	1776	2%	3%
Grenada	58	108	21%	49%
Guyana	47	106	8%	10%
Haiti	56	145	3%	22%
Jamaica	1069	1147	24%	36%
St Kitts and Nevis	65	79	29%	58%
St Lucia	268	231	48%	70%
St Vincent & Grenadines	53	60	21%	42%
Trinidad and Tobago	73	260	2%	3%

Table 7
Other Economic Features

	Trade Openness (%)	Energy Depen-dence (%)	Resource Balance (% of exports)
IMA SIDS			
Bahrain	102	57	14
Cape Verde	na	100	-215
Comoros	na	100	-147
Cyprus	51	100	-11
Guinea Bissau	29	100	-330
Madagascar	23	93	-50
Maldives	59	100	-334
Malta	97	100	-12
Mauritius	64	99	-9
Sao Tome	na	97	-337
Seychelles	59	100	-14
Singapore	over 100	100	na
Sri Lanka	37	88	-30
Caribbean SIDS			
Antigua & Barbuda	na	100	na
Bahamas	51	100	0
Barbados	49	83	3
Belize	60	100	-12
Cuba	na	na	na
Dominica	59	94	-49
Dominican Rep	27	96	-21
Grenada	51	100	-40
Guyana	91	99	-22
Haiti	14	94	-81
Jamaica	60	99	-8
St Kitts & Nevis	70	100	-39
St Lucia	na	100	-16
St Vincent & Grenadines	63	95	-55
Trinidad & Tobago	38	15	28

- Trade openness = 5(exp+imp)/GDP (average for 1990-1995)
- Energy dependence = energy imports /[imports+production] (average for 1990-1995)
- Number of exported items = number of items with a value of over 0.3% of total exports (1994)
- Concentration index = concentration index as computed by UNCTAD (1994)
- Resource balance = Exports of goods and services less imports of goods and services as percent of exports (average for 1990-1995)
- Debt ratio = long term debt expressed as a ratio of GDP (1994).

3.2 Population and human development

Population and human development indicators for the SIDS considered in this study are shown in Table 8. There is considerable variation in the IMA-SIDS in terms of population growth, population density, with the low income and those with the lowest Human Development Index countries tending to experience the highest population growth rates and the lowest life expectancy.

The population density of the IMA-SIDS, as expected, was highest in the small islands (with the exception of Singapore). The highest densities (after Singapore) occurred in Malta, Maldives and Bahrain. In the Caribbean SIDS, population growth tended to be slower than in the IMA-SIDS. The population densities also tended to be lower than in the IMA-SIDS.

As expected, the SIDS with the highest GDP per capita tended to be those with the highest scores on the Human Development Index.

There was considerable variation in the Human Development Index of the IMA SIDS, with the highest being those of Singapore, Cyprus and Malta.

The Human Development Index of the Caribbean SIDS exhibited less variation than those in the IMA-SIDS, again confirming that the Caribbean SIDS are more homogenous. The states that depart significantly from the others in terms of the Human Development Index in the Caribbean region are Haiti and Guyana.

Table 8
Demographic Features (1995)

	Total Population ('000)	Population growth (1990-95)	Population Density per Km sqr	Human Develop-ment Index	Life Expect-ancy at birth
IMA-SIDS					
Bahrain	567	2.8	803	.870	72
Cape Verde	337	2.6	96	.547	65
Comoros	612	3.2	275	.412	56
Cyprus	745	1.8	81	.907	77
Guinea Bissau	1069	2.1	30	.291	43
Madagascar	14874	3.3	25	.350	57
Maldives	254	3.4	848	.611	63
Malta	367	0.7	1146	.887	76
Mauritius	1117	1.1	547	.831	71
Sao Tome	133	2.2	139	.534	67
Seychelles	73	0.8	162	.845	72
Singapore	3327	2.0	5367	.900	77
Sri Lanka	17928	1.0	273	.711	72
CARIBBEAN SIDS					
Antigua and Barbuda	65	0.6	150	.892	74
Bahamas	279	1.8	20	.894	73
Barbados	261	0.3	606	.907	76
Belize	213	2.6	9	.806	74
Cuba	10908	0.6	99	.723	76
Dominica	71	0.0	95	.873	72
Dominican Republic	7828	1.9	161	.718	70
Grenada	92	0.2	271	.843	72
Guyana	830	0.9	4	.649	63
Haiti	7124	1.9	257	.338	54
Jamaica	2468	0.9	225	.736	74
St Kitts and Nevis	41	-0.5	114	.853	69
St Lucia	142	1.3	229	.838	71
St Vincent and the Grenadines	112	0.9	287	.836	72
Suriname	427	1.3	3	.792	71
Trinidad and Tobago	1287	0.8	251	.880	73

3.3 Main physical features

Tables 9a present the main physical features of the SIDS located in the Indian Ocean, Mediterranean and Atlantic Regions, which here are being collectively called IMA-SIDS. It can be seen that the states in question are very heterogeneous, even those situated in proximity to each other. They differ in size (the largest being Madagascar and the smallest Maldives), climate and terrain. They also tend to face different types of natural disasters.

They vary significantly in terms of "islandness" (measured by the ratio of land area to coastal length), with Maldives and Seychelles exhibiting the highest ratios. The IMA-SIDS also vary in their natural resources endowments, terrain, climate, natural disasters and environmental concerns. The main feature which is shared by many of the islands relates to water shortages and sanitation.

Table 9b shows the main physical features of the Caribbean SIDS. Again here the states are quite heterogeneous, with some states having a large land area and others small, with the largest state being CUBA while the smallest is St Vincent and the Grenadines. As was the case with IMA-SIDS, the Caribbean SIDS differ also in their degree of islandness, natural resource endowments, terrain, climate, natural disasters and environmental concerns. The common factors in the case of the Caribbean region is that most states are susceptible to hurricanes, and they share a tropical climate. In addition, they face common problems associated with marine pollution and deforestation. In terms of terrain, many states in this area are of volcanic origin.

It would appear therefore that these two regions warrant special consideration in terms of environmental indicators. In the case of the IMA-SIDS region, it would appear that water related indicators should be given particular importance. In the case of the Caribbean SIDS, indicators related to climatic and volcanic hazards, and pollution, especially that associated with cruise shipping and industry, should be given special importance.

Table 9a
Physical Features of the IMA-SIDS

Country	Area (Km sqr)	length of coast km	ratio area to coast	Natural resources (excludes fish, timber and agricultural Products)	Natural disasters	Terrain	Climate	Environmental issues
Bahrain	680	161	0.30	oil, natural gas	dust storms and droughts	mostly low desert plain rising gently to low central escarpment	arid with mild winters and very hot, humid summers	desertification, coastal degradation, water shortages
Cape Verde	4030	965	0.25	salt, basalt rock, volcanic ash	droughts; volcanic movements	steep, rugged, rocky and volcanic.	temperate with a warm, dry summer	soil degradation, droughts
Comoros	2170	340	0.16	negligible	cyclones and tsunamis	rugged	tropical marine	soil degradation deforestation
Cyprus	9250	648	0.07	copper, pyrites, asbestos, gypsum, timber, salt, marble	earthquake	central plain with mountains scattered plains	temperate with mild, rainy winters and hot, dry summers	water shortage sewage pollution
Guinea Bissau	36120	724	0.02	phosphates, bauxite, unexploited deposits of petroleum	no serious natural disasters	mostly low coastal plain	tropical; generally hot and humid; monsoonal-type rainy season	soil erosion deforestation
Madagascar	587,040	4,828	0.01	graphite, chromite, coal, bauxite, salt, quartz, tar sands, semiprecious stones, mica	periodic cyclones	narrow coastal plain, high plateau and mountains in center	tropical along coast, temperate inland, arid in south	soil erosion endangered species
Maldives	300	644	2.00	negligible	sea level rise	flat, with white sandy beaches	tropical; hot, humid; dry, northeast rainy, southwest	depletion of freshwater
Malta	320	140	0.40	limestone	no serious natural disasters	mostly low, rocky, flat with many coastal cliffs	temperate with mild, rainy winters and hot, dry summers	water shortage, waste management
Mauritius	2040	177	0.10	negligible	cyclones and extreme climatic events	small coastal plain rising to discontinuous mountains encircling central plateau.	tropical, modified by southeast trade winds, warm, dry winter and hot, humid summer.	water pollution, loss of biodiversity
Sao Tome	960	209	0.22	negligible	no serious natural disaster	volcanic and mountainous	tropical is hot and humid with a rainy season	deforestation soil erosion
Seychelles	450	491	1.08	copra, cinnamon trees	no serious natural disaster	varies from island to island. Mostly granitic, and coral		water supply problems
Singapore	623	193	0.31	negligible	NA	lowland; gently undulating central plateau	tropical; hot, humid, rainy; frequent thunderstorms s in April)	Industrial pollution; limited natural fresh water resources;
Sri Lanka	65,610	1,340	0.02	limestone, graphite, mineral sands, gems, phosphates, clay	Occasional cyclones and tornadoes	Mostly low, flat to rolling plain; mountains in south-central interior	Tropical monsoon	Deforestation; soil erosion; coastal degradation; freshwater pollution.

Table 9b
Physical Features of the Caribbean SIDS

Country	Area (Km sqr)	length of coast km	ratio area to coast	Natural resources	Natural disasters	Terrain	Climate	Environmental issues
Antigua and Barbuda	440	153		negligible	hurricanes and tropical storms; periodic droughts	mostly low-lying limestone and coral islands with some higher volcanic areas	tropical marine; not much seasonal variation	limited natural fresh water resources, exacerbated by high rainfall run off rates
Bahamas	13940	3542		salt, aragonite, timber	hurricanes tropical storms, extensive flood and wind damage	long, flat coral formations with some low hills	tropical marine; moderated by warm waters of Gulf Stream	coral reef decay; solid waste disposal
Barbados	430	97		petroleum, fish, natural gas	periodic landslides	relatively flat; rises gently to central highland region	tropical; with a rainy season (June to October)	pollution of coastal waters resulting mostly from cruise tourism; soil erosion; contamination of aquifers
Belize	22800	386		timber, fish	hurricanes	flat, swampy coastal plain; low mountains in south	tropical; very hot and humid; rainy season (May to February)	deforestation; water pollution , industrial effluents, agricultural runoff
Cuba	110860	5746		cobalt, nickel, iron ore, copper, manganese, salt, timber, silica, petroleum	the east coast is subject to hurricanes from August to October, prone to droughts in some areas	mostly flat to rolling plains with rugged hills and mountains in the southeast	tropical; moderated by trade winds; rainy season (May to October)	pollution of Havana Bay; overhunting of wildlife; deforestation
Dominica	750	140		timber	prone to flooding; hurricanes during the late summer months	rugged mountains of volcanic origin	tropical; moderated by trade winds; heavy rainfall	NA
Dominican Republic	48730	1288		nickel, bauxite, gold, silver	prone to hurricanes and severe storms from June to October; occasional flooding and droughts	Rugged highlands and mountains with fertile valleys interspersed	tropical maritime; seasonal variation in rainfall	water shortages; soil eroding into the sea damages coral reefs; deforestation; Hurricane damage
Grenada	340	121		timber, tropical fruit	hurricanes between June and November	volcanic in origin with central mountains	tropical; tempered by northeast trade winds	
Guyana	214790	459		bauxite, gold, diamonds, hardwood timber, shrimp, fish	flash floods during rainy seasons	mostly rolling highlands; low coastal plain; savanna in south	tropical; hot, humid, moderated by trade winds; two rainy seasons	water pollution from sewage and agricultural and industrial chemicals; deforestation
Haiti	27750	1771		nickel, bauxite, gold, silver	hurricanes and severe storms from June to October; periodic flooding and droughts; earthquakes;	Mostly rough and mountainous	Tropical; semiarid (mountains in east cut off trade winds)	deforestation; soil erosion; clean water shortage
Jamaica	10990	1022		bauxite, gypsum, limestone	hurricanes	mostly mountains, with narrow, discontinuous coastal plain	tropical; hot, humid; temperate interior	deforestation; pollution of coastal waters by industrial waste, sewage, and oil spills; damage to coral reefs

St Kitts and Nevis	269	135		NA	hurricanes	volcanic with mountainous interiors	subtropical tempered by sea breezes; rainy season (May to November)	NA
St Lucia	620	158		minerals (pumice), mineral springs, geothermal potential	hurricanes and volcanic activity	Volcanic and mountainous with some fertile valleys	tropical, moderated by trade winds; dry season and rainy season from May to August	deforestation; soil erosion
St Vincent and the Grenadines	340	84		NA	hurricanes; volcanic activity	Volcanic and mountainous	Tropical with minor seasonal temperature variation; rainy season (May to November)	pollution from boat discharges and other effluents
Suriname	161820	386		timber, hydropower, bauxite, gold, and other minerals	NA	mostly tropical rain forest; mostly rolling hills; narrow coastal plain with swamps	tropical; moderated by trade winds	deforestation; pollution waterways mining activities
Trinidad and Tobago	5130	362		petroleum, natural gas, asphalt	Not serious	mostly plains with some hills and low mountains	tropical with a rainy season (June to December)	pollution; deforestation; overfishing

4. A FOCUS ON SIX IMA AND CARIBBEAN SIDS

4.1 Introduction

This section zooms-in on six small island developing states in the Caribbean and IMA regions. These are Cape Verde, Jamaica, Malta, Mauritius, St Lucia and Trinidad and Tobago. These small states were chosen on an experimental basis to extend the SOPAC EVI, which has been tested for the Caribbean, to other regions. This section also discusses possible additional indicators which may be required to take into account the special circumstances in the six SIDS in the IMA and Pacific regions.

4.2 Cape Verde[37]

The republic of Cape Verde, situated in the Atlantic Ocean on the west coast of Africa, off Senegal, is an archipelago consisting of ten islands with a total land area of 4030 sq km. The archipelago is divided into two groups (a) the Barlavento (windward), group is made up of Santo Antão, São Vicente, São Nicolau, Santa Luzia, Sal, and Boa Vista; and (b) the Sotavento (leeward) group, located to the south, includes São Tiago, Brava, Fogo, and Maio. The climate is tropical and dry, with an average temperature ranging from 20° to 25° C in January and 24° to 28° C in July.

The population of Cape Verde amounts to just under 400 thousand, growing, since 1990, at an annual rate of 2.5%. The population density is 96 persons per square kilometer. However the density differs from island to island.

Cape Verde was up to a few decades ago characterised by serious unrest, but it is now a working democracy, with political changes occurring within a constitutional framework. The new constitution was promulgated in 1992, leading to multiparty democracy, with free elections for president and parliament The republic has in recent years tended to politically lean to the West, but is it is considered as a stabilising factor in African politics.

4.2.1 The economy of Cape Verde

The GDP of Cape Verde, in 1995, amounted to $324 million, indicating that this republic has one of the smallest economy amongst the six countries surveyed in this section. The rate of growth of GDP was in the range of 4% per annum during the first half of the nineties.

The per capita income was US$862, which is relatively low by international standards.

The economy of Cape Verde is characterised by limited resources and scarce arable land due to the fact that the terrain is mountainous, and only 9 percent of the islands are suitable for cultivation.

About 13% of GDP is produced by the agricultural sector, a relatively high dependence when compared to the other five island states surveyed in this section, with the main products being maize and beans, sweet potatoes, coconuts, potatoes, cassava and dates. Industry contributes about 15%, of which 5% consists of manufactured products, mostly assembly and light manufacturing, fish processing, and artisanal production. The remaining 72% is contributed by the services sector, including commerce, transport and public administration.

Tourism in Cape Verde could potentially contribute more to the GDP and foreign exchange inflows of this country, but it is still very underdeveloped. Another form of production with good potential, but

[37] This section draws on the following websites: http://www.umassd.edu/specialprograms/caboverde/cvgeog.html http://www.abex.co.za/Cape%20Verde/cape_verde.htm; http://www.odci.gov/cia/publications/factbook/cv.html

which is still relatively underdeveloped is fishing, since the ocean surrounding the islands is very productive in this regard.

The economy is heavily dependent on imports, leading to chronic trade deficits, partially offset by transfers from other countries and remittances from Cape Verdeans living overseas. The most important clients for Cape Verdean exports are Portugal, the Netherlands and Spain, while most Cape Verdeans imports originate from Portugal and the Netherlands

The most serious problem affecting Cape Verde relates to food security, caused by a structural food deficit from domestic production due to limited arable land and balance of payments constraints.

Recently, the government of Cape Verde has embarked on major changes in economic reforms and market liberalization and promotion of private sector enterprise, and reduction of foreign exchange restrictions. It is actively trying to attract foreign direct investment through tax incentives.

4.2.2 Major environmental concerns in Cape Verde

The most important environmental characteristics of Cape Verde Islands, which are mostly volcanic in origin, relate to (1) water shortages (2) soil degradation and (3) poor natural resource endowments

Water shortage. The archipelago is very windy and rainfall is low and very irregular, giving rise to frequent droughts. This has negative impacts on the quality of life in general, and on agricultural production in particular. As already explained, water shortages in Cape Verde have adverse repercussions on food production in the islands. This problem is exacerbated by relatively high water run-off rates and limited water catchment facilities. In recent years attempts have been stepped up to reduce water run-off by earth or stone-walled terraces and building of ditches or dams.

Soil degradation and desertification. The islands suffer from soil degradation (through anthropogenic factors, including such as removal of natural vegetation for fuel and construction and intensive livestock feeding and soil erosion (as a result of steep watersheds, torrential rains, rapid water runoff, and strong winds). Soil enrichment is being stepped up by growing wind-breaking crops. It is not easy to reduce demand for fuelwood given that imported fuels are very costly - although the problems could be reduced by development of alternative energy sources such as wind, solar or geothermal. Erosion control would yield major benefits to Cape Verde, since this would conserve water and enhance the fertility of agricultural land.

Limited Resources. The islands are characterised by very poor natural resources endowments. The most important minerals are pozzolana (a volcanic rock used for cement production) and salt. Water resources are very limited, and this affects agricultural production. Vegetation is sparse and consists mostly of drought-resistant species. Wildlife is very limited and includes lizards, monkeys, wild goats, and a variety of birds.

4.2.3 Other environmental issues in Cape Verde

Coastal resources. Tourism (particularly on Sal, Boa Vista and Maio) and fisheries, which have huge potential in Cape Verde, but these industries are relatively underdeveloped, and at present do not pose serious environmental impacts. No true reefs exist along the West African coast or in the archipelagos of the Gulf of Guinea and Cape Verde but there are a number of sites with rich coral communities. Again here, there does not seem to be a serious problem in this regard.

Disaster Proneness. Cape Verde islands are not among the most disaster prone among SIDS. However at least three natural disasters were recorded between 1980 and 1992. These include a

hurricane in September 1982, a huge storm in September 1984, and a volcanic eruption on the island of Fogo in April 1992.

4.2.4 Cape Verde and the EVI

The foregoing discussion on the environment of Cape Verde suggests that the country is likely to record very high risk exposure and degradation scores, and low resilience scores on the EVI with regard to indicators related to islandness (indicator number 11), land area (indicator 10), water shortages and droughts (indicators no. 3 and 41), wind gusts (indicator no. 2), soil degradation and desertification (indicator no. 40), removal of natural vegetation (indicators no. 22 & 28) and effects of past civil strife (46).

It would appear that the EVI, as currently constructed, would require some additional indicators or modification to existing ones, to take into account vulnerability associated with desertification in states like Cape Verde which experience this reality

4.3 Jamaica[38]

Jamaica (10,938 km^2) is situated in the Caribbean Sea, west of Haiti and south of Cuba. The island`s terrain is mostly mountanous, with a fairly wide interior valleys and a narrow discontinuous coastal plain. The highest elevation on the island is the Blue Mountain peak (2256 m).

The climate is tropical (hot and humid, although interior is rather temperate) maritime, but open to northeast trade winds and land-sea breezes.

Jamaica's average annual temperature is 80°F, ranging between 78°F and 85°F. The winter season, from December to April is when Jamaica is windiest. The rainy season occurs during the fall. The island is prone to hurricanes, especially between July to November.

Jamaica gained independence from the UK in 1962 and is a Parliamanetary democracy, with elections are held every five years. Currently, the population of Jamaica is about 2.5 million, with a growth rate of around 0.9% per annum during the first half of the nineties. The life expectancy in Jamaica is about 75 years.

4.3.1 The economy of Jamaica

Jamaica was one of the most prosperous islands in the Caribbean, but its economy has experienced very slow growth rates in recent decades, with a short period of recovery between 1989 and 1992. Since 1992 high inflationary pressures, falling exchange rate and high interest rates caused particular problems to the Jamaican economy. An important contributor to Jamaica's economic difficulties related to the decline of the bauxite mining and alumina refining industries.

Jamaica depends heavily on export of alumina and bauxite and on tourism. Tourism, h is the largest foreign exchange earner of Jamaica. Manufacturing contributes about 18% to GDP, and consists mostly of processing agricultural products, including rum, beer, cigarettes and foodstuffs. Another important sector in Jamaica is agriculture, with sugar, banana and coffee being the most important products. There is also considerable income from the export in marijuana, though this is illegal.

[38] This environmental part of this section draws on information provided by Learie Miller (NRCA, Jamaica). The following websites were also consulted: http://www.odci.gov/cia/publications/factbook/jm.html; http://www.jamaicatravelnet.com/info/economy.html

4.3.2 Major environmental concerns in Jamaica

The most important environmental concerns in Jamaica relate to agriculture and forestry, mining and quarrying, tourism and fisheries.

Agriculture and forestry. The main problems associated with agriculture in Jamaica are excessive land clearing and soil erosion. There is an adverse effect on water quality and quantity by agricultural production. In addition, agriculture gives rise to a number of hazards associated with the use of chemicals, uncontrolled use of fire, loss of biodiversity and wildlife habitat, excessive siltation and risk of downstream flooding. In the case of forestry, the major concerns relate to land clearing for cultivation and fuelwood/charcoal production.

Mining and quarrying. Bauxite mining has resulted in a disposal problem specifically of red mud from the refining process. Air pollution from wind driven dust is common for both mining and quarrying activities. In addition, there is loss of aesthetic value of hillsides due to scarification associated with limestone quarrying and inadequate rehabilitation of mined out areas. Some beach erosion occur due to illegal sand mining.

Tourism. The Jamaican representative said that tourism in Jamaica is spatially concentrated on the north coast of the island. Wetlands have been dumped filled, beach sand mined, coastal structures such as groynes, piers and marinas established. The impact of tourism on coral reefs and sea grass beds due to poor sewage disposal and tourism associated recreational activities such as bathing and boating have been significant.

Fisheries. Fishing in Jamaica gives rise to considerable environmental harm especially because of over-fishing, use of dynamite, destruction of breeding ground such as wetland areas and sea grass beds, pollution of harbours and near-shore water bodies, use of fine mesh nets and traps and dragline method of fishing. Furthermore there is no practice to return juvenile fish to the wild.

4.3.3 Other areas of environmental concerns in Jamaica

Water resources. Water resource in Jamaica is affected by red mud pollution, saline intrusion where there is an over abstraction of water from some coastal aquifers, chemical, sewage pollution and sedimentation.

Energy. The bulk of the country's energy supply is obtained from imported fuel. Depending on the sulphur content combustion can result in the production of sulphur dioxide. Charcoal and fuel wood usage is still common and usually causes deforestation and habitat destruction. Historically, the use of leaded gasoline has resulted in high leads levels in some locations.

Air quality. This is associated with motor vehicle exhaust, stack gases, burning of garbage – domestic and municipal

Solid, liquid and hazardous waste. There is no sanitary landfill in Jamaica and open dumping is widespread, with known attendant problems of leachates, open burning, flies, vermin and unpleasant smells. A small percentage of the country is sewered and where sewage plants occur they often malfunction. There is no hazardous waste facility to deal with PCBs, asbestos, waste oils, lead and pecholorcthylene (Perc) among others.

Other concerns. Other concerns relate to oil spills, chemical accidents, transboundary movement of hazardous waste, climate change and attendant sea level rises.

4.3.4 Jamaica and the EVI

The Environmental Vulnerability Index would have some applicability to Jamaica based on a review of the indicators. While information may not be available on all the indicators it is likely that the Meteorological and geological data can be obtained. Information may not exist for some of the Anthropogenic indicators such as No. 36 which deals with Max 24 hours SO2 concentration and Nos. 37 and 38 which seeks to determine fertilizer and pesticide usage over the last five years respectively.

The indicators seem to be deficient in evaluating water quality and quantity and this resource is being adversely affected by development in many countries. Indicator No 47 recognizes the importance of water but it seems as if work so far has not yet identified the specific parameter for which data must be sought.

Indicator No.43 requires careful weighting considering the impact that mining and quarrying can have on a small island state such as Jamaica which has extensive bauxite deposits and where limestone constitute more than 66% of the rock material.

4.4 Malta[39]

The Republic of Malta is situated in the middle of the Mediterranean Sea, to the South of Sicily. It consists of two inhabited islands namely Malta and Gozo, and a number of smaller islands, one of which is Comino, which is inhabited mostly by tourists. The total land area of the Maltese islands is about 320 square kilometers.

The climate of Malta is typically Mediterranean, with mild, rainy winters and hot, dry summers. The islands have no rivers or mountains, with the highest point being 253 m.
The annual rainfall is about 550 mm, which occurs mostly from late September to March (the Autumn and Winter seasons). The temperature is moderate, with an average minimum temperature of 10^{o}c in the winter months (December to March) and the maximum temperature of 28^{o}c in the summer months.

In 1995, the Maltese population amounted to about 370 thousand, of which about 330 lived in Malta and the remaining 30 thousand in Gozo. The population grew at about 1% per annum during the first half of the nineties. The population density of the Maltese islands is over 1100 persons per square kilometer, with mainland Malta registering about 3 times the density of that in Gozo.

The Republic of Malta is a multiparty democracy, with political changes occurring within a constitutional framework. There are free elections for Parliament, statutorily held every five years.

Malta has in recent years been preparing itself to join the European Union - and it will probably form part of the EU by the year 2004.

4.4.1 The economy of Malta

The GDP of Malta in 1995 amounted to $3205 million, the second highest in the six countries surveyed in this study. The rate of growth of GDP was in the range of 6% per annum during the first half of the nineties.

The per capita income in 1995 was US$8744, which is one of the highest amongst the Middle income countries of the world, and the highest in the group of six islands considered in this study.

The economy of Malta is characterised by a high degree of openness, poor natural resource endowments, and high dependence on tourism.

[39] The environmental part of the section on Malta draws on information provided by Adriana Vella and Simone Borg . The following Malta government website was also consulted http://www.environment.gov.mt/ publications/soer98/

About 2% of GDP is produced by the agricultural sector, a relatively low percentage when compared to the other five island states surveyed in this study. In 1995, industry contributed about 39%, of which 27% consisted of manufactured products, mostly wearing apparel and electronic components. The remaining 58% was contributed by the services sector, including distributive trades, banking and finance, transport and public administration.

Tourism in Malta contributes about a fourth of all foreign exchange earnings and about 20% of GDP. There is tendency for the manufacturing sector to contract and the services sector to expand, with export oriented services, including tourism and banking and finance taking a larger share of this sector.

The economy is heavily dependent on imports, but exports are also relatively high as a percentage of GDP. However, the country faces chronic trade deficits, which are partially offset by investment income and transfers from other countries. The most important clients with regard to Maltese exports are Germany, the UK and Italy. Most Maltese imports originate from the European Union.

The most serious problem affecting the Maltese economy relate to government budget deficits and the difficulties faced a section of the manufacturing sector in competing in the international market, following the removal of trade barriers.

In recent years, the government of Malta embarked on major changes in economic reforms and market liberalisation, dismantling of state monopolies and removal of foreign exchange restrictions. This has ushered in a sink-or-swim situation for Maltese producers who have to compete with international firms in the absence of trade protection.

4.4.2 Major environmental issues in Malta

The more important environmental concerns in the Maltese Islands, relate to (1) water and land shortages (2) coastal zone management and soil erosion (3) pollution (4) waste management (5) limitations, over-exploitation and degradation of natural resources and (6) loss of wildlife and genetic erosion.

Water shortages. Natural water resources in Malta are totally dependent on rainwater, which percolates through the rocks and forms aquifers. Because of the low rate of precipitation, exacerbated by high rainwater runoff rates, natural freshwater is a scarce commodity in Malta. Such scarcity has traditionally had direct impact on human health and general well being, on agricultural production, and in recent years on tourism and certain manufacturing industries.

At present about 60% of water demand in Malta is supplied by desalination plants (reverse osmosis) - a very costly method of water production. Water tariffs are heavily subsidised in Malta and do not therefore reflect the cost of production, and this may be conducive towards lack of incentives for saving water.

Coastal zone management. The coastal area of the Maltese islands has played a very important role in the social and economic development of the country, with a large proportion of economic activity and of the resident population occurring on the coast. The natural harbours of the islands are extensively used for commerce and for tourism related activities. Urban settlements, new industrial and tourist infrastructures and other buildings are mushrooming along the coast, leading, as expected to increase waste generation and sewage pollution.

The coastal area is also important from an ecological point of view, since it contains habitats, including sand dunes and saline marshlands, which in turn support a number of endemic plant and animal species.

The coastal area has up to recently been considered as that restricted strip of land or rock between the sea and the human habitations. The importance of seriously considering the coastal sea areas and the vulnerability of this marine strip to the increasing local exploitation and development has been brought forward through scientific research on specific natural resources, such as local endangered marine species.

Soil and coastal erosion. Soil erosion in Malta is on the increase mainly as a result of abandoned agricultural land and limited tree cover. The building sprawl has substantially decreased the number of catchment areas, thus resulting in greater rainwater run off. Local climatic conditions and the increased over exposure of areas with soil have definitely contributed to its loss. The lack of trees and shrubs together with the loss of rubble walls further exacerbate this problem.

Waste Management. In small islands, waste management tends to be more problematic than in larger territories, due to the limited land area. In Malta the very high population density and rapid economic growth accentuate this problem. The added load of the tourist population during different seasons of the year but in particular during the summer months is not to be underestimated.

Pollution. The most important considerations in this regard relate to air and marine pollution. In Malta certain environmental damage and health risks are directly associated with elevated concentrations of air pollutants. Examples of typical pollutants are sulphur dioxide, nitrogen oxides, particulate matter and dusts, ozone, carbon monoxide, benzene, polyaromatic hydrocarbons, heavy metals (e.g. lead, mercury and cadmium). A recent scientific study has actually found strong associations between particulate air concentrations and an increasing local health problem. Such study is also starting to shed light on the dominant relationships between different weather conditions and increased presence and effects of the pollution.

As for marine pollution, the most important concern relates to solid and liquid waste disposal. A positive development in this regard is that Malta is a party to the Barcelona Convention on the Protection of the Mediterranean Sea against Pollution and its Protocols and collaborates actively in MEDPOL and there is legislation in place to control waste disposal into the sea.

4.4.3 Other environmental concerns in Malta

Other concerns related to (a) limitations, over-exploitation and degradation of natural resources (b) Loss of wildlife and biodiversity and (c) Lack of institutional and policy co-ordination.

Limitations, over-exploitation and degradation of natural resources. The initial limitations of space and biodiversity richness has imposed local limitations on the abundance of natural resources available for exploitation. This same limitation has imposed restrictions on the diversity and abundance of natural resources on and around the Maltese Islands. To avoid eradication of these natural resources serious assessment and planning of future sustainable developments and exploitations is necessary. In Malta the institutional and legal set-ups for nature conservation and protection of endemic and indigenous species are rather underdeveloped, and not adequately enforced. In addition, agricultural practices in Malta have led to a drastic reduction of forest-cover. There is also the negative impact caused by grazing goats, sheep, cattle and wild rabbits, which has led to further reduction of forest cover.

Loss of wildlife and biodiversity. Uncontrolled exploitation of natural resources is still a norm and though local expertise to undertake proper wildlife conservation assessment and monitoring exist locally the government's will and assistance to undertake conservation monitoring and management is still very poor. Specific conservation research projects have been undertaken with the goal to highlight this requirement. The awareness to consider the need for sustainable development and the conservation of natural and genetic resources in a scientific and professional manner is only recently developing. The need to preserve the variety of local genetic resources is increasingly becoming a

requirement at both national and international level. Thus assessing the genetic variation of natural resources needs to become synonymous of resource assessment for long-term management and conservation. A local high human population density in itself creates a considerable stress on natural habitats and their biota. Local wildlife has also been exploited since time immemorial, and in most cases the rate at which individual organisms are removed from their population is well above the rate at which they are replaced, leading to loss of populations, species and biodiversity.

Lack of institutional and policy co-ordination. Over the past decade, Malta has experienced a number of improvements in environmental legislation and management. One major shortcoming at present is that environmental legislation is somewhat fragmented with different lines of command leading to inefficient enforcement and sometimes contradictory signals. There is therefore a dire need for a national strategy for co-ordinating legislation and policies.

4.4.4 Malta and the EVI

Malta is likely to record very high risk exposure and degradation scores, and low resilience scores on the EVI with regard to indicators related to islandness (indicator number 11), land area (indicator 10), water shortages and droughts (indicators no. 3 and 41), natural resource monitoring and protection (indicators 16 to 24) (indicators 44, 45 & 47), soil degradation (indicator no. 40), coastal zone (indictor no. 25); tourism (indicator no. 29) removal of natural vegetation (indicators no. 22 & 28); high population density (indicator no. 26); waste generation (indicators nos. 30 and 32) and other indicators associated with economic development (indicators no. 35, 23, 18).

The EVI, as currently constructed, requires some refinements to the indicators to take into account vulnerability associated with water shortage and water salinity in states like Malta which experience this reality.

Also important is the emphasis on making sure that the EVI would be a reflection of the dynamic change of the environment apart from a descriptor of the static status. This would give the EVI a greater practical value over the State of the Environment Report.

4.5 Mauritius[40]

The state of Mauritius (1865 km^2) is situated some 800 km east of Madagascar in the Southwest Indian Ocean and forms part of the Mascarene Plateau. It has jurisdiction over a vast area of ocean space of 1.7 million km^2. Mauritius comprises the main volcanic island of Mauritius and the dependencies of Rodrigues, Agalega, Tromelin, St Brandon, the Chagos Archipelago and a number of outlying islets.

The island`s topography consists of a coastal plain which rises to a central plateau (max height 670 m), with several mountain ranges and peaks. The climate is tropical, with an average temperature ranging from 12° in August to 33°C in February. Rainfall varies between 1000 mm (winter) and 5000 mm (summer) per year. Annual tropical depressions are accompanied by heavy rain and strong winds up to 300 km/h between December and May. The diverse types of coastal habitats include basaltic cliffs, numerous sandy beaches, dunes, saltwater wetlands, mangroves, estuaries, rocky shores, sheltered bays, lagoons, and coral reefs which completely surround the island.

Mauritius gained independence in 1968, holds free elections every five years and the Parliament functions on the British Westminster model. During the period 1960s - 1990s it was transformed from a typically poor, agrarian economy with high population growth to a modern low fertility

[40] This section is based on information supplied by Dr Deolall Daby. Additional information about Mauritius can be found of the following websites: http://www.intnet.mu/iels/about_mauritius.htm; http://www.odci.gov/cia/publications/factbook/mp.html

country with high levels of education and welfare. Currently the population stands at 1.1 millions with a growth rate of 1.2% and a density of 589 persons / km^2.

4.5.1 The economy of Mauritius

During the past three decades the economy of Mauritius has been transformed from one characterized by low income, and agricultural production, to middle income diversified economy with growing industrial and tourist sectors. In 1995, the GDP of Mauritius amounted to $3290 million, or $2511 per capita. The average annual growth rate in recent years was 5%. The Export Processing Zone, established in 1970s, is considered to have contributed considerably to this economic success.

About 9% of the GDP of Mauritius is produced by the agricultural sector. Although declining in importance, sugar production is still a major source of income and employment, with sugarcane being grown on about 90% of the cultivated land area. About 33% of GDP is contributed by the Industrial sector, of which 23% is manufactured production. The remaining 58 per cent of GDP relate to services, including tourism, financial services and public administration.

Like many other middle income small island state, Mauritius is a very open economy and experiences chronic trade deficits. The lack of natural resources ,except for a very fertile soil, exacerbated by the very small internal market, imposes serious constraints on economic development.

The main exports of Mauritius are textiles and textile articles, representing about 60% of total exports. Sugar, which some decades ago was the main export of Mauritius, now accounts about 20% of total exports. The main export trading partners are the EU and the US. The main imported items are raw materials for the clothing industry, machines and food.

The most serious problem affecting the economy of Mauritius relate the globalisation process, implying a loss of preferential treatment for its exports of sugar and manufactured products.

4.5.2 Major environmental issues in Mauritius

The main areas of concern in Mauritius are (1) deforestation (2) loss of biodiversity and (3) climate change and extreme weather events.

Deforestation and the land use. Although 31% of the total land area is under forest, woodland and scrub, only 1% of native forest remains due to three centuries of deforestation and exploitation. Approximately 45% of the total land area (90% of arable land) is under sugar cane. The forests, nature reserves and coastal Pas Geometriques (public land constituting 10% of total) is under increasing pressure from competing uses (hotel, recreation and conservation). Encroachment on environmentally sensitive areas (coastal ecosystems, forested areas, hills and mountain slopes, nature reserves and catchment areas) is also increasing.

Bio-diversity Mauritius is ranked second in the world for having the highest percentage of its native plants threatened globally (39%) and nationally (71%). Natural vegetation has been largely destroyed due to clearing land for agriculture, settlements, road infrastructure, farming and pastures. Many endemic species have already become extinct. Modification of aquatic habitats (draining, pollution, competition for water), introduced species and commercial exploitation are the principal causes of decline of freshwater fish species.

Climate change and extreme weather events. Mauritius is at high risk from the effects of global climate change and its associated impacts. These include sea level rise and enhanced frequency of extreme weather events such as temperature and precipitation extremes and natural disasters (10-12 annual cyclones, floods, droughts, storm surges and landslides). The changes due to these calamities represent additional stresses on the environmental systems that are already under intense and growing pressure.

4.5.3 Other areas of environmental concern in Mauritius

Urbanization. The rate of growth of the urban population has been 1.1% over the period 1975-1995 and this is projected to increase to 1.9% by 2015. Currently just over 40% of the population is urban and by 2025 this will increase to 60%. The environmental problems associated with urbanisation include habitat and biodiversity loss, unplanned and haphazard development, pollution of surface, underground and coastal waters, and social problems.

Fresh water. Mauritius is classified as a water poor nation by the UNDP, and further demand and consumption by the growing population with a rising standard of living may hamper economic development. Mauritius is coming under increasing water stress, defined as an annual water supply of between 1100-1700 m^3 in 1995 to 1485 m^3 by 2025. During the second half of 1998 and most of 1999, Mauritius faced the most severe water stress situation in the last 20 years, impacting heavily on the economy and environment. About 75% of water withdrawals are used for agriculture, 16% for domestic use and the remaining for industrial and commercial uses. These sectors of consumption are also the main polluters of both the terrestrial and coastal marine water bodies. Further, salt water intrusions into bore holes are evident.

Agriculture. Soil fertility is probably being maintained by the high rate of fertiliser application (600kg/ha/yr) and crop production maintained by intensive pesticide use (44 kg/ha/yr). Much of such applications run-off with red soil into inland water bodies and lagoons causing hypernutrification and eutrophication problems. Enhanced soil erosion occurs in cleared areas not under sugar cane and causes siltation problems in lagoons after heavy rainfall.

Tourism. Tourism is a major earner of income for the country. It is mainly marine-based and tourist arrivals continue to increase (600,000 annually). Mauritius has invested heavily in coastal infrastructure development to accommodate the escalating tourist populations. However, such development has occurred without appropriate planning and preventive measures, and damage to coastal ecosystems (erosion, physical damage to habitats, pollution) is already evident. Expansion in the sector is often in the form of encroachment on non-tourist space.

Pollution. Oil pollution is a major source of concern in Mauritius. Oil spills can cause catastrophic effects on tourism, fisheries, coastal ecosystems and recreational activities. The region is the main transportation route of more than 475 million tonnes annually of oil from the Middle East to Europe and America. This constitutes a constant threat and at present no country in the region has the capability to deal with oil spill disasters.

Air pollution, though still low by international standards, is increasing as energy use rises. Gas emissions are particularly severe in urban centres, and dust and air pollution problems occur in areas surrounding sugar mills, from burning cane fields, emissions from boilers and release of flyash. Other sources include stone crushers, brick making plants, lime kilns, chemical processing factories, hot asphalt plants, odours from agricultural wastes, waste dump sites, coal burning for electricity and steam raising in textile industries.

Coastal zone. The intensive urbanization of the coastal zone is a major cause for concern because of unplanned construction, land reclamation, and increasing demographic pressure. Coastal habitat degradation occurs as a result of over-fishing above the MSY level, swimming, recreation and tourism activities, siltation of lagoons, mining, quarrying, dredging, nitrogen loading and recurrent HABs. Microbial contamination of coastal waters occurs from raw sewage disposal and increasing hot spots of marine pollution result from industrial effluents, high BOD load from sugar processing and run-off of agrochemicals. Inshore fishing is detrimental in various ways such as use of undersized nets, coral breakage by poling and anchoring of boats, overfishing of aquarium fish from coral reef areas, and poor enforcement of fisheries legislation.

4.5.4 Mauritius and the EVI

Mauritius is likely to register relatively high scores in terms of risks, degradation and lack of resilience, with regard to the following aspects: sea surface temperature (indicator no. 1) cyclones (indicator no. 2), droughts (indicator no. 3), degradation of coral reefs (indicator) loss of critical coastal and terrestrial habitats and biodiversity (indicator nos. 20, 22), land area, soil degradation (indicator no. 40), decreasing fish catches (indicator no.28), coastal erosion and marine pollution (indicator no. 33) ecotoxicology (indicatore 31), waste management (indicators nos. 32) and fresh water shortage and contamination (indicator no. 41).

The EVI, as currently constructed, would seem to require some additional indicators or modification to existing ones, to take into account vulnerability associated with fresh water shortage and contamination in states, which, like Mauritius experience this reality.

4.6 Saint Lucia[41]

Saint Lucia is located in the Caribbean Sea, between the islands of Martinique and Saint Vincent. It is the second largest of the Windward Islands group of the West Indies. The island has an area of 616 square kilometers and is of volcanic origin, with a rugged mountainous topography especially in the area. The Southwest area of the island, where twin volcanoes, Gros Piton and Petit Piton are located, has geothermal activity.

Saint Lucia is a parliamentary democracy with two legislative houses and is a member of the British Commonwealth. The island achieved self-government in 1967 and gained full independence in 1979. The island is of volcanic origin.

The climate is tropical with heavy rainfall and a mean temperature of 27^{o}C. Temperatures are moderated by northeast trade winds. A dry season extends from January to May, and a rainy season from June to December.

In 1998 the population of St Lucia was estimated at 152 thousand, with an annual growth rate of about 1.3% during the current decade and a density of 229 persons per square kilometer.

4.6.1 The economy of Saint Lucia

In 1995 the GDP per capita of Saint Lucia was $3915, with a total GDP of $556 million. About 11% of GDP was contributed by the agriculture sector, where banana production feature prominently. The industrial sector contributed 21% of which about 7% was manufacturing production including wearing apparel, beverages, plastics, and electrical components. The services sector, covering public administration, tourism, and transport dominates the economy, contributing about 68% to GDP.

The Saint Lucian economy is very open, as is the case of most small island states. This renders the economy as very vulnerable to economic developments outside its control. A case in point is the impact of the removal of trade preferences on exports of bananas, which has had a large negative impact on the economy. Another source of economic vulnerability relates to the high dependence of tourism, since this industry tends to be volatile, and to a large extent depends on the interests of foreign tour operators.

Saint Lucia is at present experiencing intense competition from Latin American banana producers, and this has prompted the authorities to step up the diversification, by promoting investment in tourism, manufacturing and construction.

[41] The section on Saint Lucia is based on information supplied by Ms Valerie Isaac, St Hill.

4.6.2 Major environmental concerns in Saint Lucia

The most important environmental concerns in Saint Lucia relates to (1) deforestation (2) Coastal and Marine degradation (3) unsustainable land use and (4) occurrence of natural hazards.

Deforestation and soil erosion. The historical pattern of land ownership and the concentration of large tracts of prime agricultural land in the hand so relatively few owners, has resulted in small farmers encroachment on forests and reserves and steep slopes unsuitable for agricultural purposes. The result has been extensive deforestation, soil erosion and siltation of inland and coastal waters and the contamination of inland water courses and coastal waters by runoff from agricultural land.

Coastal and Marine degradation.. The entire island mass must be considered a holistic system because natural and anthropogenic events no matter how far inland, impact on the shore and marine environment within a very short time frame of occurrence, The aggressive development policy being pursued, particularly in tourism and agricultural sectors, has placed many of the coastal resources under stress, This is made evident by the coastal degradation occurring particularly along the Northwest coast of the island in the form of erosion, poor coast water quality, reef degradation and the loss of marine habitat,

Land use. The problems associated with land use are characterised by conflicts between competing uses such as forestry and agriculture, recreation and tourism, environment and tourism, and agricultural and urban environment. These pressures on land have placed all natural areas under severe pressure. The last decade has seen progressive loss vast tracts of the central forests, almost total destruction of the remaining west coat mangroves, the loss of most areas of natural marshlands and the destruction of severe sand beaches.

Natural hazards. Natural hazards in Saint Lucia are primarily associated with Tropical cyclones, earthquakes, volcanic activity, land and rock slides and wave action. Tropical cyclones are the most common and damaging natural disasters with potential for severe impacts.

4.6.3 Other areas of environmental concern in St Lucia

Solid and liquid waste management. Solid waste management and the disposal of refuse is one of the most serious environmental issues facing Saint Lucia. Despite improvements in the garbage collection system, serious problems remain from poor solid waste management practices, illegal disposal of solid waste along raodsides, rivers and other sensitive habitats. In addition to the unpleasant sight and health risks posed by these practices, there is a threat to the ecology of the rivers and the mangroves, contamination of water supply and near shore marine eco-system. The human population residing in the coastal areas of Saint Lucia has grown over the years and is still growing, thus increasing the amounts of poorly treated or untreated sewage waste waters being discharged into the coast environment.

Use of chemicals. The intensification of agricultural activities, primarily the banana industry, has led to the increasing use of agro-chemicals to control pests and improve productivity. The regular use of these chemicals, particularly on land with relatively steep slopes, provide the potential for the contamination of streams and rivers which supply the country with drinking water.

4.6.4 Saint Lucia and the EVI

From the above it appears that Saint Lucia will record relatively high scores in the EVI with regard to a number of indicators, in particular those referring to land use and deforestation (indicator nos. 22, 28) soil erosion (coastal misuse (indicator no. 11, 25), tourism (indicator no. 29), natural hazards (indicator nos.2, 7, 8) waste (indicator no. 30, 32) and chemicals (indicator no. 37, 38).

It would appear that the EVI, as presently constructed requires additional indicators or refinement of existing one, to take into account environmental vulnerability associated with ship based pollution, especially that associated with cruise tourism for countries, which like Saint Lucia, experience this reality.

4.7 Trinidad and Tobago[42]

Trinidad and Tobago is an independent republic in the in the Caribbean Sea, located 12 km off the north-eastern coast of Venezuela. Tobago is some 32 km north-east of Trinidad. The country has a total area of about 5,128 sq. km, of which Tobago accounts for 300 sq. km. Port of Spain on Trinidad is the capital of the country. Trinidad and Tobago has a tropical climate. There is rainfall throughout the year with a wetter season from June to November. Trinidad and Tobago lies outside the hurricane zone, being too far south for violent tropical storms.

Trinidad and Tobago has a population of about 1,265,000 (1995 estimate), of whom about 50,230 live on the island of Tobago. The population density is about 250 per sq. km. More than 70 per cent of the population lives in urban areas. Port of Spain is the largest town, as well as the capital, with a population of about 58,400 (1990 census). Trinidad and Tobago gained its independence from Britain on August 31, 1962, and became a republic on August 1, 1976. Under the 1976 constitution, the Republic of Trinidad and Tobago is a unitary, multi-party democracy within the Commonwealth.

Trinidad's geology is similar to that of the adjacent mainland, to which it was once attached; its soils include alluvial deposits from the Orinoco. Tobago is of volcanic origin and is a single mountain mass, although the south-west is flat or undulating and coralline.

Trinidad has a very diverse flora and fauna with both Caribbean and South American species represented. Habitats range from the rainforests of the Northern Range to the wetlands on the eastern and western coasts. About 35.5% of the country is still forested. Also about one quarter of the country is forest reserves and state lands, and many areas of both islands have been declared national parks, wildlife reserves, or protected areas.

4.7.1 The economy of Trinidad and Tobago

In 1995, Trinidad and Tobago had a gross domestic product of about US$5330, equivalent to a per capita income of US$4141, and placing it in the upper-middle-income group of countries. This relatively high per capita income reflects the fact that the country is an oil and natural gas producer.

Although well diversified structurally, with significant agricultural, manufacturing, tourism, and mineral extraction sectors, the economy is otherwise dominated by the petroleum industry, which provides about one quarter of gross domestic product (GDP), one third of government revenue, and more than two thirds of foreign exchange earnings. Industry, excluding mining and quarrying, currently accounts for about 10 per cent of GDP and about 14 per cent of employment. A major industrial estate at Point Lisas has several world scale industrial complexes producing petrochemicals, steel, ammonia, urea, and other nitrogenous fertilisers, and the synthetic fuel methanol.

Trinidad is the world's largest exporter of ammonia and methanol. Other industries include the production of liquefied natural gas, cement, garments, beer, rum, and cigarettes, and agricultural processing, notably of sugar.

Agriculture accounts for less than 3 per cent of GDP and about 11 per cent of employment. However, the soil is rich and sugar cane, rice, cacao, coffee, coconuts, citrus and tropical fruits, flowers, and vegetables are grown. The service industries, including the public, financial, and tourism sectors, are

[42] The information contained in the section on Trinidad and Tobago was contributed by Dr John Agard and adapted for the purposes of this background paper. The following websites provide additional information about Trinidad and Tobago: http://www.ema.co.tt; http://www.ima.gov.tt

by far the most important in terms of employment, accounting for 55 per cent of jobs. Tourism is now the third-largest foreign exchange earner and the islands are being heavily promoted abroad, particularly Tobago, where there is most interest in hotel construction to take advantage of the sheltered beaches and pristine underwater environment.

Tourism in Trinidad, traditionally based on bird watching and nature tourism, has been boosted by the construction of marinas and boat-repair yards in the Chaguaramas area, which have attracted the yachting fraternity. Annual stay-over arrivals on the two islands now amount to nearly 300,000 and cruise-ship passengers' number about 30,000 per year.

Thanks to exports of crude oil and petroleum products, Trinidad and Tobago operates substantial surpluses on both the balance of trade and the current account of the balance of payments—in 1994 they totalled US$741 million and US$218 million respectively.

4.7.2 Areas of environmental concern in Trinidad and Tobago

The most important environmental problems in Trinidad and Tobago are: (1) pollution and (2) deforestation.

Pollution. Rapid population increase and industrial development fuelled by a petroleum based economy in a small island setting have led to pronounced pollution effects on the natural environment. Although new environmental and planning regulations are being put in place, many developments have taken place without the benefit of adequate physical planning or environmental impact assessments. In the built environment there is widespread pollution of land due to improper disposal of solid and toxic wastes from industry and households. Emissions from motor vehicles and industry contribute to deteriorating air quality not only in industrial areas, but also along major roads due to the presence of the largest vehicle population per capita in Latin America and the Caribbean. Industrial effluents and malfunctioning sewage (especially in Tobago) plants have contributed to the degradation of the lower courses of rivers and nearshore coastal waters.

Deforestation. There has been extensive deforestation in critical watersheds, associated with shifting cultivation, hillside slash and burn agriculture, inappropriate and illegal logging, and sand and gravel extraction. These activities cause siltation in watercourses and lead to flooding. About 31.4% of Trinidad and Tobago consists of natural forests. Deforestation averaged 2600 ha per annum (or about 0.5%/yr) from 1990 - 1995. Of critical importance to the conservation of forest resources is the annual fire problem, which occurs during the dry season. Of the total of 44,850 ha of forests burnt in the ten-year period 1987 – 1996, only 230 ha or 0.5% have been replanted.

4.7.3 Other environmental issues

Coastal resources. Pelagic fisheries and shrimp are the main living resources on the continental shelf around Trinidad and Tobago. Expansion of fisheries exploitation has traditionally been hindered by over-fishing of near-coastal waters by trawlers as well as subsistence and other small scale fishers. Tobago has well developed coral reefs, which are coming under increasing pressure from coastal tourism infrastructure developments.

Disaster proneness. Fortunately, Trinidad and Tobago is on the southern fringe of the hurricane belt. During this century, 1900 – 1998, only on seven occasions did a tropical storm or hurricane directly affect the country. Five of the tropical cyclones caused no more than torrential showers and strong gusty winds throughout Trinidad and Tobago. The remaining two attained hurricane status but only one, Hurricane Flora did substantial damage to Tobago on September 30, 1963. Trinidad and Tobago has no volcanoes. Trinidad and Tobago are on the edge of the Caribbean Plate and as such are subjected to daily minor earthquake tremors. No extensive earthquake damage has been recorded however. Even so extensive waterfront development on filled land in Port of Spain, Trinidad may make it vulnerable to earthquake induced ground failure.

4.7.4 Trinidad and Tobago and the EVI

The foregoing discussion on the environment of Trinidad and Tobago suggests that the country is likely to record very high exposure to environmental risks, degradation and lack of resilience, and therefore likely to register high scores with respect to pollution (indicator nos. 30, 31, 32, 33, 34, 35, 36, 43), removal of natural vegetation (indicator nos 22, 28).

It would appear that the EVI, as presently constructed requires additional indicators or refinement of existing one, to take into account environmental vulnerability associated with oil exploration and production of petroleum products, for countries, which like Trinidad, experience this reality.

5. CONCLUSION

This background paper has given a brief overview of the work in progress relating to the Environmental Vulnerability Index, highlighting the present stage in its development, namely its extension from the Pacific region to the IMA and Caribbean regions.

The paper has also given a brief overview of the economic, demographic and environmental characteristics of the small island developing states in the IMA and Caribbean region, with a focus on six SIDS, namely Cape Verde, Jamaica, Malta, Mauritius, St Lucia and Trinidad/Tobago, which have been selected on an experimental basis to consider whether the EVI model can be applied to these states.

It has been shown that these six states have characteristics which merit special consideration in terms of environmental indicators. In the case of the IMA-SIDS region, it would appear that water related indicators should be given particular importance. In the case of the Caribbean SIDS, indicators related to climatic and volcanic hazards, and pollution, especially that associated with cruise shipping and industry, should be given special importance.

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APPENDIX 5

DATA COLLECTION
FOR THE
ENVIRONMENTAL VULNERABILITY INDEX

Discussion Paper Prepared by Craig Pratt

for the UNEP Meeting of Experts on
the Environmental Vulnerability Index
held in Malta between 29 November and 3 December 1999
at the Foundation for International Studies, Valletta, Malta
organised by the Islands and Small States Institute (Malta)
in collaboration with the
South Pacific Applied Geoscience Commission (SOPAC)

DATA COLLECTION FOR THE ENVIRONMENTAL VULNERABILITY INDEX

1. Introduction

The SOPAC Environmental Vulnerability Index (EVI) is still in development and has been designed as a multi-level model to describe the vulnerability of the natural environment of countries to a range of natural and anthropogenic hazards. The index is being developed in such a way that it can be broken down into sub-indices that describe levels of risk and resilience and the effects of these influences on the health or integrity of a country's environment. Due to the variety of risks and complexities of ecosystem resilience and integrity, an indicator approach was taken to characterise them.

There are currently a total of 47 indicators in the EVI.[43] However the choice is still subject to change and development, on the basis of inputs made by experts from different countries and regions.

It is proposed that he formulation and choice of indicators be based on the following criteria.

The indicators should:

- be applicable globally;
- be based on data already available or easily obtainable;
- measure change or be a proxy for change which would do significant harm to the environment;
- not be selected on any political criteria but relate only to environmental vulnerability;
- be weighted to reflect the probability of change to the environment and the amount of damage which might be done;
- be relatively easy for users to understand;
- be well-defined;
- be as uncorrelated with each other as possible to limit redundancy.

The most vital criterion used in the choice of indicators is that relating to the data and its availability. The availability of appropriate environmental vulnerability data is fundamental to both the development of the EVI and ultimately the final calculation of a country's EVI value. The success of the EVI as a measure of vulnerability is therefore wholly dependent on accessing and obtaining relevant country environmental data for calculation of EVI values.

In light of the key role that data play in the development of the EVI, this discussion paper has been prepared to provide insight into some of the issues that have been faced in the identification and collection of data for the EVI in the Pacific, some of the lessons learnt and to provide some suggestions as to how we may progress this important process of data collection for the EVI internationally.

[43] Initially the EVI had 57 indicators, but following a Think Tank Meeting on the EVI in September 1999, the number of indicators was reduced to 47.

2. Approach to the Data Gathering Process

The EVI by its very essence attempts to summarise a wide variety of environmental vulnerability data for a country. The data needed for the EVI includes meteorological data, fisheries data, land area, natural hazard data and so on. The very diverse and wide-ranging nature of these data means that their sources are widely dispersed and require some effort by a country to identify, collect and compile the information. Some of the indicators require information that could only be provided by the authorities or by experts in the respective country. It is therefore essential to have full government co-operation in the data gathering process to ensure success, as has been the case in the Pacific.

The first major issue that arose in the initial stages of trying to gather data for the EVI in the Pacific was the difficulty in creating an understanding of the data required to provide responses to EVI indicators, and the lack of capacity to compile the necessary data. Overcoming these initial problems required the importation of assistance, in-country, to identify the major problems and to try to provide possible solutions so that country environmental vulnerability data files could be compiled.

The in-country approach to data gathering, while beneficial to the country and rewarding in terms of data collection, is not a sustainable method of data gathering in the long term and would be impossible to extend globally. It was therefore decided that a more simple and directed approach should be developed to assist the governments in the gathering of country data. This approach involved the use of detailed questionnaires for each of the EVI indicators.

Each indicator is presented with its detailed indicator question and is accompanied by an explanation of what the proxy indicator is trying to measure. All indicators require a response and guidance is provided towards the possible agency or agencies that may be sources for the information required. Each indicator is also accompanied by a description of what data is needed for a complete response to the indicator question.

3. Issues Relating to Data Gathering in the Pacific

During the process of data gathering in the Pacific, several important issues arose. These include difficulties in the following areas:

- Data source identification
- Accessibility
- Availability
- Quality
- Capacity

3.1 Data Source Identification

The identification of possible data sources and appropriate agencies to approach for the required data has been difficult. This is due to the major differences in bureaucratic structures of the various governments throughout the Pacific. Although agencies may have similar titles they can be given quite different responsibilities and hold different data sets compared with other countries. This has made the identification of appropriate sources and collection of information very difficult.

Another issue is the identification of data that may be held by agencies but which may not be known to its officers or which has not be recognised by its officers as relevant to the EVI. This has largely been due to an inability to fully understand an indicator and its data requirements, the changing of staff or just a lack of knowledge of the databases held by the agency.

3.2 Accessibility

Collection, analysis and storage of data is without doubt an expensive exercise. As a result there is increasing recognition of the importance and true value of data. This has had a significant impact on access to information. As many government agencies are asked to carry out these tasks on ever-reducing budgets, many are looking to recover their costs through charges for both primary data and time taken by personnel to access and compile required data.

Also in many cases, certain data may be considered sensitive by a country resulting in limited access. Although most data required for EVI indicators would not be considered sensitive, there have been several instances where access to information has required special authorisation. The support of government for the EVI and the data gathering process has therefore been essential in overcoming these problems in the Pacific.

3.3 Availability

Despite international recognition of the value and importance of environmental data in decision-making, collection and the maintenance of these data sets in Pacific Island countries have not always been given priority. In many countries there is either no data collection or it is inconsistent, or when data is collected regularly, there is no proper handling or storage of the data sets leading to incomplete databases and loss of, or poor access to the information.

3.4 Quality

The issue of data quality is not peculiar to the Pacific. In the course of data gathering, several inconsistencies between local data and international data sets have arisen. The use of different standards or methods of data collection or the use of general assessments based on small-sample-biased data may have contributed to these differences. There is also the potential of inaccurate equipment, lack of proper training in measurement procedures, lack of quality control procedures and many other reasons which could all lead to inaccuracies in data reported.

3.5 Capacity

The issue of the lack of capacity is a common one throughout SIDS. In Pacific countries this has been one of the main difficulties in the facilitation of EVI data gathering. The lack of capacity is two-fold in that it involves both institutional as well as personnel capacity problems.

In the Pacific, data gathering exercises like the EVI have placed an added burden on existing institutions' responsibilities to provide data and information. With limited resources and few trained personnel this task can often be an impossible expectation. The only way to assist these countries facilitate their country collection of environmental data has been to provide

in-country input and assistance. This is extremely costly and it is imperative that alternative approaches are found to provide the assistance needed.

Another issue that has arisen is that it has been difficult to create an adequate understanding in personnel on the specific data and information requirements needed for a response to indicator questions. This is due in part to a lack of understanding of the purpose of the EVI, its mechanics and, more generally, the inadequate training of personnel in the identification, collection, analysis and manipulation of data.

4. The Future

The development of an approach to data gathering that is simple and can be easily adopted by countries both large and small is critical to the overall development of the EVI. Currently, SOPAC is attempting to develop an alternative questionnaire approach to facilitate country environmental data gathering. It still requires a lot of improvement and refinement to ensure that users of the EVI are able to get a better understanding of the purpose of the EVI, the data requirements and answers to frequently asked questions to the questionnaires.

A help handbook would prove useful as a possible way to provide a detailed background to the EVI, its mechanics and specific instructions and assistance in how to identify and gather the required information so as to reduce the need for continued assistance and support in the data gathering process.