Global International Waters Assessment

Caribbean Sea/ Small Islands

GIWA Regional assessment 3a

Bernal, M.C., Londoño, L.M., Troncoso, W., Sierra-Correa, P.C. and F.A. Arias-Isaza

UNEP

GEF

Högskolan Kalmar University

Global International Waters Assessment

Regional assessments

Other reports in this series:

Caribbean Islands – GIWA Regional assessment 4

Barents Sea – GIWA Regional assessment 11

Caspian Sea – GIWA Regional assessment 23

Gulf of California/Colorado River Basin – GIWA Regional assessment 27

Patagonian Shelf – GIWA Regional assessment 38

Brazil Current – GIWA Regional assessment 39

Amazon Basin – GIWA Regional assessment 40b

Guinea Current – GIWA Regional assessment 42

Lake Chad Basin – GIWA Regional assessment 43

Indian Ocean Islands – GIWA Regional assessment 45b

East African Rift Valley Lakes – GIWA Regional assessment 47

Pacific Islands – GIWA Regional assessment 62

Global International Waters Assessment

Regional assessment 3a
Caribbean Sea/Small Islands

GIWA report production

Series editor: Ulla Li Zweifel

Report editors: Matthew Fortnam

Editorial assistance: Johanna Egerup, Malin Karlsson

Maps & GIS: Niklas Holmgren

Design & graphics: Joakim Palmqvist

Global International Waters Assessment
Caribbean Sea/Small Islands, GIWA Regional assessment 3a

Published by the University of Kalmar on behalf of
United Nations Environment Programme

ISSN 1651-940X

University of Kalmar
SE-391 82 Kalmar
Sweden

United Nations Environment Programme
PO Box 30552,
Nairobi, Kenya

CITATIONS
When citing this report, please use:
UNEP, 2004. Bernal, M.C., Londoño, L.M., Troncoso, W., Sierra-Correa, P.C. and F.A. Arias-Isaza. Caribbean Sea/Small Islands, GIWA Regional assessment 3a. University of Kalmar, Kalmar, Sweden.

DISCLAIMER
The views expressed in this publication are those of the authors and do not necessarily reflect those of UNEP. The designations employed and the presentations do not imply the expressions of any opinion whatsoever on the part of UNEP or cooperating agencies concerning the legal status of any country, territory, city or areas or its authority, or concerning the delimitation of its frontiers or boundaries.

This publication has been peer-reviewed and the information herein is believed to be reliable, but the publisher does not warrant its completeness or accuracy.

Printed and bound in Kalmar, Sweden, by Sunds Tryck Öland AB.

Contents

Executive summary

The GIWA region 3 Caribbean Sea is located in the Wider Caribbean within tropical and sub-tropical latitudes, bounded to the east by the Antilles Island chain, to the west by the Central American isthmus, while the northern portion of the South American sub-continent limits the southern border. The region has some of the most diverse physical and socio-economic characteristics in the world, containing 28 countries or territories of the Central/South American sub-continents and the Lesser Antilles (Small Islands). The borders correlate in principal with those of the Caribbean Sea Large Marine Ecosystem (LME) with bathymetry as the main biophysical denominator. The Greater Antilles; Cuba, La Hispaniola, Puerto Rico, Jamaica and the Bahamas, are included in GIWA region 4 Caribbean Islands.

The Caribbean Sea region was divided into three sub-systems, delimited according to physical, biological and socio-economic characteristics. This report will focus in particular on sub-system 3a, the Small Islands, which is composed of Antigua and Barbuda, Anguilla, Aruba, United States Virgin Islands, Barbados, British Virgin Islands, Cayman Islands, Dominica, Grenada, Guadeloupe, Martinique, Montserrat, Netherlands Antilles, Saint Vincent & the Grenadines, St. Kitts & Nevis, St. Lucia, Turks & Caicos and Trinidad & Tobago. Sub-system 3b consists of Colombia and Venezuela, and sub-system 3c contains Central America and Mexico (state of Quintana Roo), Belize, Guatemala, Honduras, Nicaragua, Costa Rica and Panama.

The Small Islands sub-system forms the eastern border of the Caribbean Sea and is characterised by a chain of islands of different size, that extend from the north of Venezuela to south of Florida, USA. Taking into account the geographical extent of most of the islands, the entire land area of the countries can be considered as coastal ecosystems. The influence of the surrounding sea is more pronounced on these small islands compared with large islands and continental landmasses (Khaka 1998, Kofi 1999). The islands are characterised by a variety of sensitive habitats including beaches, deltas, coral reefs, mangrove swamps, wetlands, seagrass beds, lakes, rivers and coastal lagoons. There are diverse communities of flora and fauna, including some endemic species. The islands have relatively limited surface areas and natural resources (arable land, freshwater, mineral resources, conventional energy sources), are isolated from continental landmasses, and are particularly vulnerable to natural hazards, principally hurricanes and other tropical storms.

Despite containing 18 countries and territories, the sub-system contains the smallest population in the Caribbean Sea region, but as a result of the countries limited land area, the population densities are the highest in the region; in 2001 the total number of inhabitants in Caribbean Small Islands sub-system was only 3.5 million) but there is an average of 232 inhabitants per km^2. Such high population densities place enormous pressure on the islands ecosystems. The countries in the Small Islands sub-system can be classified as having a medium-high income, with the most significant contribution to GDP provided by the agricultural sector, particularly crops such as bananas, sugar cane, coconuts and other fruits, and the services sector, which includes financial services, tourism and shipping.

The regional environmental legislative regime is comprised of different international conventions that are related to marine and coastal resource management. The United Nations Environment Programme (UNEP) has played a leading role in the establishment of a number of conventions, action plans and protocols. Some of these include: the Caribbean Action Plan; The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (the Cartagena Convention) and its protocol; the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region; and the Protocol Concerning Pollution from Land-Based Sources and Activities (LBS).

The GIWA assessment evaluated the relative importance of different impacts on the international aquatic system of the Small Islands sub-system. The environmental and socio-economic impacts were assessed for present and future conditions, and overall impacts and priorities were identified. The concerns for the Small Islands sub-system were ranked in the descending order:

1. Global change
2. Habitat and community modification
3. Pollution
4. Freshwater shortage
5. Unsustainable exploitation of fish and other living resources

The GIWA assessment determined that the concern of Global change exerted the greatest impacts on the Small Islands sub-system. However, since it is an international concern addressed through other initiatives (e.g. the United Nations Framework Convention on Climate Change), Habitat and community modification was selected as the GIWA priority concern for further analysis in the Causal chain and Policy options analysis.

Hazards originating from Global change are a severe problem for the region. The islands are often impacted by hurricanes, and also, with less frequency, tornadoes. The islands are particularly vulnerable to future sea level rise, which may potentially submerge low-lying coastal areas, and more frequent and intense hurricanes. Coastal habitats, which provide coastal protection such as coral reefs, will be further threatened by these climate induced changes. Assessing the environmental and socio-economic impacts of global change on the region is problematic due to the lack of reliable data. The main socio-economic concern is the cost of protection from, or adaptation to, global change.

The assessment ranked Habitat and community modification as having severe impacts. The main anthropogenic impacts stem from deforestation, extraction of marine resources and tourism. Deforestation and the cultivation of steep slopes cause considerable land degradation, which has increased the sediment load of rivers and eventually coastal waters. Consequently, seagrass beds and coral reefs have been affected by chronic sedimentation that reduces sunlight penetration and increases ecosystem stress. Tourism is affecting the health of coastal ecosystems: mangroves are cleared for developments, which also once constructed further disturb coastal habitats due to their proximity to the high water mark; harbour dredging destroys benthic fauna and increases the turbidity of coastal waters; boat anchors and dive activity damages reefs and seagrass beds; and tourist activities result in a variety of pollution impacts. In addition, dredging, sand extraction, groyne construction and sewage effluents have affected reefs, especially in US Virgin Islands around St. Thomas and St. Croix. These anthropogenic stresses weaken the ecosystems ability to withstand and recover from natural disturbances such as hurricanes and places a risk factor for the sustainable use and harvest of goods and services provided by marine ecosystems (e.g. recreational values, protection of coast line).

The environmental impacts of pollution were assessed as moderate to severe. The discharge of nutrient-rich sewage and agricultural run-off is causing euthrophication. The resultant algal blooms deoxygenate freshwater and coastal waters after collapsing, and prevent sunlight from penetrating surface waters, consequently reducing bioproductivity. The discharge of sewage is also causing micro-biological contamination of drinking water and can cause a proliferation of diseases with subsequent human health impacts. Pollution has had a variety of impacts on the marine environment and severely affected economic activities. For example, pollution has adversely affected tourism due to the loss in aesthetic value of beaches, and marine species have been injured or killed from entanglement and ingestion of solid wastes.

The environmental impacts of freshwater shortage on the Small Island sub-system were assessed as moderate, although it is not strictly a transboundary issue in this region. Many small islands have virtually no freshwater ecosystems (Virgin Islands, Netherlands Antilles, Antigua, Barbados), and groundwater resources in many islands are being exhausted, polluted or contaminated by saltwater intrusion. Polluted surface and groundwater are major causes of degradation of coastal and near-shore marine ecosystems and declines in biodiversity, including critical salt-pond, mangrove, estuary, seagrass and coral reef systems. Socio-economic impacts associated with freshwater shortage are, for example, the high cost of producing desalinated water, hygiene prolems and diseases realted to sanitation problems.

The impacts of the unsustainable exploitation of living resources result principally from overexploitation and destructive fishing practices. Certain stocks are exploited beyond maximum sustainable yields, and as a consequence, techniques such as closed fishing seasons, and restrictions on certain species, have been used as fisheries management tools. Destructive fishing methods have increasingly been employed by fishers, including the use of explosives, poisons, large small-meshed traps, and scuba gear. Degradation of fisheries habitats is considered to have also significantly reduced the size of fish stocks. It is expected that in the future, this situation will not have changed significantly, although the rate of exploitation may increase with the employment of more efficient fishing technologies.

The Causal chain analysis identified the root causes of the prioritised concern of Habitat and community modification. It was found that the governments of the region have sought to develop their economies rapidly, which they have failed to balance with the conservation and protection of ecosystems, in order to achieve sustainable development. This can be attributed to institutional weaknesses that have facilitated a lack of cross-sectoral coordination and uncontrolled development of the coastal zone. Stakeholders are not involved during the planning and implementation of development projects, and therefore the needs of the local community are not considered. For example, there has been inadequate valuation of the essential income and nutritional benefits that habitats provide for local communities, prior to land clearance for development.

Regional conventions such as the Cartegena Convention and national legislation aimed at managing natural resources, have not been implemented due to enforcement agencies lacking the capacity to do so, and as a result of fragmented management, with government agencies and stakeholders having ill-defined and often conflicting responsibilities. National laws related to the environment are not harmonised and there is an absence of integrated management of the coastal zone at the national and regional level. In addition, informed decision-making is inhibited by the lack of monitoring programmes and appropriate technologies to adequately assess the current, and predict the future, status of the ecosystems in the region.

A fundamental hindrance to sustainable development is the lack of understanding, from the public to policy makers, of the importance of conserving aquatic ecosystems. This may stem from unsatisfactory incorporation of environmental issues in educational curriculum, and the lack of public awareness programmes.

The policy options section aimed to describe alternative courses of action that may be taken by policy makers in the region, and discusses the projected outcomes and trade-offs of each action. These actions were designed to address the root causes identified in the causal chain analysis.

The first policy option aims to build institutional capacity in order to integrate land and water resources management with development planning within the regional context. This should improve the ability of the islands to actively manage and conserve their natural resources, and allow the implementation of further initiatives. A second policy option proposes designing and implementing a Strategic Regional Plan for Integrated Coastal and Marine Management. This was formulated to organise economical activities and define environmental protection areas on the basis of a legal framework. Additionally, the establishment of such a plan will clearly define the responsibilities of the relevant authorities and the principal mechanisms to coordinate the formulation and implementation of policies at a regional level.

These policy options should be supported by appropriate monitoring and data management. Stakeholders should be involved in the planning and implementation of the policy options and a continuous evaluation and review process conducted.

It should be noted that the policy options are a preliminary analysis of conceptual ideas and actions that are currently being considered. Therefore more detailed assessment of the options is necessary. However, these policy options are promising solutions to some of the fundamental problems facing the region.

Acknowledgement

The Colombian Institute of Marine and Coastal Research (INVEMAR) Focal point of GIWA region 3 Caribbean Sea, would like to acknowledge the following:

- The Scientific project direction, the Project coordinator and Reports preparation and the Researchers Task team (see Annex I List of contributing authors) for their permanent advise, effort and, constant availability and readiness to attend all the study requirements.
- The Colombian Ministry of Environment, Housing and Territory Planning, for its unconditional support.
- The Regional Task team (see Annex I List of contributing authors), for their dedication, information supply, interest and continuous support.
- The Caribbean Small Islands governments and environmental authorities for facilitating representative experts (see Annex I List of contributing authors) to attend the project requirements and for providing information and data used in this assessment. The Focal point specially thanks the Sustainable Development and Environmental Unit of Saint Lucia Ministry of Physical Development and Environment and, the Department of Planning and Natural Resources of the US Virgin Islands Commission of Natural Resources and Coastal Zone Management, for their special support, through their experts, in the development of this project.
- The general advisors, consultants, special participants and general support Task team (see Annex I List of contributing authors) for their collaboration.
- The GIWA Caribbean Sea region coordinators, GIWA Core team, University of Kalmar, for their technical support and permanent support.
- The GEF, UNEP and Sida for providing the funding required to undertake the study.

Abbreviations and acronyms

BVI	British Virgin Islands
CARICOM	Caribbean Community and Common Market
CATHALAC	Water Center for the Humid Tropics of Latin America and the Caribbean
CBD	The Convention on Biological Diversity
CEHI	Caribbean Environment Health Institute
COP	Conferences of the Parties
CPACC	Caribbean Planning and Adaptation to Global Climate Change
DPW	US Virgin Island's Government Department of Public Works
ECCLAC	United Nations Commission for Latin America and the Caribbean
EEZ	Exclusive Economic Zone
EPA	US Environmental Protection Agency
FAO	United Nations Food and Agricultural Organization
GEF	Global Environment Facility
GDP	Gross Domestic Product
GIS	Geographic Information Systems
IDP	Integrated Development Planning
IOCARIBE	International Oceanographic Commission for the Caribbean
ISM	Island Systems Management
IUCN	The World Conservation Union
LBS	Land-Based Sources
LBSMP	Land Based Sources of Marine Pollution Protocol
LME	Large Marine Ecosystem
MARPOL	International Convention for the Prevention of Pollution from Ships
MPDEH	Ministry of Planning, Development, Environment and Housing
MSY	Maximum Sustainable Yields
NGO	Non-Governmental Organisation
NMR	Net Migration Rate
NSDS	National Sustainable Development Strategies
OECS	Organization of the Eastern Caribbean States
PNUMA	Programa de las Naciones Unidas para el Medio Ambiente
RO	Reverse Osmosis
SIDS	Small Island Developing States
SPAW	Protocol Concerning Specially Protected Areas and Wildlife
SST	Sea Surface Temperature
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCC	United Nations Framework Convention on Climate Change
USVI	United States Virgin Islands
VOC	Volatile Organic Compounds
WASCO	Saint Lucia Water and Sewage Company
WPI	Water Poverty Index
WSSD	World Summit on Sustainable Development

List of figures

List of tables

Regional definition

This section describes the boundaries and the main physical and socio-economic characteristics of the region in order to define the area considered in the regional GIWA assessment and to provide sufficient background information to establish the context within which the assessment was conducted.

Boundaries of the region

The GIWA Caribbean Sea region is part of the Wider Caribbean and includes a range of countries and territories with different environmental, economic and social characteristics. The Caribbean Sea region includes 28 countries: Antigua & Barbuda, Anguilla, Aruba, Belize, Barbados, British Virgin Islands, Cayman Islands, Costa Rica,

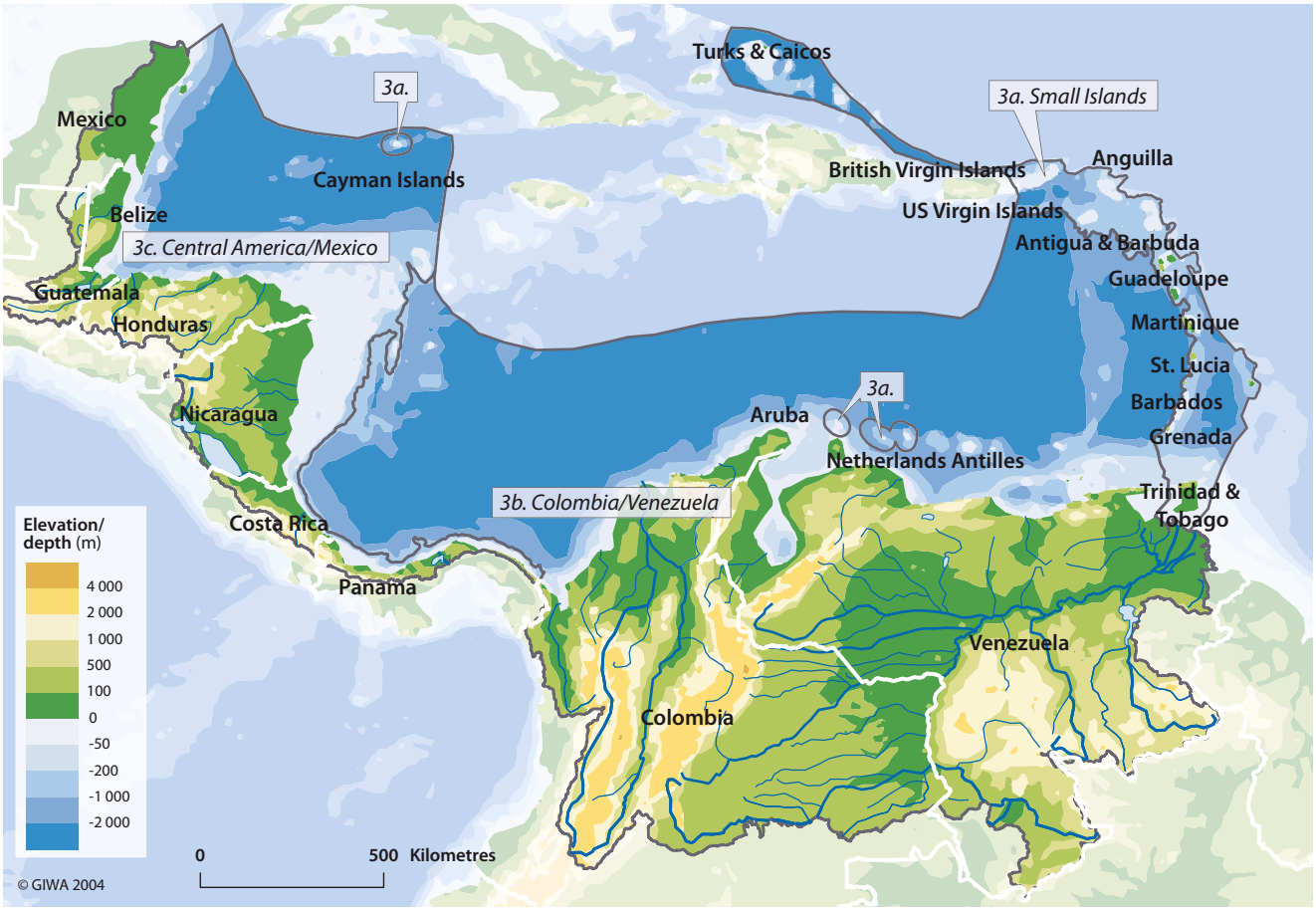


Figure 1 Boundaries of the Caribbean Sea region.

Colombia, Dominica, Grenada, Guatemala, Guadeloupe, Honduras, Martinique, Mexico (Quintana Roo State), Montserrat, Netherlands Antilles (Bonaire and Curaçao), Nicaragua, Panama, Saint Vincent & The Grenadines, Saint Kitts & Nevis, Saint Lucia, Trinidad & Tobago, Turks & Caicos, United States Virgin Islands and Venezuela (Figure 1). The regional borders of the Caribbean Sea are based on the limits of the Caribbean Sea Large Marine Ecosystem (LME) with some exceptions. Since this LME includes both the Caribbean Sea (GIWA region 3) and Caribbean Islands (GIWA region 4), the border dividing the two regions was defined as the 200 nautical mile Exclusive Economic Zone (EEZ) of the countries in the Caribbean Islands region.

The number of countries and their diversity prompted the division of the region into three different sub-systems: 3a Small Islands; 3b Colombia and Venezuela; and 3c Central America and Mexico (Figure 1).

- Sub-system 3a Caribbean Sea/Small Islands includes: Antigua & Barbuda, Anguilla, Aruba, Barbados, British Virgin Islands, Cayman Islands, Dominica, Grenada, Guadeloupe, Martinique, Montserrat, Netherlands Antilles, Saint Kitts & Nevis, Saint Lucia, Saint Vincent & The Grenadines, Trinidad & Tobago, Turks & Caicos, and United States Virgin Islands.
- Sub-system 3b Caribbean Sea/Colombia and Venezuela is composed of Colombia and Venezuela.
- Sub-system 3c Caribbean Sea/Central America and Mexico contains Belize, Costa Rica, Guatemala, Honduras, Mexico (Quintana Roo State), Nicaragua and Panama.

The foloowing assessment and causal chain and policy options sections will focus on the Smal Islands sub-system in particular.

Physical characteristics

Caribbean Sea region

The Caribbean Sea is a semi-enclosed basin bounded by the Lesser Antilles to the east, the Greater Antilles (Cuba, Hispaniola, and Puerto Rico) to the north, and by Central America to the west. The Caribbean Sea is located within the tropics; and it covers 1 943 000 km^2 whereas the Wider Caribbean, which includes the marine environment of the Gulf of Mexico, the Caribbean Sea and the areas of the Atlantic Ocean adjacent thereto, is significantly larger, encompassing an area of 2 515 900 km^2 (IUCN 2003, Sheppard 2000, Bjorn 1997).

The Caribbean region was formed during the Jurassic period. With the division of the mega-continent Pangaea 180 million years ago came the separation of the lands that would shape North and South America. The continuous collision of continental plates produced, additionally to the subduction of the Cocos and Nazca plates, the formation of continental and submarine mountain ranges and several islands, coastal shapes, the Central America elevation, and the land rise, including the formation of the San Juan River mouth. In addition to these events, the Flamenca oceans transgression occurred, changing coastal morphology to its present appearance, e.g. Magdalena River mouth and Maracaibo Lake Basin. Central America formed a biogeographic bridge, allowing the migration of floral and faunal species between North and South America, which is an important factor causing the high biodiversity in the region (Windevoxhel 2003).

The Caribbean Sea is deep, averaging 2 200 m, with the deepest part, known as the Cayman trench, plunging to 7 100 m. The drainage basin is large, covering 7.5 million km^2 and encompasses eight major river systems, from the Mississippi to the Orinoco (Hinrichsen 1998). The Mississippi River is in the Wider Caribbean, but is part of GIWA region 2 Gulf of Mexico.

The Caribbean Current transports significant amounts of water northwestward through the Caribbean Sea and into the Gulf of Mexico, via the Yucatan Current (Figure 2). The source of the Caribbean Current is the equatorial Atlantic Ocean via the North Equatorial, North Brazil, and Guiana currents. Water flows into the Caribbean Sea mostly through the Grenada, Saint Vincent, and Saint Lucia passages in the southeast. The water then continues westward as the Caribbean Current, the main surface circulation in the Caribbean Sea (Wust 1964, Gordon 1967, Roemich 1981, Hernandez-Guerra & Joyce 2000, in Gyory et al. 2004).

The strongest flow in the Caribbean is found in the southern third of the Sea and belongs to the Caribbean Current (Gordon 1967, Kinder 1983, in Gyory et al. 2004). In this area, the highest surface velocities can reach 0.7 m/s along the coasts of Venezuela and the Netherlands Antilles (Fratantoni 2001, in Gyory et al. 2004). There are also strong (0.6 m/s) currents along the Panama and Colombian coasts, but there is little flow over the Central American Rise, since most of the northwestward flow is channelled to the southwest of Jamaica. The flow turns sharply westward as it crosses the Cayman Basin, and enters the Gulf of Mexico as a narrow boundary current that hugs the Yucatan Peninsula (Fratantoni 2001, in Gyory et al. 2004). This Yucatan Current flows into the Gulf of Mexico through the Yucatan Channel. It eventually separates from the Campeche Bank and becomes the Loop Current. The Loop Current then becomes the Florida Current as it exits the Gulf of Mexico

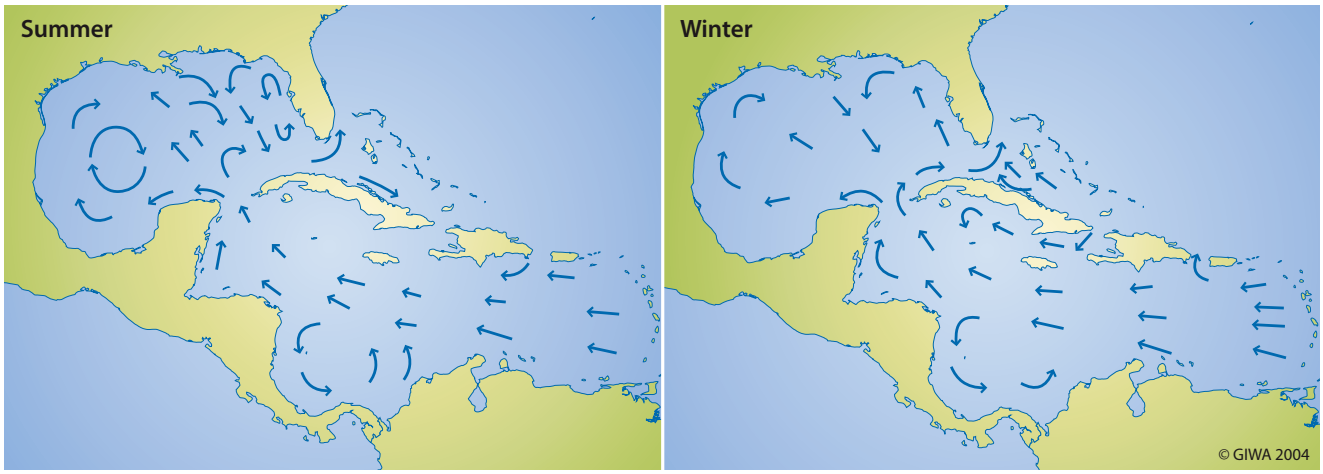


Figure 2 Superficial water circulation of the Caribbean Sea during summer (A) and winter (B).
(Source: NIMA 2000)

through the Straits of Florida (Molinari & Morrison 1998, in Gyory et al. 2004). The overall speed of the water as it travels from Aves Ridge to the Florida Straits was estimated by Morrison and Smith (1990, in Gyory et al. 2004). They detected a transport maximum in the Florida Straits approximately 90-100 days after detecting a transport maximum in the Eastern Caribbean. Thus, the calculated propagation speed is about 0.3-0.4 m/s, depending upon the path and mean current speed between Aves Ridge (65°W) and the Florida Straits (Figure 2).

The winds in the Caribbean region generate a circulation cell where deep waters upwell along the north coast of South America and surface waters (enriched by upwelling and by discharges from the Orinoco River) are advected northwards into the region, especially during the rainy period. In agreement with Sheppard (2000), satellite images in the visible spectrum clearly show the meridian spreading of green water in the eastern Caribbean. Superimposed on the mean circulation, tidal currents are the dominant component of the offshore currents. Tides throughout the northeast Caribbean Sea exhibit a complex behaviour. Caribbean waters are well stratified, which means that at different depths the water is moving in different directions, according to the sources and sinks for each water mass. The structure and composition of the Caribbean surface water exhibit a well-defined seasonal pattern (Sheppard 2000). An estimation of sediment discharge into the Wider Caribbean region is presented in Table 1.

Mangrove wetlands, seagrass beds and coral reefs dominate the land-sea interface in the tropics and harbour the highest biological diversity within the ocean. Caribbean mangrove, seagrasses and coral reefs are closely associated; they exist in a dynamic equilibrium influenced by coastal activities. The Caribbean contains 7% of the world's coral reefs

Table 1 Estimations of sediment discharge into the Wider Caribbean region.

Region/ River	**Sediments charge** (tonnes/year)
Mississippi River	320 000 000
Rivers that flow into the Gulf of Mexico	121 000 000
Rivers form Central America and the Antilles	300 000 000
Magdalena River	235 000 000
Orinoco River	85 000 000
Other rivers from Colombia and Venezuela	50 000 000

(Source: UNEP 1994)

(about 20 000 km^2) with a great array of marine biodiversity (UNEP 1999b). However, in the Caribbean, 22% of coral reefs have already been degraded, with the major threats linked to human activities: sewage, industrial and agricultural pollution, erosion and overexploitation of fisheries (Bryant et al. 1998).

The geology of the coastline is dominated by three main types; limestone or igneous rock, eolianite or beach rock, and unconsolidated geomorphologic forms such as beach, alluvial fan, alluvial plain, or dune. A fourth category is the mangrove shorelines, where there is often accretion (Sheppard 2000). There are approximately 535 terrestrial protected areas in the Caribbean. These areas cover 4.26 million ha or 18.62% of the total land mass (UNEP/WCMC 2003), but it is pertinent to remember that due to weak governmental capacity, most of these are paper parks without effective management.

Small Islands sub-system

The Small Islands sub-system forms the eastern border of the Caribbean Sea and is characterised by a chain of islands of different size, that

extend from the north of Venezuela to south of Florida, USA. Different groups of islands form most of the countries or territories; some of them are occupied by human settlements and others are completely inhospitable due to their biophysical characteristics. Taking into account the geographical extent of most of the islands, the entire land area of these countries can be considered as coastal ecosystems.

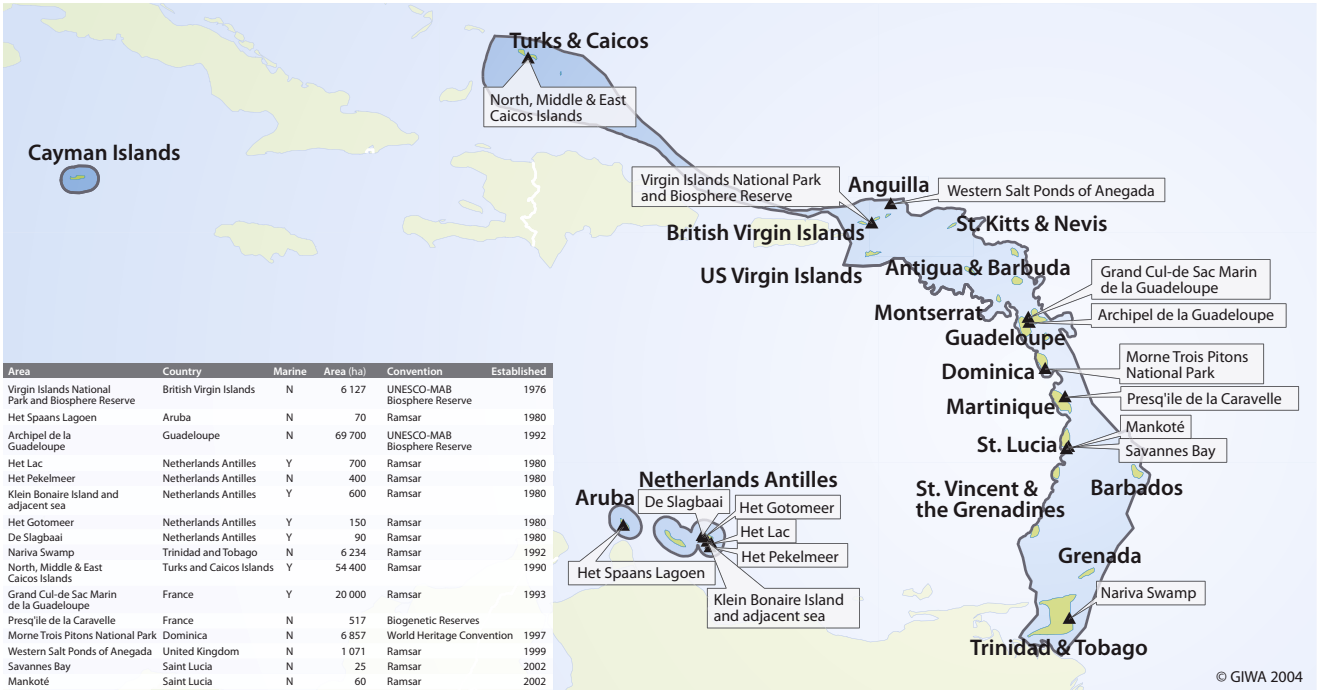
Some of the islands are coral limestone formations, while the others have volcanic origin, generating different environmental and biophysical conditions. The climate is tropical, and the annual rainfall varies across the sub-system (50-1 250 mm). Natural hazards affecting the islands principally include hurricanes and other tropical storms (from July to October) (Agard & Gobin 2000), and there are also volcanoes, earthquakes, landslides and flooding. The predominant ecosystems of the Small Islands sub-system are typical for the Caribbean Sea and include mangroves, swamps, sandy beaches, coral reefs, seagrass beds and salt ponds, which are breeding grounds for sea birds, sea turtles and fish, as well as fish recruitment areas. Figure 3 shows the international protected areas in the Small Islands sub-system.

Among the mangrove species found on the coast are the Red mangrove (*Rhizophora mangle*), White mangrove (*Laguncularia racemosa*), Black mangrove (*Avicennia germinans*), and Buttonwood (*Conocarpus erectus*). The seagrass beds offshore include Turtle grass (*Thalassia testudinum*) and Manatee grass (*Syringodium filiforme*). The marine turtles that nest in the islands include the Hawksbill (*Eretmochelys imbricata)*, the Green (*Chelonia mydas*) and the Leatherback (*Dermochelys coriacea*). There have also been occasional sightings of marine mammals such as the Humpback whale (*Megaptera novaeangliae*), the Sperm whale (*Physeter catodon*) and the Killer whale (*Orcinus orca*). Over 50 species of corals have been recorded and over 100 different species of commercially important reef fish including groupers, parrotfish, wrasses, snappers, grunts, squirrelfish, goatfish, boxfish and surgeonfish. However, it is generally agreed that the marine biodiversity of many of the islands remains understudied and the number of endemic species is not entirely known (Table 2).

Table 2 Number of endemic species.

Countries or territories	Birds	Mammals	Amphibians and reptiles	Higher plants
Antigua and Barbuda	ND	0	1	1
Barbados	ND	0	0	ND
Dominica	ND	1	0	ND
Montserrat	ND	0	5	ND
St.Kitts, St Eustatius and Nevis	ND	0	1	ND
Saint Lucia	5	5	5	16
St. Martin, Anguilla and St. Barthelemy	ND	ND	0	0
Saint Vincent and the Grenadines	ND	0	2	ND
US Virgin Islands	2	0	30	26

Note: ND = No Data.
(Source: World Bank Group 2003, UNEP 1996 , UNEP 2000b, Government of Saint Lucia 2001)



Area	Country	Marine	Area (ha)	Convention	Established
Virgin Islands National Park and Biosphere Reserve	British Virgin Islands	N	6 127	UNESCO-MAB Biosphere Reserve	1976
Het Spaans Lagoen	Aruba	N	70	Ramsar	1980
Archipel de la Guadeloupe	Guadeloupe	N	69 700	UNESCO-MAB Biosphere Reserve	1992
Het Lac	Netherlands Antilles	Y	700	Ramsar	1980
Het Pekelmeer	Netherlands Antilles	N	400	Ramsar	1980
Klein Bonaire Island and adjacent sea	Netherlands Antilles	Y	600	Ramsar	1980
Het Gotomeer	Netherlands Antilles	Y	150	Ramsar	1980
De Slagbaai	Netherlands Antilles	Y	90	Ramsar	1980
Nariva Swamp	Trinidad and Tobago	N	6 234	Ramsar	1992
North, Middle & East Caicos Islands	Turks and Caicos Islands	Y	54 400	Ramsar	1990
Grand Cul-de Sac Marin de la Guadeloupe	France	Y	20 000	Ramsar	1993
Presq'ile de la Caravelle	France	N	517	Biogenetic Reserves	
Morne Trois Pitons National Park	Dominica	N	6 857	World Heritage Convention	1997
Western Salt Ponds of Anegada	United Kingdom	N	1 071	Ramsar	1999
Savannes Bay	Saint Lucia	N	25	Ramsar	2002
Mankoté	Saint Lucia	N	60	Ramsar	2002

Figure 3 International protected areas in the Small Islands sub-system.
(Source: UNEP/WCMC 2003)

Figure 4 Reefs at risk in the Small Islands sub-system.
(Source: Bryant et al. 1998)

Figure 4 shows the reefs at risk in the Small Islands sub-system. For a summary of physical characteristics and a brief listing of environmental problems by country see Annex III.

Socio-economic characteristics

Caribbean Sea region

In 2001, the number of inhabitants in the Caribbean Sea region was close to 73.6 million, of which 82% was in the Colombia/Venezuela sub-system, 14% in the Central America/Mexico sub-system and 5% in the Small Islands sub-system (World Bank Group 2003, CIA 2001, Landscan 2001, GIWA Task team estimations). The population in each sub-system has shown different trends of growth. In the Colombia/Venezuela and Central America/Mexico sub-systems, the average growth rate was close to 2% annually between 1996 and 2002, while in the Small Islands it was less than 1%. The growth rate of Aruba, Cayman Islands, Guadeloupe, Martinique, Montserrat, Netherlands Antilles and Turks & Caicos are not included due to a lack of information (World Bank Group 2003, CIA 2001, Landscan 2001, GIWA Task team estimations). Taking into account the population growth rate for each country in the Caribbean Sea region, it is expected that the number of inhabitants will be close to 89 million in 2020 (the projections for Aruba, Cayman Islands, Guadeloupe, Martinique, Montserrat, Netherlands Antilles and Turks and Caicos are not included due to a lack of information regarding growth rates).

Additionally, the population of the Caribbean Sea region increases every year by the influx of million of tourists, the majority of which visit the region's beaches. Almost all the countries in the Small Islands sub-system are amongst the world's premier tourist destinations. This sector is an important source of income but also creates several environmental problems. The tourism industry has a significant impact on water resources for a variety of reasons. Often when large hotels or golf courses are developed, vegetation is cleared from the area, which can lead to flooding, soil erosion, destruction of habitat, and poor aquifer recharge. The high demand for freshwater leads to overextraction of water from aquifers and the rapid depletion of surface resources, and waste produced by the tourism industry can contaminate existing water supplies (Organization of American States 2001).

Small Islands sub-system

The Small Islands sub-system includes the highest number of countries or territories (18) but also the smallest population of the sub-systems in the Caribbean Sea region. According to the World Bank Group (2003) in 2001, the total number of inhabitants in Caribbean Small Islands sub-system was 3.5 million (Table 3).

Table 3 Population and net migration rate in the Caribbean Sea region.

Country	Population (2001)	Migrants/1 000 population
Anguilla	11 600	10.8
Antigua & Barbuda	68 490	6.3
Aruba	68 700	0
Barbados	268 200	-0.3
British Virgin Islands	21 000	10.0
Cayman Islands	35 530	18.8
Dominica	71 870	-20.4
Grenada	100 400	-15.9
Guadeloupe	431 200	-0.15
Martinique	418 400	-0.1
Montserrat	7 570	0
Netherlands Antilles (Bonaire and Curaçao)	212 200	-0.4
St. Kitts & Nevis	45 050	-10.7
Saint Lucia	156 700	-4.2
Saint Vincent & The Grenadines	115 900	-7.7
Trinidad & Tobago	1 300 000	-9.9
Turks & Caicos	18 100	11.7
US Virgin Islands	109 300	-8.9

(Source: The World Bank Group 2003, Anguilla Government 2002, DPU 2002, CIA 2001)

In general, these countries or territories are small, with populations in 2001 ranging from 7 570 (Montserrat) to 1.3 million (Trinidad & Tobago). As previously mentioned, the average population growth rate is low (less than 1%) and is the lowest of all the Caribbean Sea sub-systems. Between 1996 and 2002, the highest registered population growth rate in this sub-system was in Saint Kitts and Nevis (1.9%), followed by St Lucia (1.3%) and Grenada (1.1%) (World Bank Group 2002). In some cases, population growth was less than 1%, such as in Antigua & Barbuda (0.8%), St Vincent & The Grenadines (0.7%), Trinidad & Tobago (0.6%), US Virgin islands (0.5%) and Barbados (0.3%). In other cases there was negative growth, as in Dominica (-2%). These low rates are related to a moderate population growth rate and to a negative net migration rate (NMR). In 2001, a significant number of countries had a negative NMR (Table 3).

Attributed to the limited land area of the sub-system, the population densities of countries in the Small Islands sub-system are the highest in the region, with an average of 232 inhabitants per km^2. Such high population densities place enormous pressure on the islands ecosystems. The highest densities occur in Barbados (622 inhabitants per km^2), Martinique (395 inhabitants per km^2), Aruba (356 inhabitants per km^2) and the US Virgin Islands (313 inhabitants per km^2). The sub-system also has the peculiarity of having a moderate percentage of urban population, on average 50%. The highest rates occur on Cayman Island (100%), Trinidad & Tobago (74%) and Dominica (71%) (World Bank Group 2002).

The infant mortality rate for this sub-system is the lowest average value in the Caribbean Seas region, with approximately 15 infants per 1 000 live births. This average is surpassed by the British Virgin Islands (19), Grenada (20), St Vincent & The Grenadines (22), St Kitts & Nevis (22), Saint Lucia (17), Trinidad & Tobago (17) and Turk & Caicos (17) (CIA 2001, World Bank Group 2002).

The access to treated water sources in the Small Islands sub-system is on average 96%, the highest in the Caribbean Sea region. In Barbados, 100% of the population has access to treated water (World Bank Group 2002), and according to the recently developed Water Poverty Index (WPI), Barbados is one of the 21 countries with one of the highest access to water in the world, for industrial and agricultural use.

Data of per capita income is not available for all the countries. The available information for 2001 indicates that the countries in the Small Islands sub-system can be classified as having a medium to high income, according to the World Bank Group. Barbados, Antigua & Barbuda and St Kitts & Nevis have the highest incomes; 9 750, 9 150 and 7 270 USD respectively (World Bank Group 2002).

GDP is not available from formal references for all the islands. The available data in 2001 for Anguilla, Antigua & Barbuda, Aruba, Barbados, Dominica, Grenada, Saint Vincent & The Grenadines, Saint Kitts & Nevis, Saint Lucia and Trinidad & Tobago indicates that their GDP was 13.2 billion USD; where 67% was contributed by Trinidad & Tobago and 21.2% by Barbados. The GDP of these countries has been growing at an average rate of 3.7% per year between 1997 and 2001, surpassed only by St Kitts & Nevis (4.6%), Aruba (4.4%) and Trinidad & Tobago (4%) (CIA 2001).

In 2001, with the exception of Trinidad & Tobago, the services sector generally contributed between 60-80% of the GDP of countries comprising the Small Islands sub-system and exceeded 90% in the Cayman Islands (96%), the British Virgin Islands (92%) and Martinique (83%) (CIA 2001). This shows the high dependence of the economies on services, particularly tourism. Contributions by industrial, manufacturing and agricultural sectors vary among the countries of the system; the highest contribution to GDP from industry is in Trinidad & Tobago (45%), Saint Kitts & Nevis (29%) and Saint Vincent & The Grenadines (24%). Countries with a strong manufacturing base are Saint Kitts & Nevis (10%), Barbados (8.5%) and Grenada (8.4%).The agricultural sector is most important in Dominica (17%), Guadeloupe (15%) and Grenada (8%).

Table 4 Cruise passenger arrivals 1991-2003.

Country	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Anguilla	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antigua & Barbuda	256 000	250 000	238 000	236 000	227 000	270 000	286 000	336 000	328 000	429 000	409 000	312 000	386 000
Aruba	133 000	217 000	251 000	257 000	294 000	317 000	298 000	258 000	289 000	490 000	417 000	513 000	542 000
Barbados	372 000	400 000	429 000	460 000	485 000	510 000	518 000	507 000	433 000	533 000	518 000	519 000	559 000
Bonaire	13 000	28 000	17 000	12 000	11 000	15 000	20 000	20 000	17 000	44 000	23 000	23 000	45 000
British Virgin Islands	79 000	88 000	113 000	82 000	122 000	160 000	105 000	105 000	181 000	189 000	ND	ND	179 000
Cayman Islands	475 000	614 000	606 000	599 000	683 000	800 000	867 000	871 000	1 036 000	1 031 000	1 215 000	1 575 000	1 818 000
Curaçao	157 000	160 000	183 000	161 000	172 000	173 000	215 000	231 000	221 000	309 000	300 000	318 000	279 000
Dominica	65 000	90 000	88 000	126 000	135 000	193 000	231 000	239 000	202 000	240 000	ND	ND	177 000
Grenada	196 000	196 000	200 000	201 000	250 000	267 000	247 000	266 000	246 000	180 000	147 000	135 000	147 000
Guadeloupe	261 000	246 000	263 000	314 000	419 000	613 000	544 000	334 000	293 000	392 000	ND	ND	ND
Martinique	417 000	399 000	429 000	420 000	428 000	408 000	387 000	415 000	339 000	286 000	203 000	207 000	269 000
Montserrat	ND	6 000	9 000	11 000	9 000	ND	ND	ND	ND	ND	ND	ND	ND
Saint Kitts and Nevis	53 000	74 000	83 000	113 000	121 000	86 000	96 000	154 000	137 000	164 000	ND	ND	ND
Saint Lucia	153 000	165 000	154 000	172 000	176 000	182 000	310 000	372 000	351 000	444 000	490 000	387 000	393 000
Saint Vincent and the Grenadines	88 000	63 000	69 000	71 000	85 000	63 000	31 000	35 000	48 000	86 000	54 000	50 000	65 000
Trinidad and Tobago	32 000	27 000	33 000	45 000	49 000	48 000	32 000	47 000	57 000	82 000	82 000	60 000	56 000
Turks and Caicos	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
US Virgin Islands	1 221 000	1 277 000	1 209 000	1 241 000	1 171 000	1 316 000	1 619 000	1 616 000	1 403 000	1 .768 000	1 881 000	1 729 000	1 774 000

Note: ND = No Data. (Source: Caribbean Tourism Organization 2002, 2003, 2004)

The OECS countries have shown some degree of economic diversification in recent years. It is evident that the economies have restructured away from agriculture and manufacturing towards the provision of services. There has been some structural transformation of the economies to more service-oriented activities, but more often than not shifts have meant that, while the type of economic activity might have changed, these economies still depend on a single economic activity or sector to support constant growth. At the same time, the economies of the OECS countries can still be described as highly open and consequently heavily dependent on foreign trade. Real diversification therefore remains a somewhat elusive goal (OECS/SSWSSD 2002).

Although the economies of the countries in the Organization of the Eastern Caribbean States (OECS) are classified as "middle-income" developing economies, recent poverty surveys reveal that there are growing pockets of poverty in these countries due to a lack of initiatives to improve access to land, financial resources, public infrastructure and services (OECS/SSWSSD 2002).

The agricultural sector, particularly crops such as bananas, sugar cane, coconuts and other fruits, and the services sector, which includes financial services, tourism and shipping, are significant contributors to the GDP.

The cruise industry has expanded in the past decade (Table 4), with cruise passenger arrivals growing at an annual average of 5% between 1991 and 2003. While tourism is expected to increase, it is not always reliable and consistent from year to year, especially since the Caribbean region is prone to hurricanes and is also sensitive to global security concerns. The increase in tourism is also expected to contribute to more environmental degradation (UNEP 2003).

The tourism sector makes the greatest use of coastal and marine resources in the Wider Caribbean region. According to data provided by the Caribbean Tourism Organization (2003), the number of tourist arrivals to the Small Islands (calculated from the total number of tourist arrivals in each country) increased from 4.1 million in 1991 to 5.7 million in 2001, showing an annual average growing rate of approximately 3% (Table 5). In 2001, the ratio of tourist arrivals to inhabitants was 1.7:1, considering that the total number of inhabitants in the sub-system was 3.5 million.

The ratio of tourist arrivals to inhabitants could be considered as a good indicator of resources demand during the high tourist season, mainly

Table 5 Tourist arrivals 1991-2001.

Country	Population 2001	Tourist arrivals											Proportion Tourists: Population 2001
		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	
US Virgin Island	109 300	470 300	478 000	549 500	540 500	454 000	372 600	392 900	422 300	483 800	607 200	592 000	5.4
Anguilla	11 567	29 692	30 400	37 700	43 700	38 531	37 500	43 200	43 900	46 800	43 800	48 000	4.1
Antigua & Barbuda	68 490	204 700	217 900	249 400	262 900	220 000	228 200	240 400	234 300	239 600	236 700	222 100	3.2
Aruba	68 724	501 324	541 700	562 000	582 100	618 916	640 800	646 000	647 400	683 300	721 200	691 400	10.1
Barbados	268 200	394 200	385 500	396 000	425 600	442 100	447 100	472 300	512 400	514 600	544 700	507 100	1.9
Netherland Antilles	212 226	819 718	857 200	815 300	892 400	781 665	662 127	726 100	738 000	723 100	692 800	676 200	3.2
British Virgin Islands	21 000	136 443	116 900	200 200	238 700	219 481	243 700	244 300	279 100	285 900	281 100	295 600	14.1
Cayman Island	35 527	237 351	245 900	278 600	314 400	361 444	373 200	334 000	354 000	345 000	354 100	334 100	9.4
Dominica	71 870	46 300	47 000	51 900	56 500	60 500	63 300	65 400	65 500	73 500	69 600	66 400	0.9
Grenada	100 400	85 000	87 600	93 900	109 000	108 000	108 200	110 700	115 800	125 300	128 900	123 400	1.2
Guadeloupe	431 170	326 000	340 500	452 700	555 600	640 000	625 000	660 000	693 000	711 000	807 000	773 400	1.8
Martinica	418 454	315 100	320 700	366 400	419 000	457 200	477 000	513 200	548 800	564 300	526 300	460 400	1.1
Monserrat	7 574	19 200	17 300	21 000	21 300	17 700	8 700	5 100	7 500	9 900	10 300	9 800	1.3
Saint Vincent & The Granadines	115 900	51 600	53 100	56 700	55 000	60 200	57 900	65 100	67 200	68 300	72 900	70 700	0.6
Saint Kitts & Nevis	45 050	83 900	88 300	88 600	94 200	78 900	84 200	88 300	93 200	84 000	73 100	70 600	1.6
Saint Lucia	156 700	159 000	177 500	194 100	218 600	232 300	235 700	248 400	252 200	260 600	269 900	250 100	1.6
Trinidad & Tobago	1 300 000	219 700	234 700	248 000	265 600	259 800	265 900	324 300	334 000	358 200	398 600	383 100	0.3
Turks & Caicos	18 122	54 616	52 000	66 800	70 900	77 845	86 500	92 100	105 900	117 600	151 400	165 400	9.1
Small Islands sub-system	3 460 274	4 154 144	4 292 200	4 728 800	5 166 000	5 128 582	5 017 627	5 271 800	5 514 500	5 694 800	5 989 600	5 739 800	1.7
Annual growth rate (%)			3	10	9	-1	-2	5	5	3	5	-4	

(Source: Caribbean Tourism Organization 2003)

for public services. In 2001, the ratio was greatest in the British Virgin Islands (14), Aruba (10), Cayman Islands and Turks and Caicos (9) and US Virgin Islands (5). Another indicator is the total number of tourist arrivals to each country per year, which gives an idea about the most popular destinations. The islands with the highest number of tourist arrivals in 2001 were Guadeloupe, with 13% of the total number of visitors to the sub-region, followed by Aruba with 12%, Netherlands Antilles (Bonaire and Curaçao) with 12%, US Virgin Islands with 10% and Barbados with 9% (Table 5) (Caribbean Tourism Organization 2003).

Legal framework

The regional environmental legislative regime is comprised of different international conventions that are related to marine and coastal resource management. For the Caribbean region in particular, the United Nations Environment Programme (UNEP) has played a leading role in the establishment of a number of conventions, action plans and protocols. Some of these include:

- The Caribbean Action Plan,
- The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (the Cartagena Convention), and its protocols:
  - The Protocol Concerning Cooperation in Combating Oil Spills
  - The Protocol Concerning Specially Protected Areas and Wildlife (SPAW);
  - The Protocol Concerning Marine Pollution from Land-Based Sources and Activities (LBS).

The Caribbean Action Plan

The Caribbean Action Plan emerged as a result of many years of work by governmental and non-governmental representatives of the Caribbean community, assisted primarily by UNEP. The programme objectives embraced by the Caribbean Action Plan, adopted in 1981, include the following (CEP 2003):

- Assistance to all countries of the region recognising the special situation of the smaller islands;
- Coordination of international assistance activities;
- Strengthening existing national and sub-regional institutions;
- Technical cooperation in the use of the region's human, financial and natural resources.

The Cartagena Convention

The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention) was adopted in Cartagena, Colombia in March 1983 and entered into force in October 1986, for the legal implementation of the Action Plan for the Caribbean Environment Programme (UNEP/CEP 1983). The Cartagena Convention has been ratified by 21 United Nations Member States in the Wider Caribbean Region, and has already carried out 21 Conferences of the Parties (COP). Its area of application comprises the marine environment of the Gulf of Mexico, the Caribbean Sea and the areas of the Atlantic Ocean adjacent thereto, south of 30° N and within 200 nautical miles of the Atlantic Coasts of the United States.

The legal structure of the Convention is such that it covers the various aspects of marine pollution for which the Contracting Parties must adopt measures. Thus, the Convention requires the adoption of measures aimed at preventing, reducing and controlling pollution of the following areas:

- Pollution from ships;
- Pollution caused by dumping;
- Pollution from sea-bed activities;
- Airborne pollution;
- Pollution from land-based sources and activities.

In addition, the countries are required to take appropriate measures to protect and preserve rare or fragile ecosystems, as well as the habitat of depleted, threatened or endangered species and to develop technical and other guidelines for the planning and environmental impact assessments of important development projects in order to prevent or reduce harmful impacts (CEP 2003).

The Cartagena Convention has been supplemented by three Protocols:

The Protocol Concerning Cooperation in Combating Oil Spills

The Protocol was also adopted in 1983 and entered into force in October 1986. This Protocol applies to oil spill incidents which have resulted in, or which pose a significant threat of pollution to the marine and coastal environment of the Wider Caribbean region or which adversely affect the related interests of one or more of the Contracting Parties. The countries shall, within their capabilities, cooperate in taking all necessary measures, both preventive and remedial, for the protection of the marine and coastal environment of the Wider Caribbean; particularly the coastal areas of the islands of the region, from oil spill incidents. The countries shall, within their capabilities, establish and maintain, or ensure the establishment and maintenance of the means of responding to oil spill incidents and shall endeavour to reduce the risk thereof. Such means shall include the enactment, as necessary, of relevant legislation, the preparation of contingency plans, the identification and development of the capability to respond to an oil spill incident and the designation of an authority responsible for the implementation of this Protocol.

The Protocol Concerning Specially Protected Areas and Wildlife (SPAW)

The Protocol was adopted in January 1990 and entered into force in June 2000, and already carried out 11 COP. Every country shall, in accordance with its laws and regulations and the terms of the Protocol, take the necessary measures to protect, preserve and manage in a sustainable way, within areas of the Wider Caribbean region in which it exercises sovereignty, or sovereign rights or jurisdiction: areas that require protection to safeguard their special value; and threatened or endangered species of flora and fauna. Each country shall regulate and, where necessary, prohibit activities having adverse effects on these areas and species. Each country shall endeavour to cooperate in the enforcement of these measures, without prejudice to the sovereignty, or sovereign rights or jurisdiction of other Parties. Each country, to the extent possible, consistent with each Party's legal system, shall manage species of fauna and flora with the objective of preventing species from becoming endangered or threatened.

The Protocol Concerning Marine Pollution from Land-Based Sources and Activities (LBS)

The adoption of this Protocol took place in October 1999 in Aruba. Sixteen Member States signed the Final Act to adopt the Protocol, and six (Colombia, Costa Rica, Dominican Republic, France, the Netherlands, and the United States of America) have signed the Protocol itself. The protocol will enter into force after it has been ratified by nine Member States following 2 COP. Each country shall, in accordance with its laws, the provisions of this Protocol, and international law, take appropriate measures to prevent, reduce and control pollution of the Convention area from land-based sources and activities, using for this purpose the best practicable means at its disposal and in accordance with its capabilities. Each country shall develop and implement appropriate plans, programmes and measures. In such plans, programmes and measures, each country shall adopt effective means of preventing, reducing or controlling pollution of the Convention area from land-based sources and activities on its territory, including the use of most appropriate technology and management approaches such as integrated coastal area management. Countries shall, as appropriate, and having due regard to their laws and their individual social, economic and environmental characteristics and the characteristics of a specific

area or sub-region, jointly develop sub-regional and regional plans, programmes and measures to prevent, reduce and control pollution of the Convention area from land-based sources and activities.

The Cartagena Convention is not the only multilateral environmental agreement applicable in the region. However, its regional area of application makes it an important complement to other agreements (CEP 2003). Other applicable agreements include the Convention on Biological Diversity, the Convention on Climate Change, MARPOL 73/78, RAMSAR, and the Law of the Sea (see also Annex VI).

The Convention on Biological Diversity (CBD)

This convention has the objective to be pursued in accordance with its relevant provisions, which are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

The United Nations Framework Convention on Climate Change (UNFCC)

This convention has the objective to achieve, in accordance with the relevant provisions of the Convention, stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

International Convention for the Prevention of Pollution from Ships (MARPOL)

A convention that provides for inspection and certificates for compliance with the requirements of the Convention, international cooperation in detecting violations and enforcement measures, reporting requirements of incidents involving harmful substances, settlement of disputes and technical cooperation.

- Annex I deals with the prevention of pollution by oil including operational and structural requirements for ships, designation of special zones, reception facilities in harbours and record keeping. It also deals with marine structures.
- Annex II deals with the control of noxious liquid substances in bulk (to be classified into four categories depending on the level of hazard involved).
- Annex III covers the prevention of pollution by harmful substances carried by sea in packaged forms, or in freight containers, portable tanks or road and rail tank wagons.
- Annex IV relates to the prevention of pollution by sewage from ships.
- Annex V concerns dumping of garbage from ships.

Annexes III, IV and V are optional and states may, when signing or acceding etc. declare that they do not accept one or all of these Annexes.

The Convention on Wetlands (the Ramsar Convention)

The Convention was signed in Ramsar, Iran, in 1971 and is an inter-governmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

The United Nations Convention on the Law of the Sea (UNCLOS)

This Convention from 1982 establishes the legal status of the territorial sea, of the air space over the territorial sea and of its bed and subsoil. The basic principle is stated in Article 192: "States have the obligation to protect and preserve the marine environment." Part XII, which covers "all sources of pollution", deals with such areas as global and regional cooperation, technical assistance, enforcement and safeguards.

Assessment

Table 6 Scoring table for Caribbean Sea/Small Islands.

Assessment of GIWA concerns and issues according to scoring criteria (see Methodology chapter)	The arrow indicates the likely direction of future changes.
0 No known impacts; 1 Slight impacts; 2 Moderate impacts; 3 Severe impacts	↗ Increased impact; → No changes; ↘ Decreased impact

Caribbean Sea/ Small Islands	Environmental impacts	Economic impacts	Health impacts	Other community impacts	Overall Score**	Priority***
Freshwater shortage	2.0* →	3.0 ↘	1.7 ↘	2.0 ↘	2.1	4
Modification of stream flow	2					
Pollution of existing supplies	2					
Changes in the water table	2					
Pollution	2.4* ↘	2.7 ↗	2.0 ↘	2.0 ↘	2.1	3
Microbiological pollution	3					
Eutrophication	2					
Chemical	2					
Suspended solids	3					
Solid wastes	2					
Thermal	1					
Radionuclides	0					
Spills	2					
Habitat and community modification	3.0* ↘	3.0 →	1.0 →	3.0 →	2.4	2
Loss of ecosystems	3					
Modification of ecosystems	3					
Unsustainable exploitation of fish	1.9* →	2.0 ↗	2.2 →	1.6 →	2.0	5
Overexploitation	3					
Excessive by-catch and discards	1					
Destructive fishing practices	2					
Decreased viability of stock	1					
Impact on biological and genetic diversity	1					
Global change	1.5* ↗	3.0 ↗	1.0 ↗	3.0 ↗	2.5	1
Changes in hydrological cycle	2					
Sea level change	1					
Increased UV-B radiation	1					
Changes in ocean CO_2 source/sink function	1					

* This value represents an average weighted score of the environmental issues associated to the concern.

** This value represents the overall score including environmental, socio-economic and likely future impacts.

*** Priority refers to the ranking of GIWA concerns.

This section presents the results of the assessment of the impacts of each of the five predefined GIWA concerns i.e. Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, Global change, and their constituent issues and the priorities identified during this process. The evaluation of severity of each issue adheres to a set of predefined criteria as provided in the chapter describing the GIWA methodology. In this section, the scoring of GIWA concerns and issues is presented in Table 6.

This assessment is based principally on criteria established by the GIWA experts, their professional judgment and, whenever possible, the best available information. In most countries within the GIWA Caribbean Sea/Small Islands sub-system, the impact of human activities on the environment is fairly well studied, but knowledge of how degradation of the environment affects social and economic issues is less understood.

Assessing the situation for the Caribbean Sea/Small Islands sub-system is complicated by the fact that the present knowledge and understanding of the extent of the islands' water resources is limited. In fact, with the exception of rainfall data, there is a paucity of information for any realistic assessment of water resources. The availability of information and data varies between countries and is dependent on the existence of research facilities and resources. Much of the information is old, anecdotal, indirect or included in specific research studies that are not available to the general public.

It is also important to mention that because most of the Small Islands Developing States (SIDS) of the Caribbean have limited and fragile terrestrial and marine resources, it would be ideal to have cause and effect relationships and more extensive data but since this is not the case at the present time, the precautionary principle must be applied

in the assessment. Since deterioration of the environment has been identified qualitatively, and quantitative assessments have been limited, it is not recommended to score issues as "low" or "slight" due to lack of information. It is important to keep in mind that any alteration of the Small Islands' ecosystems will affect the entire region. The impacts of the five concerns considered by GIWA were evident in environmental and socio-economical sectors, considering the islands' economic dependency on their natural resources.

Freshwater shortage

The issue of freshwater resources for the Small Islands involves many of the problems facing developing countries in general, including inadequate resources, both human and financial. Considering the general situation in the sub-system, the average impact of freshwater shortage in the Small Islands sub-system is moderate concerning environmental issues, and moderate to severe for socio-economic issues. Freshwater shortage is, however, not a genuine transboundary concern in the sub-system but it was considered as a regional problem since the islands are affected by the large river systems of the neighbouring continental countries. It is also pertinent to mention that even if the impacts from freshwater shortage are moderate at a sub-system scale, not all the islands in the sub-system have problems which are similar or of the same magnitude.

Participating nations in the project Integrating Watershed And Coastal Area Management in Small Island Developing States of the Caribbean (GEF/CEHI/CARICOM/UNEP 2001), were fairly consistent in their identification of major threats to the management of watersheds and freshwater ecosystems. Primarily, these threats are related to pollution, land use patterns, demand for watershed and coastal resources, and the competing interests of different stakeholder groups. These threats are not mutually exclusive. As watersheds and ecosystems demand an integrated and holistic approach to their management, the threats must also be viewed in this manner. For example, the impacts of the deforestation on a watershed can range from erosion to reduced water retention of the soil (GEF/CEHI/CARICOM/UNEP 2001).

Environmental impacts

Modification of stream flow

The impacts of modification of stream flow on the sub-system are assessed as moderate because even if the islands do not have major basins, there is a significant change in river flows and surface water, causing sedimentation or erosion. Several of the islands' river systems are comparatively small and not easily accessible, and their monitoring is not continuous. As a consequence, the countries do not have supporting time series data describing changes in stream flow. Nevertheless, the modification of stream flow has affected wetlands, coastal marshes and swamps and aquatic freshwater species, as many rivers dry up; again much of this has not been scientifically documented. In general for this sub-system, freshwater supply is decreasing, particularly in Barbados and Antigua & Barbuda.

For most of the islands, the principal sources of water are surface water from rivers and/or aquifers. The predominant source is primarily determined by the geological characteristics of the island. The islands of coralline origin depend more on groundwater sources and suffer more acute shortages in freshwater supply. The islands where freshwater is limited due to geology and hydrological regimes are: Barbados, Antigua & Barbuda, US Virgin Islands, British Virgin Islands, Anguilla, Montserrat (where volcanic activity impedes water access), Turks & Caicos, Cayman Islands and Saint Kitts & Nevis.

Groundwater and surface water use and conditions vary significantly from island to island. For example, Saint Vincent has abundant surface water and therefore does not need to exploit its groundwater resources. On the other hand, Trinidad & Tobago has both surface water and groundwater. In Barbados, small farmers use the island's potable water supply extensively for irrigation (FAO 2000, GEF/CEHI/CARICOM/UNEP 2001).

In general, growing water demand is principally related to land use needs and affects water supply. According to different national reports, land use is one of the factors that most strongly affects the river basins, the health of freshwater ecosystems and coastal areas in the Caribbean region. In Barbados, for example, irrigation uses 16.2 million m^3 water per year and is the second highest consumer after domestic use (GEF/CEHI/CARICOM/UNEP 2001). Over the next 10 to 15 years, the volume of water used for irrigation is forecast to increase by an average of 1% per year if agriculture only supplies local markets. However, if export markets can be accessed, increases are likely to be of the order of 15-20%. In St. Vincent & The Grenadines the irrigation system is only just beginning to develop, hence its demand for water is still growing. Currently, the irrigation system supports 490 ha with plans to extend to 810 ha by 2001. This acreage is expected to utilise most of the available dry season river flow in the country (GEF/CEHI/CARICOM/UNEP 2001).

Tourism is another sector that is having a significant impact on freshwater resources, for a variety of reasons. Often, when large hotels

Figure 5 Resort development, Bonaire, Netherlands Antilles.
(Photo: J. Oliver, Reefbasse)

or golf courses are developed (Figure 5), vegetation is cleared from the area, which has led to flooding, soil erosion, destruction of terrestrial habitats, and poor aquifer recharge. The high demand for freshwater contributes to overextraction from aquifers and the rapid depletion of surface resources. The south of Saint Lucia has been targeted for extensive development ranging from hotels to a sports stadium as well as other development projects which depend heavily on the availability of a reliable supply of water (MPDEH 2002). In Barbados, there is also a growing demand for water due to the development of golf courses and it is estimated that, given current plans, the water demand for irrigation of golf courses will increase five-fold (GEF/CEHI/CARICOM/UNEP 2001).

In recent years, the public water supply in Saint Lucia has been severely impacted by increased demand, denudation of upper basins and increased exploitation of the rivers and wetlands. While the issue is primarily one of an inefficient, inadequate and aging water distribution network, limited supplies experienced during the dry season and heavy salinisation during the rainy months, combine to significantly impact the ability of the Water and Sewage Company (WASCO) to meet the current demand. This demand is likely to increase significantly in the short to medium-term. Unofficial estimates indicate that disruptions of water supply in the south of the island range between 50 to 150 days per year, and last several hours per occasion.

Scarcity of water is not a problem everywhere. Substantial amounts of land in for example the US Virgin Islands are subject to flooding because of the islands' stream flow characteristics and topography (DPNR/DEP & USDA/NRCS 1998).

Pollution of existing supplies

The impacts from the pollution of existing water supplies in the Small Islands sub-system were assessed as moderate. Several islands have highly polluted but localised surface and underground water sources. Many of these islands, such as Saint Lucia, Dominica, St. Kitts & Nevis, Saint Vincent, are dependent on agriculture and are consequently prone to contamination by agro-chemicals such as pesticides and fertilisers. They are also subject to contamination from sewage, either from septic tanks or outfalls. There is some industrial pollution, mostly from small manufacturing and food processing industries in the smaller islands and from the chemical and oil industries in Trinidad & Tobago. These pollution sources are major causes of degradation of coastal and near-shore marine ecosystems and reduction in biodiversity, including critical salt-pond, mangrove, estuary, seagrass and coral reef systems (there is possible transboundary effect in islands such as Saint Lucia, Saint Vincent, Dominica, Grenada, and Trinidad & Tobago). In September 1999, a fish kill outbreak affected species on Barbados, Martinique, Grenada and Saint Vincent & The Grenadines, and Trinidad & Tobago, and in some islands it was attributed to factors related to the freshwater plumes of the Orinoco and Amazon rivers (PAHO 2000). In most islands the specific cause was not determined, but in Barbados a high incidence of a *Streptococcus* pathogen was believed to be responsible.

Water quality is deteriorating in the Small Islands sub-system as a result of the discharge of agricultural pollutants such as herbicides and pesticides, especially in urban and industrial areas (FAO 2000). This results directly from run-off and erosion due to uncontrolled agricultural intensification, poor agricultural practices (such as cultivation or construction on steep slopes and along river banks), inappropriate land use, and direct and/or indirect discharge of untreated effluent into waterways. Problems encountered result primarily from inadequate public education and participation in ecosystem conservation efforts (MPDEH 2002). In Saint Lucia, land use has affected the health of freshwater ecosystems, drainage basins and coastal areas. There is a direct relationship between the use of land for domestic, commercial, industrial or agricultural purposes, the generation of waste by these uses, and the impact on the quality of both surface and groundwater resources. Additionally, rural water sources in Saint Lucia, which comprise mainly small and medium intakes, are subject to gross contamination, especially in the rainy season (MPDEH 2002).

In for example the US Virgin Islands contamination of groundwater is principally attributed to (DPNR-DEP 2002):

- Bacteriological contamination from failing septic systems;
- Leaking municipal sewer lines and underground storage tanks;

- Relocation of contamination from previous disposal practices;
- Frequent sewage by-passes (generally described as discharges direct to the sea, but with some percolation into sub-soils);
- Improper disposal of used oil;
- Saltwater intrusion (caused by the overpumping of the aquifers);
- Infiltration of volatile organic compounds (VOC).

In Barbados, relatively little wastewater is reused for irrigation at present. A few hotels treat their wastewater and re-use it for irrigating lawns and gardens. Also, a number of private homes divert their wastewater to fruit trees or small banana plantations (FAO 2000).

Changes in the water table

The environmental impacts from changes in the water table were assessed as moderate. Additionally, it is considered that this issue is directly related to the modification of stream flow. There is evidence that many small islands have virtually no freshwater ecosystems (e.g. US Virgin Islands, Netherlands Antilles, Antigua, Barbados); and that groundwater resources are being exhausted, polluted or displaced by saltwater intrusion (e.g. Barbados, Antigua, Bahamas).

Some of the countries in the Small Islands sub-system depend heavily on groundwater resources due to erratic or low rainfall and the limited capacity to store water for use in the dry season. Also, a lack of river basin management or environmental protection, coupled with economic development has severely reduced the spatial extent of drainage basins. Expansion of banana cultivation is one of the agricultural activities that has reduced freshwater availability in the sub-system. Where this is the case, the islanders depend heavily on groundwater resources, which often exist as freshwater lenses containing limited quantities of water. However, withdrawal rates that exceed the sustainable water yield can result in temporary or permanent seawater intrusion, thereby damaging or destroying the freshwater lenses.

Saltwater intrusion into groundwater supplies is a significant problem in the Small Islands sub-system. Desalination of seawater as a source of freshwater supply is an option, but it is very costly (Khaka 1998). In the past, saltwater intrusion has been a problem for the Bahamas as a result of overexploitation of groundwater resources. The government has responded by limiting abstraction in order to allow aquifer recharge. Additionally, measures are now in place to avoid this problem in the future, including safe-yield amounts, situating wells further inland, and frequent monitoring (GEF/CEHI/CARICOM/UNEP 2001).

Socio-economic impacts

Economic impacts

The economic impacts of freshwater shortage in the Small Islands sub-system were assessed as severe. The islands are highly vulnerable and any effect will be visible in the national economy.

The tourism industry is heavily dependent on healthy drainage basins and good water quality for its success. Water demand by tourists is many times that of residents of island nations. Accordingly, without sufficient access to high-quality water resources, the tourist industry will not thrive and develop (GEF/CEHI/CARICOM/UNEP 2001).

In Saint Lucia for example, water demand from the tourism sector is estimated to be 10% of the total (Government of Saint Lucia 2002). The negative impacts of high water demand from this sector often go unaddressed until tourist attractions are visibly affected. Consequently water use has been undervalued by the tourism sector, producing an inter-temporal cost that will affect tourism products in the medium and long-term.

Some islands are using seawater desalination as a source of freshwater supply, despite the significant costs associated with this technology (Khaka 1998), rather than cheaper methods, such as groundwater extraction or rainwater harvesting. The costs and scale of Reverse Osmosis (RO) technology plants are so considerable that only public water supply companies with a large number of consumers, and industries or resort hotels, have considered this technology as an option. Small RO plants have been built in rural areas where there is no other water supply option. In some cases, such as the British Virgin Islands, the government has promoted such plants by providing land, allowing tax and customs exemptions, and guaranteeing payment for bulk water received. The government also monitors the quality of the final product, distributes the water and in some cases provides assistance for the operation of the plants (UNEP/IETC 1997). In Antigua & Barbuda, the relatively higher cost of producing desalinated water compared to surface and groundwater is a major constraint to providing water that would not be affected by variable rainfall. High cost notwithstanding, a commitment to increasing desalinated water production may be required to reduce the vulnerability of settlements as water demands increase in the future (Organization of American States 2001).

As an example of the impacts of freshwater shortage on economic sectors, Table 7 shows the comparative costs of reverse osmosis desalination for some Latin American and Caribbean developing countries.

Table 7 Comparative costs of reverse osmosis desalinisation.

Country	Production cost (USD/m^3) [1]
Bahamas	4.60-5.10
Brazil	0.12-0.37
British Virgin Islands	3.40-4.30 [2]
Chile	1.00

Notes: [1] Includes amortisation of capital, operation and maintenance, and membrane replacement. [2] Values of 2.30-3.60 USD were reported in February 1994.
(Source: UNEP/IETC 1997)

Health impacts

The health impacts of freshwater shortage were assessed as moderate. Health impacts from freshwater shortage tend to occur mainly in the dry seasons and following natural disasters, such as hurricanes. A contributing factor is the high population concentration in the coastal area causing problems because of sanitation facilities located too close to the pollution source. There are a range of gastrointestinal diseases that are associated with sanitation and hygiene problems caused by freshwater shortages. Generally, it is difficult to give figures for diseases caused by freshwater shortages in isolation of other issues pertaining to water and sanitation. However, some indicators are available regarding water-borne diseases, indicating that there have been no reports of cholera between 1997 and 2000 for the countries in Small Islands sub-system, while incidence of gastroenteritis continues affecting the population in these countries. The incidence of gastroenteritis is high in some countries; Martinique with 5 425 cases in 2000 and Trinidad & Tobago with 20 000 cases in 1999 (PAHO 2002).

Other social and community impacts

The other social and community impacts of freshwater shortage were assessed as moderate. The population of the islands with coral origin is experiencing serious water supply problems, while the islands of volcanic origin are less susceptible. The impacts are mainly related to cultural aspects and farming activities. While the agriculture sector depends on the availability of an adequate supply of water for its survival, the evidence indicates that water resources are facing a serious threat from unsustainable farming practices including uncontrolled agricultural intensification, inappropriate land use (such as cultivation on slopes and river banks) and poor irrigation practices. For example, the Vieux-Fort water supply system in southern Saint Lucia is plagued by water quality problems, resulting in its intake having to be relocated in the upper reaches of the drainage basins (Government of Saint Lucia 2002).

Conclusions and future outlook

The environmental impacts of freshwater shortage on the Small Island sub-system were assessed as moderate, although it is not strictly a transboundary issue in this region. However, there are some key issues that should be considered. Many small islands have virtually no freshwater ecosystems (US Virgin Islands, Netherlands Antilles, Antigua, Barbados), and groundwater resources in many islands are being exhausted, polluted or contaminated by saltwater intrusion. Polluted surface and groundwater are major causes of degradation of coastal and near-shore marine ecosystems and declines in biodiversity, including critical salt-pond, mangrove, estuary, seagrass and coral reef systems (with possible transboundary effects in Saint Lucia, Saint Vincent, Dominica, Grenada, Trinidad & Tobago). Increasing rates of deforestation and urbanisation are contributing to water shortages in several of the islands (e.g. Saint Lucia) and the situation is likely to worsen in the future in response to climate change. Tourism is a major consumer of water with many resorts showing water consumption 5 or 10 times higher than other residential areas (UNEP 1999). Even if tourism is not a traditional transboundary issue, it reflects the influences that the movement of people have on water resources.

The impacts of freshwater shortage are severe on economic sectors, mainly tourism and agriculture. For human health and social issues the impact is assessed as moderate, taking into account poor freshwater and recreational water quality, and problems faced by farmers.

Demand exceeding supply is one of the most pressing concerns regarding freshwater resource management in the sub-system. Due to economic and demographic changes, demand for water resources is increasing rapidly. Generally, water is not given an economic value and consequently, water rights, water markets and pricing are not used to improve management and, for the most part, there is no incentive for consumers to use water efficiently. Many threats to human health are a direct result of inadequate sewage treatment, necessitating the proper collection, treatment and disposal of sewage (MPDEH 2002).

The more pronounced impacts of natural disasters on the water sector in for example Saint Lucia have been linked mainly to extreme weather events such as hurricanes, droughts, and floods. Several public sector agencies including WASCO (the Saint Lucia Water and Sewerage Co. Inc.) and the Ministry of Communications, Works and Public Utilities have disaster management plans in place. However, these plans have tended to focus mainly on post-disaster remediation rather than on proactive measures to reduce the impacts of such disasters. The evidence suggests that much of the damage to the water supply, experienced during and after extreme weather events, is caused, not by the events themselves but by weaknesses arising from the absence of an integrated approach to water resources management. For example, the social, economic and environmental impacts of floods on the water

supply could be significantly reduced through proper drainage and better land use practices (MPDEH 2002).

The size of the Small Islands determines that development and freshwater resources are closely related and inter-linked. Water resource management must therefore seek to rationalise the use of island resources with a goal of sustainable development. An appropriate framework for this is provided by the Island Systems Management (ISM), which was developed by the Organization of the Eastern Caribbean States (OECS) and adopted by the First Ministerial Meeting on the Implementation for the Barbados Program of Action (held in Barbados in November 1997) (Khaka 1998).

In general, the impacts of the different issues of freshwater shortage are expected to remain moderate in the future, with both environmental and economic conditions improving somewhat.

Pollution

The overall impact of pollution in the Small Islands sub-system ranges from moderate to severe regarding environmental issues and socio-economic impacts. Water quality problems, common to the whole region, include toxic contamination from industry, waste disposal, and eutrophication caused by human sewage. Bacterial pollution of water supplies in the region is a continuous problem with adverse effects on human health. The major concerns of high bacterial and organic loads include poor-quality drinking water, eutrophication, and aquatic life loss, as well as human alimentary species pollution and prevalence of water-borne diseases (UNEP 1991).

Pollution affects the marine environment in many ways. Beaches are less attractive if polluted by solid waste, deposited by strong currents or dumped in the local harbour. Oil and other waste kill fish, and other animals are injured or die from entanglement and ingestion of waste materials. Marine pollution is also becoming a significant human health concern (PCA 1999).

Thermal pollution was assessed as slight due to insignificant effects beyond the mixing zone of thermal plants and no evidence of interference with migration of species. The radionuclide pollution was assessed as as having no known impact in the Small Islands sub-system. These two issues will therefore not be further discussed.

Environmental impacts

Microbiological

The impacts of microbiological pollution were assessed as severe, mainly considering the effect on freshwater ecosystems of the islands. Rapid population growth and urbanisation have resulted in increased discharge of solid wastes and effluents. The coverage of the sewage and water supply network varies from island to island. Wastewater treatment facilities are inadequate in many locations. For example, in Saint Lucia only 13% of the population is connected to the sewage system (GEF/CEHI/CARICOM/UNEP 2001). The untreated wastewater carries elevated bacteria and viruses, which pose risks to users of coastal areas and to consumers of shellfish.

In addition to the threats of inadequate sanitation treatment, the unregulated disposal of human waste for example in Antigua & Barbuda is further compounded by insufficient drainage which results in standing pools of contaminated water. During severe weather conditions (e.g. hurricanes, floods, and heavy rainfall), these pools present a major source of sewage-related outbreaks of diseases (GEF/CEHI/CARICOM/UNEP 2001).

Although there are numerous problems associated with non-point pollution sources, one primary problem affecting the inhabitants of the US Virgin Islands is bacterial contamination from sources such as failed septic systems, run-off from animal operations, and sewage discharged from boats. These cause serious threats to human health and impair water quality with algal blooms. High bacterial counts have been detected in some bays, especially in those with a large concentration of boats and boating berths. Contamination is partly the result of sewage and wastewater discharges from the boats, particularly from live-aboard vessels (USVI 1998).

Microbiological pollution also poses a threat to the marine environment, mainly as a result of excessive nutrients and sewage discharge into coastal waters, which has altered the species composition both in the water column and in benthic communities, leading to local changes in biodiversity (Office of the Prime Minister 2001). Fish kills at ecologically sensitive wetlands have occurred repeatedly in the US Virgin Islands, and swimming beaches around the Hess Oil Virgin Islands Corporation (HOVIC) have been closed on numerous occasions, primarily because of a poorly designed and failing sewage system in St. Croix that permits raw sewage to flow directly into the Caribbean Sea (DPNR/DEP & USDA/NRCS 1998). Additionally, the discharging of wastes overboard directly into the sea and point source pollution which can be attributed to a failing and overloaded municipal sewage system, have been detected in the US Virgin Islands (DPNR/DEP 2002). Poor preventative maintenance

practices due to lack of funding within the Department of Public Works, and negligence result in a pattern of frequent "by-passes" that empty sewage directly into the waters of the US Virgin Islands.

Eutrophication

The impacts of eutrophication were assessed as moderate. The major source of coastal and marine pollution in the sub-system is untreated domestic waste and sewage discharge, agricultural run-off, and industrial activities, especially from oil and tourism industries (UNEP 1997). Eutrophication tends to be seasonal and might not be caused by land-based activities. There is an increased abundance of epiphytic algae in the sub-system unfortunately however, there is very little data available for this study (GIWA Task team 2004). The assessment of this issue is therefore based on visual observations in the field and internal government reports and is estimated to occur primarily in the near-shore marine environment.

In Antigua & Barbuda and the US Virgin Islands, failed septic systems, run-off from animal operations, and sewage discharged from boats are the most likely causes of eutrophication and algal blooms (DPNR-DEP & USDA-NRCS 1998, Office of the Prime Minister 2001). In Barbados the coral reefs have indirectly been impacted by eutrophication. There has been an increase in the rate of bioerosion by reef cavity dwellers (clionid sponges) and their abundance is positively correlated to eutrophication. The increased bioerosion is further thought to change the species composition of corals, favouring branching corals since these rely on fragmentation as their principal mode of propagation (Holmes 1997 in Linton & Warner 2003)

Chemical

Based on qualitative evidence of large-scale use of pesticides on many islands and the effects of industrial activities, the impacts of chemical pollution were assessed as moderate.

In most countries in the sub-system, unsustainable land-clearance practices, inefficient irrigation, and the use of agro-chemicals within the agricultural sector is a source of significant damage to both surface and groundwater resources. Within the domestic sector, land-clearing and construction on previously uninhabited land is resulting in sedimentation, deforestation, and pollution. Agriculture is the primarly sector that causes water pollution; manly through agro-chemical leaching, direct agro-chemical influx from aerial spraying and indiscriminate and improper disposal of solid waste. The trend towards using low-lying wetlands for rice cultivation, which requires heavy pesticide use, is exacerbating the environmental degradation. St. Kitts has been susceptible to agricultural pollution, partly because significant water sources are located at a lower elevation than agricultural activities (GEF/CEHI/CARICOM/UNEP 2001).

The industrial sector also contributes to the problem through discharges of wastewater. It has been indicated that often the industrial sectors of the countries discharge effluents directly into rivers and/or store them in unlined holding ponds (Figure 6) (GEF/CEHI/CARICOM/UNEP 2001). Industrial pollution is a particularly pressing problem for Trinidad & Tobago, given its high level of industrialisation in comparison to its neighbours. The industries in Trinidad & Tobago generate pollution from processes used in sugar and oil refining, rum distillation, manufacturing of petro-chemicals, paint and metal finishing, and agro-processing. The impact of industrial effluents on the water resources is prominent along the foothills of the northern range and the western coast of Trinidad. Industrial activity in Tobago is relatively small, being concentrated in the southwest part of the island. Effluents from oil and sugar cane refining particularly affect the rivers in south Trinidad, and other areas in the country are affected by petroleum products, which are discharged into the watercourses from leaking tanks, washings, and improper disposal of oil waste (Organization of American States 2001).

Caribbean reefs are affected, not only by oil spills but also by supposedly harmless grey water, which is the by-product from ships of baths, showers and other cleaning activities. In the US Virgins Island the oil company HOVENSA LLC directly discharged oil with no treatment or adequate disposal measures, however action from the Environmental Protection Agency in 1999 was sufficient in initiating a clean-up of the site (EPA 2004).

Suspended solids

Suspended solids were assessed as having severe impacts on the Small Islands as there is an increase of suspended solids and turbidity, principally produced by poor agricultural and construction practices but there is also the transboundary impacts of sediment transport from continental land masses. This increase in turbidity can be seen in small areas of streams and/or riverside and marine environments, causing changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity. According to the GIWA experts, the effects on seagrass in some islands is considered as evidence but there is no documentation.

The concentration of suspended and dissolved solids has increased due to human activities, including deforestation, urbanisation and agriculture. Rivers from Central America and the Antilles discharge 300 million tonnes of sediments into the Greater Caribbean region annually (PNUMA 1999). Changes in sedimentation or erosion rates

Figure 6 Run-off from bauxite mining in Jamaica.
(Photo: Coris)

have increased because the protective vegetative cover has been removed and as a consequence of river development that have changed river dynamics and flow to facilitate construction flood mitigation mechanisms.

Sedimentation is a primary problem affecting the US Virgin Islands. Dirt roads, farmlands, construction sites, urban encroachments, and other disturbed soils are the primary non-point sources of sediment threatening the islands water resources. Additionally, the topography of the islands, with a combination of short steep slopes terminating in sensitive wetlands and marine environments make them susceptible to damage from even slight increases in erosion (DPNR/DEP & USDA/NRCS 1998). In Antigua & Barbuda, turbidity of inshore water and elevated algal cover on reefs are linked to the impacts of coastal development, with sedimentation being a major influence on the condition of reefs (Smith et al. 2000).

Solid wastes

The impacts of solid waste were assessed as moderate, considering the abundance of solid waste on beaches causing public concern regarding recreational use and the high influence of benthic litter recovery, as well as the interference with trawling activities. The PNUMA (1999) report considered that an average of 0.8 kg solid waste/day/person is produced in the Caribbean.

In the Small Island sub-system, there is limited data to quantify the amount of solid waste interfering with trawling activities or how much ends up on the region's beaches. Studies throughout the Wider Caribbean region have shown that a combination of marine-based waste and solid waste from land-based sources affect beach areas. There are also movements of wastes from one country to another with much ending up on eastern coastlines or leeward facing beaches on the islands.

With the Caribbean's high volume of marine traffic, pollution from ship-generated solid waste, wastewater, and bilge water by both commercial and cruise ships pollutes the coasts and threatens regional tourism (GEF/CEHI/CARICOM/UNEP 2001). The Caribbean cruise industry accounts for about 58% of the world's cruise ship passengers (Ocean Conservancy 2002 in Burke & Maidens 2004). According to recent

estimates by the Ocean Conservancy, 25 million passenger bed-days on cruise ships in the Caribbean generated an estimated 90 000 tonnes of waste in 2000 (Ocean Conservancy 2002 in Burke & Maidens 2004). On average, passengers on a typical cruise ship (3 000 passengers and crew) produces 50 tonnes of solid waste during a one-week cruise (Ocean Conservancy 2002). However, disposal, not quantity, is the real issue. The discharging of wastes directly into the sea by boat owners and the difficulty in regulating littering also contributes to problems, as seen in the US Virgin Islands (DPNR/DEP 2002).

In most of the countries the solid waste management receives low priority when compared to other national needs (CEHI 2003). Household waste continues to be a problem throughout the region, countries lack sufficient solid waste collection and wastewater treatment systems. As a result, many citizens inappropriately dispose of their waste in gullies and along riverbanks, which pollutes rivers, streams and ultimately, the coastal waters into which they drain (GEF/CEHI/CARICOM/UNEP 2001). The US Virgin Islands, for example, have a solid waste crisis. Presently, the territory is relying exclusively on land filling as the only option for solid waste disposal (DPNR/DEP 2002). There are also many problems with solid waste disposal in St. Kitts & Nevis, and Saint Lucia, in particular indiscriminate waste disposal and unlined landfills, which could allow hazardous leachates to contaminate the groundwater (GEF/CEHI/CARICOM/UNEP 2001).

Oil spills

The impacts of oil spills were assessed as moderate. The Eastern Caribbean region is a major tanker traffic route and a cruising path of oil cargo ships; while there have not been large numbers of oil spills in the sub-system, the risk and the potential damage remains extremely high, which is a clear transboundary issue.

The heavy maritime traffic that transits the Caribbean Sea, influenced particularly by the Panama Canal, produces very high levels of pollution from oil tankers and the threat of an even more devastating source, namely the regular movement of nuclear and other hazardous materials across the Sea. The existence of these risks imposes great demands on the planning capacity of the Small Islands of the Caribbean region because of the need to incorporate adequate risk assessments, prevention and mitigation measures into all aspects of sustainable development planning. The most common transboundary pollution threats to the islands are oil spills; especially for Trinidad & Tobago. Due to the islands close location to the mouth of the Orinoco River, oil waste from different activities near the River, e.g. from the Venezuelan petroleum company (PDEVESA), is transported by local currents to the islands.

Thousands of large vessels transporting oil, gas, and chemicals pass between the Small Islands annually. In general for the Small Island sub-system, oil spills, although infrequent, have very harmful effects on marine life and ecosystems, as well as on humans who consume contaminated seafood. Nevertheless, this issue is not the principal cause of species mortality in the sub-system. In agreement with GEF/CEHI/CARICOM/UNEP (2001), a regional spill-response plan is needed. All nations have adopted the 1989 Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal, but none have signed the Basel Protocol on Liability and Compensation.

Trinidad, because of its petroleum-based industry, continues to have a higher risk of oil spills both inland and within its coastal and marine regions. In fact, the last spill occurred as recently as 2000. Such spills have had short-term damaging impacts on the coastlines, particularly within the Gulf of Paria. The beaches of Vessigny, La Brea and Mayaro in the south of Trinidad continue to be affected by the presence of petroleum-based residues emanating from the nearby oil industries and oil tankers (GEF/CEHI/CARICOM/UNEP 2001). There are also reports of tar balls located on the beaches of the Cayman Islands and Curaçao, and at the Barlovento beaches of Barbados and Grenada among others (PNUMA 1999).

Socio-economic impacts

Economic impacts

The economic impacts of pollution were assessed as severe. Looking at the economic sectors, tourism, represented by data from hotels and restaurants, was a major contributor to the GDP of the OECS (Organization of Eastern Caribbean States) (CEPS/OECS 2002). The tourism industry is expected to generate 2 416 500 directly and indirectly jobs in Caribbean in 2004, representing almost 15% of GDP (WTTC 2004). With the Caribbean's high volume of marine traffic, pollution from the discharge of ship-generated solid wastes is threatening regional tourism. In the Wider Caribbean Initiative on Ship generated Waste (WCISW) project sponsored by the International Maritime Organization, Antigua & Barbuda, Dominica, Grenada, Saint Lucia, Saint Vincent & The Grenadines, and St. Kitts & Nevis have cooperated to improve the collection, treatment and disposal of wastes. Each nation have established port waste reception facilities and collaborated in drafting a common legal framework for regional ship waste management (Khaka 1998).

Even if there is some evidence of environmental impacts from pollution, there are no developed indicators measuring the way in which they cause economic costs for water supply, the tourism industry, and other economic activities. There is correspondingly a lack of data for economic valuation of environmental damage.

As mentioned previously, Trinidad & Tobago is the most populous country and has the largest economy of the Small Island sub-system. In this country, hydrocarbon resources promise to provide a continuing platform for viable industrial activity. However, it poses one of the most important challenges for the environment, taking into account current problems such as oil pollution of beaches and water (CIA 2004, World Resources Institute 2004) with associated losses in revenues for the tourism sector in the short, medium and long-term.

Health impacts

The healt impact of pollution were assessed as moderate. Water treatment is difficult in situations where the drainage basin may be contaminated by multiple types of pollutants from various sectors (e.g. agro-chemicals, sewage) and by rapid population growth and urbanisation that have resulted in increased solid waste and wastewater pollution. These pollutants are detrimental to human health, causing gastroenteritis, diarrhoea, jaundice, rashes, and various infections. During severe weather conditions (e.g. hurricanes, floods, and heavy rainfall), disposal pools in Antigua & Barbuda present a major threat from sewage-related outbreaks of diseases. In St. Kitts & Nevis, during these weather events, gastroenteritis becomes prevalent amongst the population. The outbreaks are often localised and are responded to by the Ministry of Health; it implements public awareness programmes and deliver water when needed (GEF/CEHI/CARICOM/UNEP 2001).

In Barbados, the diarrhoea disease surveillance system reported 1 610 cases in 1993, 1 550 cases in 1994, and 2 100 cases in 1995 (PAHO 1999). In addition, there was 53 cases of gastroenteritis reported in 1993. In the Cayman Islands, reported cases of gastroenteritis among children less than 5 years of age have been less than 100 per year, but have fluctuated widely. In Saint Vincent & The Grenadines, gastroenteritis has become less widespread (PAHO 1999). However, an increase in circulation of viral pathogens and the improved active surveillance systems could be factors contributing to the rise of reported cases of diarrhoeal diseases in the last year. Ciguatera in humans is caused by consuming tropical fish that have bio-accumulated toxins from microalgae. Where algal biomasses are significantly elevated due to eutrophication, such as in nutrient/sewage-enriched areas in Antigua & Barbuda, the risk of ciguatera poisoning is high (PNUMA 1999b).

The available information for OECS countries indicates that in spite of their socio-economic and environmental challenges, these countries enjoy strong social indicators. Some improvements concerning health issues have been noticed; for example, no cases of cholera have been reported from the countries in the sub-system during the last years (PAHO 2002). The infant mortality rate is 15 deaths per 1 000 live births, which is low compared with some Latin American countries, and infant mortality caused by intestinal digestive infections has dropped from 5 per 1 000 live birth to 2 per 1 000 during the period from 1985 to 1995 (Caribbean Epidemiology Centre 2000, World Bank Group 2000).

Other social and community impacts

The other social and community impacts of pollution were assessed as moderate. In the Caribbean a high percentage of the population has access to piped water. Although there has been progress in improving access to water supply, they have been very slow improving sewage facilities, due partly to spatial limitations. However, sanitation coverage is high, particularly through individual excreta disposal system. With the indirect health risk for the population as a result of poor solid waste management practices, it is important to consider that the existing systems for the collection and disposal of waste need to be upgraded (CEHI 2003).

Conclusions and future outlook

The environmental impacts of pollution were assessed as moderate to severe. The major consideration taken into account is that most pollutants stem principally from agriculture, small industrial plants, hotels and sewage.

The impact of pollution on economic activity is considered severe because of the importance of surface and coastal ecosystems for small islands, and also considering that there is not much investment in prevention strategies, due to high costs and lack of appropriate regulations. Greater emphasis is placed on remedial actions, which incur higher socio-economic costs. This general situation affects the tourism sector directly, since most of the sub-system's economy is based on this activity. The impacts on the health of the population are moderate, taking into account that there are some risk factors related to inadequate sanitation facilities and treatment of drinking water and other kinds of pollution. Finally, social or community impacts are also regarded as moderate as a result of the most vulnerable groups being affected by the consequences of inadequate sewage disposal services.

In the future, the environmental impacts of pollution are expected to decrease but will remain moderate. The socio-economic impacts will also decrease, principally concerning health and other community issues, while the impact on the economic sectors are predicted to increase. For the future scenario it is vital to consider the importance and growth of science and technology in the sub-system, in particular the growth of information technology, which will cause less environmental damage than traditional economic sectors. In addition, the increased

application of science and technology in other sectors is likely to minimise the impacts of pollution through cleaner technologies and processes, to mitigate and provide remedial measures for existing damage and to improve end of pipe treatment technology.

Habitat and community modification

The environmental and socio-economic impacts of habitat and community modification were assessed as severe except for impacts on human health which was considered slight. One factor contributing to the severity of the problem is that all islands have established some aquatic preserves to protect valuable habitat but the authorities lack the necessary manpower and funding to enforce the regulations (GEF/CEHI/CARICOM/UNEP 2001).

Environmental impacts

Modification and loss of ecosystems or ecotones

The impacts of modification and loss of ecosystems or ecotones were assessed as severe. The most critical ecosystems in the sub-system are coral reefs, mangroves, seagrass beds and sandy shores, on which the islands economic activities and development are heavily dependent.

The main anthropogenic impacts stem from deforestation, extraction of marine resources and tourism. In islands like Dominica and Saint Lucia deforestation and the cultivation of steep slopes cause considerable land degradation. In the 1980s, large areas of prime rainforest were cleared in the small islands of the Eastern Caribbean to make way for bananas plantations. Today, many of those once productive banana fields have been abandoned (Colmore 1999).

Moreover, within the domestic sector, land clearance and construction on previously uninhabited land is producing sedimentation, deforestation, and pollution, on top of the obvious problem of biological habitat degradation and destruction (MPDEH 2002). The variety and frequency of coral reef diseases have increased across the Caribbean during the last 10 years; other diseases have attacked many other organisms during this period, including gorgonians, sponges, and echinoderms, even though many of those diseases are still unknown (Goureu et al. 1997). Extraction of living marine resources is a significant threat in all countries in the sub-system, and in Barbados a three-year moratorium has been established on the harvesting of sea urchins in an attempt to restore the population (GEF/CEHI/CARICOM/UNEP 2001). Tourism is also affecting the health of coastal ecosystems through buildings that are located too close to high water marks, harbour dredging, the destruction of mangroves, mooring on reefs and seagrass beds, and pollution. The issue of construction in coastal areas is illustrated in Antigua & Barbuda where 39 of the 55 hotels have a beachfront location (GEF/CEHI/CARICOM/UNEP 2001).

Antigua & Barbuda, like other island states, is renowned for its diverse flora and fauna. However, due to the small size, isolation and fragility of the islands' ecosystems, its biological diversity is among the most threatened in the world. The majority of threats result from changes brought about by human action, while others result from natural causes. Despite the inadequate research, the major conservation threats have been identified as loss of habitat, which results in the gradual loss of numerous species of invertebrate animals found within each of the islands' vegetation communities. Habitat is lost in Antigua & Barbuda primarily through the sub-division of lands for housing, tourism development, agriculture, and mining and dredging sand. Significant areas of wildlife habitat in both terrestrial and marine ecosystems have been eliminated to accommodate development. In recent years, the development of the tourism industry has been facilitated by clearing natural vegetation and altering beaches, while coral reefs have been damaged by divers and boat operators (Office of the Prime Minister 2001).

Deforestation, coral reef deterioration, the introduction of certain non-indigenous species and other forms of habitat degradation are causes of loss of biodiversity in Antigua & Barbuda. Mangrove species, cactus species, and littoral woodland species have been affected. Additionally, even though little is known about the fish fauna, several of the species that exist are known to have been deliberately introduced for aquaculture. The loss of nesting habitat is considered to be the greatest threat to the three species of endangered sea turtles (*Eretmochelys imbricata, Chelonia mydas, Dermochelys coriacea*), the only marine reptiles to nest in Antigua & Barbuda (Office of the Prime Minister 2001). Regarding the status of coral reefs there has been a recent trend of deterioration compared with the situation of 1986 when reefs were described as exceptional in their variety, beauty and health. In 1998, the overall reef condition was considered generally poor, with live coral cover averaging 20% or less except in north Barbuda (Smith et al. 2000).

Several two-three year periods of severe drought over the past two decades in Antigua and Barbuda are assumed to have impacted bird populations, as have the almost annual hurricanes that have hit the country since 1995. Drastic reductions in the populations of small passerines have been noted (Office of the Prime Minister 2001).

The US Virgin Islands are aware of damage to the aquatic systems, including: declines in habitat and ecosystem health and living resources; degraded aquatic systems (e.g. wetland condition and current and historical rates of loss, percent impervious surface, and other measures of aquatic habitat); and decline in the condition of living and natural resources that are part of the aquatic system (e.g. decline in the populations of rare and endangered aquatic species, decline in healthy populations of fish and shellfish). Although the focus of natural resource concern in the territory is on coastal and marine habitats, the loss of forest cover due to development activities cannot be ignored. Not only is the habitat loss impacting resident forest species such as pigeons and fruit bats, it is also a significant contributor to the islands watershed problems (DPNR/DEP & USDA/NRCS 1998).

These problems have led to the US Virgin Islands losing over 50% of the territory's mangrove habitat during the last 70 years due to land clearance and land fill operations to create development sites or provide access to water (DPNR/DEP & USDA/NRCS 1998). There is a lack of awareness of the value of mangroves in filtering sediments and other pollutants that would otherwise diminish water quality in near-shore environments. Seagrass beds and coral reefs are also affected by chronic sedimentation that reduces sunlight penetration and increases ecosystem stress.

There are also reports from the sub-system of an array of environmental stresses that have degraded coral reefs and other marine ecosystems, as well as the fisheries resources. Anchoring and ship groundings on coral reefs and seagrass beds are examples of acute stresses with immediate, and sometimes long-term, effects. The chain and anchor of a large cruise ship can weight 4.5 tonnes and even in calm seas, reckless anchoring can damage up to 200 m^2 of sea bottom (Sweeting & Wayne 2003 in Burke & Maidens 2004).

Dredging, sand extraction, groyne construction and sewage effluent have affected reefs, especially around St. Thomas and St. Croix in US Virgin Islands. Moreover, many of the stresses can combine with natural disturbances to accelerate damage to reefs or slow their rate of recovery. Existing zoning, erosion control and fishing regulations are not providing sufficient protection against natural and human stresses. These have caused extensive mortality on reefs around St. John and St. Croix. Corals around Buck Island experienced less disease than those around St. John, except for white band disease. Recent measures show that disease on corals is 5.4% (St. Thomas), 5.6% (St. John) and 2.0% (St. Croix) (Causey et al. 2002). The branching *Acropora palmata,* and *A. cervicornis* are the most vulnerable to storm damage and are also susceptible to white band disease. There was extensive coral bleaching in 1998, but cases of mortality were relatively minor. Bleaching on Newfound and Lameshur reefs, St. John was 43% and 47% respectively, and 41% on Caret Bay Reef, St. Thomas during the hottest summer sea surface temperatures on record. All corals that were bleached at Buck Island had fully recovered their pigmentation within six months. There has been previous bleaching events in 1987 and 1990 around St. Thomas (Causey et al. 2000).

In Saint Lucia, between 1995 and 2001, reefs in the Soufriere area lost on average 47% of coral cover in shallow waters and 48% of the coral cover in deeper waters. On the northwest coast of Saint Lucia, 82% of the reefs are either dead or in poor condition (Department of Fisheries St. Lucia 2003a,b). Smith et al. (2000) notes that a reef check survey at Malgretoute in June and December 1999 showed live coral cover had declined from 50 to 25% at 3 m depth, and from 35 to 17% at 10 m. Recently, there has been an unusually high incidence of white band disease on reefs in the Soufriere Marine Management Area, resulting in a living coral loss of over 3% between 1997 and 1998 (Smith et al. 2000). Other habitats affected in Saint Lucia are beaches and wetlands. In 1990, 43% of the beaches in Saint Lucia were mined for sand. Estimates have shown that, to date, Saint Lucia has lost over 50% of its coastal wetlands (GIWA Task team 2004).

In other islands, such as the Cayman Islands, *Acropora* species have been severely impacted by white band disease, although isolated healthy stands still exist. Black band disease has been locally significant and most other coral diseases have been reported (Causey et al. 2000). Coral bleaching in 1998 was as severe as in 1995, when 10% mortality was measured affecting *Montrastea annularis* colonies. In the Turks & Caicos, the level of active coral disease was low but many different diseases (including damage and breaking) were reported, especially on the north side of Providenciales where tourism activities (such as diving and pollution) are intense, and at other heavily dived sites.

The major human threats to coral reefs in Turks & Caicos include (Woodley et al. 2000):

- Nutrient discharge from marinas and coastal development, fish processing plants, conch aquaculture (Figure 7) and hotel sewage;
- Heavy metal contamination from anti-fouling paints;
- Damage to corals caused by snorkellers and divers;
- Anchoring on coral reefs and seagrass beds;
- Stranded boats;
- Construction of tourism infrastructure and private jetties in the near-shore environment;
- Uncontrolled fishing in the marine parks and increasing visitor use of selected marine areas.

Figure 7 Piles of conch shells which have been harvested for their meat, Bonaire.
(Photo: J. Oliver, Reefbase)

During the 1980s, many shallow reefs around Grenada & The Grenadines were degraded and became overgrown with algae, presumably resulting from a combination of sewage and agrochemical pollution, and sedimentation caused by coastal development (Smith et al. 2000).

Only 15 to 20% of the marine communities of Martinique and Guadeloupe comprise of flourishing coral communities. On Pigeon Island (Guadeloupe), coral cover dropped from 46% in 1995 to 26% in 1999, and equally worrying is the large percentage of the surviving colonies that are partially diseased, ranging from 11 to 56%, with an average 19 to 53% of surfaces being dead (Moyne-Pickard 1999). There is similar degradation of the coral communities on Martinique Island. These losses are probably due to the combination of both natural and anthropogenic factors, such as (Smith et al. 2000):

- Hurricanes;
- The loss of the sea urchin *Diadema antillarum* in 1983 favoured quick algal growth and the loss is still evident in the high abundance of these algae;
- Coral bleaching, there was a major bleaching event in 1998 when sea surface temperatures exceeded 29°C during September and October;
- Heavy siltation, as a result of increased sediments from deforestation, mangrove clearing and poorly planned development;
- Pollution, heavy metals and pesticides have been found in sediments and animals, 1 500 to 2 000 tonnes of pesticides are imported every year to Martinique and Guadeloupe;
- Tourism, the Pigeon Islets on the leeward side of Guadeloupe are visited by approximately 60 000 to 80 000 divers each year;
- Algal proliferation, which is likely caused by eutrophication of the coastal waters as a consequence of nutrient inputs from the city of Fort-de-France and the lack of algal grazers. Most of the reefs in Martinique suffer from algal proliferation of *Turbinaria* on the reefs front, *Sargassum* on the fore reef zone and *Dictyota* in the lagoons; a similar situation occurs in Guadeloupe.

A further threat to the coral reefs arises from massive volcanic eruptions, particularly in Montserrat (Figure 8) where large quantities of ash are deposited on reefs along the south and southwest coasts (Smith et al. 2000).

Figure 8 Volcanic activity on the Island of Montserrat, July 9 2001.
(Photo: NASA)

Socio-economic impacts

Economic impacts

The economic impacts of habitat modification were assessed as severe. Habitat modification affects all of the islands inhabitants since they depend completely on their ecosystems for their welfare. There are limited opportunities for economic diversification in the Small Islands, and many depend heavily on international trade and tourism for their economic viability. However, the successful promotion of tourism is strongly correlated with the quality, ambience and aesthetic value of the environment. Despite its obvious economic potential, the development of tourism also contributes to the modification of habitats (Khaka 1998).

It is difficult to identify a direct cause-effect relationship between tourism and habitat modification, as there is a multitude of synergies and inter-linkages. However, tourism revenues are often directly

impacted by habitat modification because of the loss of amenity value for activities, such as fishing, snorkelling, diving etc. Habitat modification represents loss of income opportunities in the tourism sector in medium and long-term. In the Cayman Islands, there are more than 40 000 locals, along with 1.4 million tourists per year, 40% of whom go diving. The contribution from tourism to GDP was in 1996 32% in Anguilla, 15% in Antigua & Barbuda, 12.5% in Saint Lucia, 7% in Grenada, 7% in St. Kitts & Nevis, but only 2.5% or less in Dominica, St. Vincent & The Grenadines and Montserrat (CEPS/OECS 2002). In Saint Lucia, there has been a shift in employment opportunities with tourism and restaurants providing 10% of the jobs while fishing now only accounts for 1%. Current anthropogenic threats originate mostly from recent population growth and economic development in the absence of any growth management plans or coastal area management policies. These threats include dredging and filling of wetlands, coastal engineering projects, anchoring of cruise ships, and over-use of dive sites, in many cases exceeding 15 000 dives per year (Figure 9) (Woodley et al. 2000).

Figure 9 Diving boat, Divi Flamingo, Bonaire, Netherlands Antilles.
(Photo: J. Oliver, Reefbase)

Aside from tourism, habitat and community modification has also reduced the capacity of the local populations to meet their basic human needs as well as changed employment opportunities. It has also caused a loss of recreational values, reduced existing income and foreign exchange from fisheries and other sectors, inhibited investment, provoked national and international political conflicts, and created a loss of educational and scientific values. Other economic impacts of habitat and community impacts are degraded land due to loss of physical protection, costs of responding to risks, international inequity, affected cultural heritage, increased costs of controlling invasive species and costs of restoration of modified ecosystems.

Health impacts

The health impacts of habitat and community were assessed as slight for the Small Islands sub-system since there is no evidence of effects on health due to habitat modification. However, the habitat modification in this sub-system is related to pollution, and therefore many of the health impacts are similar. Many countries included within the Small Islands sub-system have inadequate water treatment facilities, which is causing contamination of the watershed by pollutants from the various sectors (agro-chemicals, sewage system, ballast water etc.) (PNUMA 1999).

Other social and community impacts

The other social and community impacts of habitat and community modification were assessed as severe. In the context of habitat modification explained by pollution, an illustrative case is Saint Lucia, where the primary concern in the provision of water for post-harvest purposes is the quality of water and its implications for food safety (Government of Saint Lucia 2002). A primary environmental issue among many communities in St. Lucia is water, specifically its availability and quality. Drinking water is extracted from streams around the island. The land areas that drain into these streams are therefore high on the priority list for management. However, in many of those areas intensive agriculture is practiced with high levels of erosion and agro-chemicals, presenting water quality problems for many communities (Cox n.d)

Conclusions and future outlook

Habitat modification was identified as the principal problem for the Small Islands; its environmental impacts were assessed as severe. Although there is a lot of data available describing damage and declines in coral reefs, mangroves and seagrass beds, reduction in fish stocks, destruction of watersheds and the associated reduction in freshwater, there is a lack of international initiatives aimed at conserving these habitats. Since the Small Islands are dependent of the economic sectors of agriculture and tourism, these limited and fragile natural resources and habitats must be managed in a sustainable way.

Habitat modification, caused by expansion in the tourism sector has inevitable severe impacts on the other economic sectors. Many islands depend heavily on tourism which is based on the quality, health and aesthetic value of the environment. However, as a consequence of habitat modification, there are changes in employment opportunities and loss of recreational amenities. For impacts on human health, the assessment indicates a slight impact since there have been no specific studies of the effects on health due from habitat modification. Finally, pollution causing water quality problems for many rural communities and habitat and community modification causes severe social and community impacts.

Since the economic activities of the islands are highly dependant on the region's ecosystems, there will be a realisation that more effective and integrated management systems are required, and it is therefore predicted there will be improvements in environmental conditions. It is important to keep in mind that the surface area of the islands is small, and both positive and negative changes in the future will affect the entire country.

Unsustainable exploitation of fish and other living resources

The environmental and socio-economic impacts of unsustainable exploitation of fish and other living resources on the Small Islands sub-system are moderate. The Organization of Eastern Caribbean States (OECS) enjoys a common fishery zone consisting of all the Exclusive Economic Zones (EEZs) of the Member States, as defined in the United Nations Convention on the Law of the Sea (UNCLOS) (with some exceptions). Member governments have recognised the importance of effective control of the EEZs for the enhancement of the fishing industry, as well as the economic importance of maintaining a pollution-free marine environment. As a result, the OECS Authority has agreed on a harmonised approach to negotiation of maritime delimitation agreements within the sub-system and with non-OECS countries having maritime interests in the area (OECS 2001).

Environmental impacts

Overexploitation

The impacts of overexploitation were assessed as severe and certain stocks are exploited beyond maximum sustainable yields (MSY). As a consequence, the system has restrictive fishing seasons, and high restriction on certain species. The fishing effort in the region and the species restriction varies from country to country but include, in general, lobsters, white sea urchins and sea turtles.

A study by the FAO has shown that around 35% of the Caribbean species are overexploited (FAO 1997c in UNEP 2000b). The total reported catch of fish, crustaceans and mollusks for the countries in the Small islands sub-system rose from approximately 8 900 tonnes in 1950 to around 35 000 tonnes in the beginning of the 1980s and was 60 000 tonnes in 2000 (Figure 10) (FAO FISHSTAT 2003).

It is difficult to separate the effects on mangrove, seagrass bed and reef loss from the effects of overfishing. Degradation of these habitats in for example US Virgin Islands has undoubtedly contributed to significant

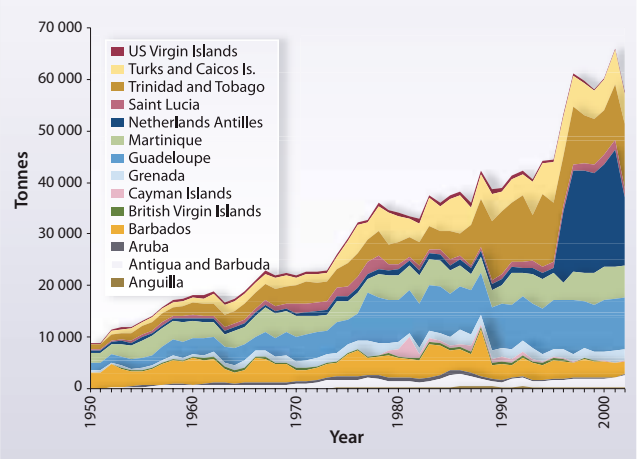


Figure 10 Total capture of fish, crustaceans and mollusks in the Small Islands sub-system.
(Source: FAO FISHSTAT 2003)

changes in reef fish populations but there is also clear evidence of overfishing, with reduced stock even within the national parks. Existing regulations have failed to protect reef fishes or return populations of large groupers and snappers to natural levels and enforcement is poor. For example, over 50% of traps found on the islands do not have the legally required biodegradable panels to allow fish to escape if traps were lost. However, it is unlikely that full compliance with existing regulations will reverse these alarming trends. Queen conch (*Strombus gigas*) used to be abundant around St. John, but populations are decreasing, even at the same rate within the US Virgin Islands National Park. Similar estimations show a decrease in the average size of lobsters since 1970 (Causey et al. 2000).

In the Cayman Islands, coral reef fishing is restricted to low volume recreational and subsistence fishing, which still may have a relatively high impact because of the limited habitat area. Conch and lobster are also subject to intensive recreational and subsistence fisheries and are overexploited, despite conservation regulations (Woodley et al. 2000). Fish stocks in Guadeloupe and Martinique are overexploited and large fish such as groupers, snappers, parrotfish are relatively rare. In the British Virgin Islands, conch have been fished to the point of collapse (Smith et al. 2000).

Despite the serious situation in many islands, fish landings increased in Saint Lucia between 1996 and 2001 from 1 310 to 1 970 tonnes (Figure 11). The increased catch is correlated with an increase in the number of registered fishing vessels, which during the same period rose from 769 to 1 055 (Saint Lucias Fisheries Department 2004). Even if the countries have legislation that promotes the conservation and rational use of resources, biodiversity loss and economical species exploitation is still occurring.

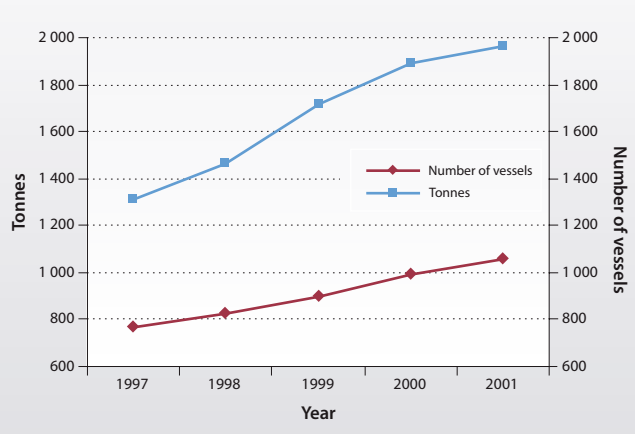


Figure 11 Estimated fish landings and vessel registration in Saint Lucia.
(Source: Saint Lucias Fisheries Department 2004)

Excessive by-catch and discards

The impacts of excessive by-catch and discards are considered slight but since no information is avaliable the issue will not be further discussed.

Destructive fishing practices

The impacts of destructive fishing practices are assessed as moderate, since fishing using explosives, poisons and inappropriate nets still occurs, affecting key ecosystems such as coral reefs. However, some efforts have been made to address this issue. For example, in Saint Lucia, use of destructive fishing methods has been reduced due to improvements in regulations, enforcement, monitoring, as well as provision of alternative fishing methods and gear. Unfortunately, this situation is not as common elsewhere. In the Cayman Islands, the increasing use of large, small-meshed fish traps is causing localised depletion, and four spawning aggregations of Nassau grouper (*Epinephelus striatus*) are intensively fished with hand-lines, resulting in a decline in the average size and catch per unit effort. Fishing with scuba gear is banned but 500 licensed local residents are permitted to use spear guns (Woodley et al. 2000).

In the British Virgin Islands, the decline of demersal fish due to trap fishing over the last 10-20 years has also been reported by local dive guides. In Guadeloupe traditional practices are used, but there are approximately 1 000 people who regularly fish unlicensed. There are 40 000 Caribbean traps around the French Caribbean Islands and about 20 000 are lost each year in Guadeloupe during the hurricane season, and as they are built with wire netting, they continue to catch fish for months. In the Netherlands Antilles, artisanal fishing practices include hook and line fishing, rod fishing, and the use of kanasters (fish traps), trai (throwing nets) and reda (encircling nets). Spear guns and spears, although illegal, are still in sporadic use (Smith et al. 2000).

Throughout the islands, stresses like commercial fishing, hand-line, trap fishing, spear fishing, net, long-line, trawling, and driftnet have considerable damage on coral reefs. Overfishing has markedly reduced resources, including those within the US Virgin Islands National Park and Buck Islands Reef National Monument. Reports from 20 years ago suggested that fishing was already changing the reef populations, even before development on land caused extensive loss of habitat as well coral diseases, hurricanes, and other stresses. Fisheries in St. Lucia are close to collapse and even the areas within the boundaries of marine protected areas are deteriorating (Causey et al. 2000).

Decreased viability of stock through pollution and disease

The impacts of decreased viability of stocks though pollution and disease were assessed as slight. There is seasonal fish mortality, principally every summer, but the magnitude is small and the causes unknown. In most cases the fish kills are restricted to estuarine areas, while large-scale mortality in the marine environment is less common.

Impact on biological and genetic diversity

According to available information, the impacts of this concern were assessed as slight as a result of the introduction of alien species, associated with marine traffic through the territorial waters of the islands. Seagrass beds are known to have been affected by predation from invasive urchins but there is a lack of data concerning the impacts. It must be emphasised that the small size of the islands makes it very difficult, if not almost impossible, to differentiate the significance of varying components of multiple impacts on the coastal and marine environment. While the net effect is a decline in resources, the specific or immediate causes are less obvious.

Socio-economic impacts

Economic impacts

The islands in the sub-system do not depend heavily on fisheries, rather on other activities such as tourism. The primary sector (which includes fishery) for example in Saint Lucia contribute with 7% of GDP and the service sector (which includes tourism) with 73%. Nevertheless, the situation is not the same for all the islands, since they do not depend on the same activities. Unsustainable fishing pratices can have a severe impact on the community that uses these resources. The role of industrial fishing in the Small Islands sub-system also has some influence on the socio-economic conditions, and even if there are some incentives, the resources are still overexploited, and harmful fishing practices remain commonplace. Fishermen have subsequently

been forced to change livelihood strategy, despite it being difficult to find other employment.

In Barbados, fisheries resources are an important part of the local economy and culture, even though the total contribution of fisheries is relatively small (around 1% per year). It is believed that presently, many local stocks of near-shore piscine and shellfish species are either fully exploited or overexploited (UNEP 2000a).

In the US Virgin Islands, a total of 343, 369 and 342 commercial fishermen were registered for the years 1996-1997, 1997-1998 and 1998-1999, respectively (Tobias et al. 2000). The price per kg of resources landed in the US Virgin Islands remained the same on St. Croix in 1997 and 1999, but increases were recorded for five species for St. Thomas/St. John, mainly due to decreasing inshore resources, and increasing harvesting expenses and demand (Table 8). The value of the commercial landings reported for 1996-1997, 1997-1998 and 1998-1999 was 4 874 200, 6 291 700 and 4 783 400 USD respectively. This data is reliable but does not allow sufficient analysis of the behaviour and abundance of the fisheries.

Table 8 Species with increased harvesting expenses for St. Thomas/St. John in 1997 and 1999.

Species	**Harvesting expenses** (USD/kg)	
	1997	1999
Grouper and snapper	7.7	8.8
Mackerel	6.6	8.8
Dolphin fish (durado)	8.8	9.9
Lobster	13.2	15.4

(Source: Tobias et al. 2000)

In Bonaire (Netherlands Antilles), there are only approximately 20 commercial fishermen, although practically everyone "goes fishing". Since commercial fishermen target pelagic fish species (for example tuna, durado, wahoo) and fish predominantly with hook and line, their impact on reef fish populations is negligible. Fish caught are generally consumed locally; only Big eye scad (*Selar crumenophthalmus*) may be exported to Curaçao (Smith et al. 2000).

Health impacts

The health impacts are assessed as moderate and result primarily from toxins such as ciguatera. Ciguatera is the commonly reported marine toxin disease in the world and is associated with consumption of contaminated reef fish such as barracuda, grouper, and snapper. This toxin is present in fish species that are not traditionally caught and consumed, especially in the northern Antilles. However, due to unsustainable exploitation, coastal communities have to rely on these species and since fish often provides the only source of protein, the health impact is on the reduction of nutrition quality.

Misdiagnosis and under-reporting (especially in endemic areas such as the Caribbean) make it difficult to know the true worldwide incidence of this disease. At least 50 000 people per year who live in, or visit, tropical and sub-tropical areas suffer from ciguatera worldwide. In the US Virgin Islands, there are an estimated 300 cases per 10 000 or 3% of the population per year; a similar rate is found in Guadeloupe and Martinique. In St. Thomas, a household survey estimated that 4.4% of all households suffered from ciguatera annually (at least 2 640 persons per year) (PAHO 1999). Another example is from Antigua & Barbuda, where ciguatera poisoning is associated with locally caught barracuda and other fish. There were 322 cases reported in 1995 and 330 in 1994. Many cases go unreported because they are commonly treated with home remedies (PAHO 1999). In the Cayman Islands, there have been sporadic cases of food poisoning, especially due to ciguatera. The incidence of ciguatera fluctuated widely. There were 10 cases in 1990, 18 in 1993, and 2 cases in 1995 (PAHO 1999).

Other social and community impacts

Other social and community impacts were assessed as moderate. There is a productive fisheries market as seafood is an important source of protein and the industry locally generates a valuable source of income. Advancements in the fishing gear used, and decreases in fish stocks due to the effects of pollution and the degradation of marine ecosystems, have contributed to overexploitation of local fish stocks. Rural communities have to change from fishing to alternative livelihood because the fish stocks have been overfished and it has been necessary to develop alternative sources of livelihood for many of these traditional fishing communities.

Conclusions and future outlook

The impacts of unsustainable exploitation of marine resources result principally from overexploitation and destructive fishing practices. It is expected that by 2020, this situation will not have changed significantly and the average impact on environmental and socio-economic issues will still be moderate. However, the impact on the economic sectors will increase in severity taking into account the continuity of pressures for harvesting and technological advancements.

Global change

Environmental assessment and monitoring of the actual and potential impact of climate change and natural disasters on coastal areas and drainage basins is emerging as a major concern for all of the countries in the Caribbean Seas/Small Islands sub-system. All Caribbean countries have signed the United Nations Framework Convention on Climate Change (UNFCC). The countries have not yet been able to measure whether the sea level has risen as a result of global climate change, but nevertheless, they are examining the possible scenarios and how to address them. Hazards, induced by global change are a serious issue for the region. The countries in the sub-system are continuously affected by hurricanes and, less frequently, tornadoes, earthquakes and volcanic eruptions. These events often produce flooding and landslides in areas where anthropogenic activities, such as deforestation and construction, have destabilised the land (GEF/CEHI/CARICOM/UNEP 2001).

Assessing the impacts of global change on the environmental and socio-economic integrity of the sub-system is problematic due to a lack of data since this has only recently arisen as a major concern. This fact obstructs the estimations for increased UV-B radiation as a result of ozone depletion and for changes in ocean CO_2 source/sink function. Although changes in sea temperature resulting from global warming is not a GIWA issue, studies by Roach (2003) stated that "Coral bleaching–related mainly to rising sea temperature – has affected other parts of the world to a much greater extent than the Caribbean so far, (…). However, the threat of climate change…remains a serious concern for the future."

Although there is a dearth of information describing changes in UV-B levels, employment of the precautionary principle dictates that the impacts of UV-B radiation should be assessed as slight. The impacts of changes in ocean CO_2 source/sink functionary were also assessed as slight due to a lack of information. These issues have not been assessed or measured, but it is not recommended to establish that there is no known impact.

Environmental impacts

Changes in the hydrological cycle

The impact of changes in the hydrological cycle due to climate change is assessed as moderate in the Small Islands sub-system. Changes in the hydrological cycle are documented in some islands, where there is increased flooding and incidences of extreme weather phenomena. Nevertheless, data describing the impacts of climate changes on ecosystems is limited, and estimations are made by extrapolating from other islands such as those in the Pacific. There is however no doubt that the Caribbean islands are extremely vulnerable to any impacts of global climate change, for example climate variability and sea level rise.

In Saint Vincent and the Grenadines, it has been reported that, "if climate change is responsible for the intensity of storms and storm surges over the last five years, then it is responsible for major coastal erosion on Saint Vincent" (GEF/CEHI/CARICOM/UNEP 2001). Some shorelines on the northern windward side of the island have receded as much as 25 m over the last five years. Hurricane Lenny destroyed 10 m of coastal forest that had stood for over 50 years. Increased storm activity also results in heavy rainfall, which has significant negative effects on the coastal environment.

Coral reefs in the sub-system are under stress from natural processes, mainly hurricanes. Hurricane Hugo (1989) significantly affected the coral reefs of Antigua & Barbuda. Hurricanes have also inflicted serious damage to the southern and southeastern reefs, but signs of recovery are evident. Hurricane Luis (September 1995), Marylin (1995), Jose (1998) and Lenny (1999) caused additional stress to the country's reefs (Figures 12 and 13) (Office of the Prime Minister 2001). Prior to Hurricane Lenny (1999), Malgretoute, in Saint Lucia, was characterised by high densities of the sea urchin *Diadema antillarum* and low algal abundance at depths of 3 m, but following the hurricane urchins declined from 1.4 to 0.1 per m^2 and a proliferation of filamentous algae (Smith et al. 2000). There

Figure 12 Hurricane Lenny in the Caribbean Sea, 1999.
(Photo: NASA)

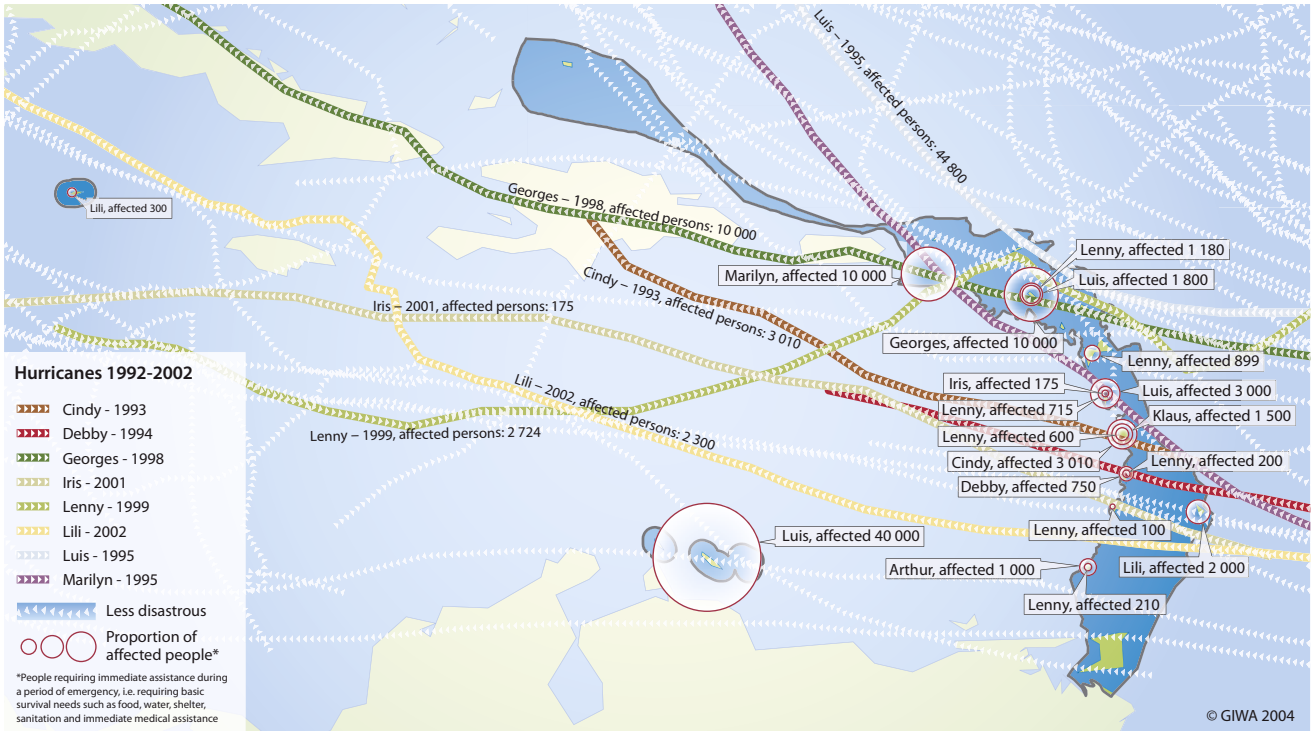


Figure 13 Hurricanes and the number of affected peoples (requiring immediate assistance during a period of emergency) during 10 years in the Small Islands sub-system.
(Source: NOAA 2004, Center for Research on the Epidemiology of Disasters 2004)

was a 3% decline in coral cover between 1997 and 1998. The unusual track of this hurricane resulted in severe wave action on the leeward coast of Saint Lucia, severely damaging coastal infrastructure. Data from west coast reefs indicate live coral cover was generally higher than 50% prior to the series of storms in 1994 (Smith et al. 2000). This began with Hurricane Debbie, the sedimentation from which reduced coral cover by 50% at some sites, particularly near large river mouths. The passage of numerous storms through the British Virgin Islands since 1995, and more recent hurricanes, such as Jose and Lenny in late 1999, caused severe damage in dive sites at Morman Island, Peter Island, Salt Island, Cooper Island, Ginger Island and Virgin Goda (Smith et al. 2000).

Sea level change

The impact of sea level change were assessed as slight. This issue is important for the islands but there are no statistics on sea level rise. Sea level monitoring equipment has only recently been established in the region. Nevertheless, experts estimate that sea level change currently has less impact than changes in the hydrological cycle.

The possible effects of climate change on coastal water levels and temperatures are a threat to the fragile coral reef ecosystems. The coastal region is the most economically valuable area on most islands and even small changes could produce permanent environmental damage, severely affecting the islands' economies (GEF/CEHI/CARICOM/UNEP 2001).

The studies referred to by Roach (2003) for National Geographic News states that the composition of coral species has changed over the past 25 years. Many of the new coral growth comes from species known as non-framework builders that do not contribute to the growth of reef structure. "If this is a widespread phenomenon, then there is serious concern about the capacity of Caribbean reefs to cope with rising sea levels," (…) (Roach 2003).

Socio-economic impacts

Economic impacts

Considering the number and importance of economic and public sectors that could be affected by global change (tourism, agriculture, fisheries, etc.), its economic impacts on the Small Islands sub-system are considered severe even if no infromation about the current economic impacts is available for the sub-system. The coastal region is the most economically valuable area on most islands and even small changes could produce permanent environmental damage, severely affecting the islands' economies (GEF/CEHI/CARICOM/UNEP 2001).

Tourism and agriculture are two of the sectors that could be affected by global change which being the primary economic sectors of the Small Islands. Tourism's total contribution to the OECS's GDP was 10% in 1996. The contribution of the agricultural sector to the GDP of Antigua & Barbuda, Grenada, Montserrat, St. Kitts & Nevis, Saint Lucia and Saint Vincent & The Grenadines was 8.5% (World Bank Caribbean Division 1994).

Climate change affects tourism in many ways, directly and indirectly, for example: loss of beaches due to erosion, flooding, degradation of ecosystems and related impacts (e.g. loss of coral reefs to bleaching, saline intrusion), as well as damage to critical infrastructure. These are only a few consequences that could undermine the tourism resource base of vulnerable small island states (Alm et al. 1993). Although some of these impacts can be triggered by non-climate related factors, there is a growing consensus that climate change is likely to precipitate such changes, and that they could be disruptive (Holthus et al. 1992, Pernetta 1992, Sestini 1992, IPCC 1996, SPREP 1996 in IPCC 1997). There is evidence that any disruption in the tourism sector would have severe repercussions for the economic, political, and socio-cultural integrity of many small islands (IPCC 1998).

Some studies of the impacts of climate change have predicted that a minimum temperature rise of 1°C may decrease sugar production by approximately 7.4 tonnes per ha. In addition, temperature rise can negatively impact yields of transitory crops grown in subsistence agriculture (GEF/CEHI/CARICOM/UNEP 2001).

Taking into account the increase in storm frequency resulting from global change, the economic costs of these phenomena on the islands should be considered. At present, there are documented figures for the OECS islands on the economic losses caused from tropical storms and hurricanes, which could be provided as evidence. The cost of damage to five OECS states from hurricanes Luis and Marilyn in 1995 is given in Table 9.

Table 9 Cost of damage from hurricanes Luis and Marilyn.

Country	Cost of damage	
	USD	% of GDP
Anguilla	94 000 000	147
Antigua & Barbuda	300 000 000	71
Montserrat	3 000 000	5.4
Dominica	97 000 000	53
St. Kitts & Nevis	197 000 000	105

(Source: ECLAC 2000)

Another impact from global change in the Small Islands is the high cost of coastal protection and impacts from salt intrusion. The Small Islands, like other coastal areas, face difficult decisions in confronting the adverse effects of global climate change and the associated sea level rise. There could be significant costs from protecting the islands from sea level rise which may not be viable considering the size of their economies, however no information from the sub-system is available (CPAAC 2000).

The impacts of climate change largely depend on the initial condition of the water supply system and on the ability of water resource managers to respond, not only to climate change but also to population growth and changes in demands, technology and economic, social and legislative conditions (MPDEH 2002).

Health impacts

The health impacts were assessed as slight. Some assessments of the impacts of climate change on health predict that increases in temperature and humidity could lead to the proliferation of species, such as the *Aedes aegypti* mosquito, which could result in outbreaks of dengue fever and malaria but no information is available for the Small Islands sub-system. Furthermore, temperature increases could affect the elderly and very young by an increase in respiratory diseases (GEF/CEHI/CARICOM/UNEP 2001).

Other social and community impacts

Other social and community impacts were assessed as severe. One of the most important social and community impacts due to global change is the availability of potable water and, at present, access to an improved water source is partial in some islands. Saltwater intrusion in coastal aquifers is negatively impacting water supply. A reduction in rainfall could decrease the rate of groundwater recharge. Elevated temperatures will increase the evapotranspiration rate which, together with less precipitation, will reduce water stored in reservoirs. Greater demand and less water availability per capita is expected (GEF/CEHI/CARICOM/UNEP 2001).

As an example of the social impacts of global change, in the US Virgin Islands, Hurricane Georges impacted the territory in September 1998, resulting in a decrease in the number of commercial fishermen for 1998-1999 (Tobias et al. 2000). While all commercial fishermen suffer gear losses due to severe storms, hurricanes typically cause a reduction in the number of part-time fishermen in the commercial fishery due to the secondary importance of fishing as an income and the immediate increase in construction jobs following the hurricane.

Conclusions and future outlook

External factors are crucial for the current and future conditions of global change in the Small Islands sub-system. Hazards originating from global change are a serious problem for the region. The islands are often impacted by hurricanes, and with less frequency, but just as damaging, are tornadoes, earthquakes and volcanic eruptions. Based on the current level of understanding, the main environmental issue caused by global change is changes in hydrological cycle and ocean circulation. The main socio-economic concern is the cost of protection from, or adaptation to, global change.

The impacts of climate change will tend to increase in the future if no regulations are implemented, and it will affect all the other concerns and sectors. This is a global concern which needs to be addressed at an international forum, while regional management systems should focus their attention on more immediate and local concerns.

Priority concerns for further analysis

The geographical extent of countries in the Small Islands sub-system, their ecological fragility, small populations, limited resources, geographic dispersion and isolation from markets are all characteristics of Small Island Developing States (SIDS) and place them at an economic disadvantage. For the SIDS, the ocean and coastal environment is of strategic importance and constitutes a valuable development resource. However, one of the most important demands on the environment is that of a volatile tourism industry, with rapid economic cycles and high vulnerability to recessions in developed countries.

The GIWA concerns were prioritised as follows:

1. Global change
2. Habitat and community modification
3. Pollution
4. Freshwater shortage
5. Unsustainable exploitation of fish and other living resources

The GIWA assessment determined that the concern of Global change exerted the greatest impact on the Small Islands sub-system. However, since it is an international concern addressed through other initiatives (e.g. the United Nations Framework Convention on Climate Change), Habitat and community modification was therefore selected as the GIWA priority concern for further analysis in the Causal chain and Policy options analysis.

The justification of scores was presented in the Assessment section. However, some relevant issues supporting the priority concern for the Small Islands sub-system, Habitat and community modification, are presented below:

The Small Islands depend almost exclusively on their ecosystems, which are very fragile and vulnerable, and any alteration can influence the whole system. The ecosystems and their resources are indispensable in maintaining the dynamic equilibrium of the islands. The importance of surface and coastal ecosystems for small islands has been highlighted, considering that there is not much investment in preventive strategies, due principally to high costs. There is more attention directed towards remedial actions, incurring subsequential socio-economic costs. Many islands depend on sandy shorelines, coral reefs and mangroves for protection from waves and natural hazards, such as tropical storms and communities, on marine resources and tourism for their livelihood. Even in the absence of climate change (for example sea level rise) and other environmental concerns, small islands are highly vulnerable to natural or anthropogenic impacts (GESAMP 2001).

Pollution is also important in its relation to habitat modification. Pollution of freshwater supplies (surface and groundwater) and sedimentation or erosion, caused by human activities such as infrastructure development, or changes in river flows, decrease natural resources. It furthermore contributes to the degradation of terrestrial, coastal and near-shore marine ecosystems, including a reduction in biodiversity (critical salt-pond, mangrove, estuary, seagrass and coral reef systems), and affects the health of human populations and economic activities. The health risk to the population is associated with poor quality freshwater and water used for recreational purposes. In countries like Barbados, protective reef systems have been degraded by eutrophication caused by faecal material in water, contributing to soil erosion and beach destruction (PNUMA 1999b in UNEP 2000a).

In order to strengthen this analysis, it is important to consider human population densities and sustainability as variables, since excessive population growth (permanent or temporal) jeopardises environmental conditions, thus affecting available resources (including freshwater and living resources). The islands' economy largely depends on marine tourism as its major source of income. Uncoordinated tourism development and the influx of additional tourists can limit the local resources base and services to such an extent that the initial tourist attractions may be destroyed. Tourism increases demand for energy and water supplies, increases sewage, competes for land resources and perturbs coastal and marine ecosystems (GESAMP 2001, Bernal & Cicin-Sain 2001).

Freshwater pollution in the Small Islands sub-system is not strictly a transboundary issue since there are no shared freshwater resources. However, the islands are affected by the large river systems of the neighbouring continental countries, such as Venezuela and Guyana. This transboundary impact between the continent and the islands may be affecting habitats and associated species communities. Additionally, the islands are on the transit route of oil tankers, which is also a clear transboundary issue.

Some conclusions from other organisations support the assessment of the Small Islands sub-system, in accordance with the following issues:

- The five environmental impacts considered by GIWA were also considered by the Barbados +5 Convention in 1999, when the experts identified four problem areas as priorities for the next 5 years (2000-2005) as follows: coastal and marine resources (protecting coastal ecosystem from pollution and overexploitation); freshwater resources (preventing further freshwater shortages associated with growing demand); climate change (adaptation); and tourism (managing tourism growth to protect the environment and cultural integrity) (Bernal & Cicin-Sain 2001).
- The recent UNEP/EU publications (i.e. Global Environment Outlook reports) for the Caribbean mention that the common environmental problems in SIDS are: loss of marine and terrestrial ecosystems; threats to freshwater resources (potential climate change impacts such as salt intrusion or changes in the hydrological regime, and the pressure from growing population and tourism development); climate change; and land and sea-based pollution (Bernal & Cicin-Sain 2001).
- Finally, the working group 7 at the Global Conference on Ocean and Coasts at Rio+10, recognised the importance of the above mentioned concerns for the islands, especially regarding the environmental issues, since an considerable gap was identified in ecosystem monitoring, bio-prospecting, essential data collection and research for food security and economy reform.

Causal chain analysis

This section aims to identify the root causes of the environmental and socio-economic impacts resulting from those issues and concerns that were prioritised during the assessment, so that appropriate policy interventions can be developed and focused where they will yield the greatest benefits for the region. In order to achieve this aim, the analysis involves a step-by-step process that identifies the most important causal links between the environmental and socio-economic impacts, their immediate causes, the human activities and economic sectors responsible and, finally, the root causes that determine the behaviour of those sectors. The GIWA Causal chain analysis also recognises that, within each region, there is often enormous variation in capacity and great social, cultural, political and environmental diversity. In order to ensure that the final outcomes of the GIWA are viable options for future remediation, the Causal chain analyses of the GIWA adopt relatively simple and practical analytical models and focus on specific sites within the region. For further details, please refer to the chapter describing the GIWA methodology.

The United Nations Commission for Latin America and the Caribbean (ECLAC) produced the report "Small Island Developing States Programme of Action for Sustainable Development: Opportunities and Constraints" (Ismael 1998) which identifies some of the particular vulnerabilities of Caribbean Small Islands Developing States (SIDS) such as:

- Economies are largely undiversified, highly open and excessively dependent on trade and export of very few goods;
- Islands are highly dependent on preferential access to export markets;
- Countries are highly vulnerable to fluctuations in commodity prices (e.g. oil);
- The islands are highly vulnerable to natural disasters, such as hurricanes, which can wipe out the entire productive capacity of a country in a few hours;
- National and regional communications systems and policies are weak;
- Small island size equates with limited human resources and consequent limited capacity. As a result, public administration is costly and basic infrastructure is weak with low technology.

For the Causal chain analysis (CCA) of the Caribbean Sea/Small Islands sub-system, it is necessary to mention that the whole sub-system is studied, rather than a specific case study, as was undertaken for sub-system 3b Caribbean Sea/Colombia and Venezuela and 3c Caribbean Sea/Central America and Mexico. The focus of the CCA is to determine the root causes of habitat and community modification in the sub-system, so that the driving forces of the issues can be addressed by policy makers rather than the more visible causes. This process traces the cause-effect pathways, associated with the habitat and community modification concern from the socio-economic and environment impacts identified in the assessment back to the root causes. The root causes can then be targeted by appropriate policy measures.

Due to the geographical location of the Small Islands sub-system, the islands aquatic systems are vulnerable to a multitude of impacts of local and transboundary origin. A number of regional initiatives and conventions have been undertaken to address the concern of habitat modification and the pollution that often triggers these environmental changes. These include the following:

- Demonstration of Innovative Approaches to the Rehabilitation of Heavily Contaminated Bays in the Wider Caribbean (GEF/UNDP/UNEP);
- Reducing Pesticide Run-off to the Caribbean Sea (GEF/UNEP);
- Integrated Freshwater and Coastal Zone Management in Small Island Developing States (GEF/UNEP);
- Cartagena Convention and its protocol (see Regional definition, Legal framework).

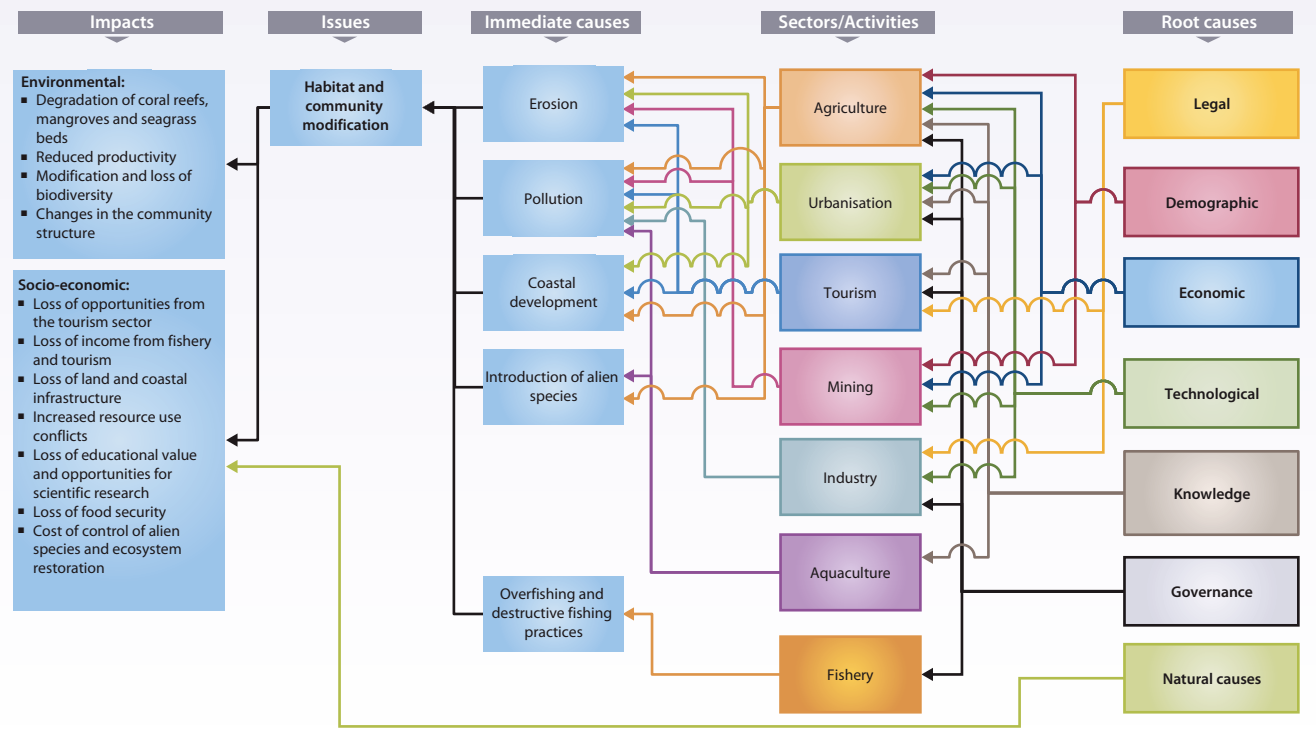


Figure 14 Causal chain diagram illustrating the causal links for habitat and community modification.

A description of the system can be found in the regional definition section, since the casual chain analysis is for the whole sub-system and not case specific.

Environmental and socio-economic impacts

Figure 14 illustrates the main causal links for habitat and community modification in the Small Islands sub-system. This concern in the region has resulted in the following environmental and socio-economic impacts (for further explanation refer to Assessment, Habitat and community modification):

Environmental impacts

Degradation of coral reefs, mangroves and seagrass beds

Coral reefs and other marine ecosystems, as well as fisheries resources, have been degraded and statistics show that around 35% of the Caribbean species are overexploited (FAO 1997c in UNEP 2000b). The degradation of mangroves and seagrass beds has affected important nursery grounds for many reef dwelling fish. There has also been widespread coral mortality. In for example in Saint Lucia, between 1995 and 2001, reefs in the Soufriere area lost on average 47% of coral cover in shallow waters and 48% of the coral cover in deeper waters. On the northwest coast of Saint Lucia, 82% of the reefs are either dead or in poor condition (Department of Fisheries 2003a,b).

Modification and loss of biodiversity

In Antigua & Barbuda for example, loss of nesting habitat was considered to be the greatest threat to the three species of endangered sea turtles (*Eretmochelys imbricata, Chelonia mydas, Dermochelys coriacea*), which are the only marine reptiles to nest on the islands (Office of the Prime Minister 2001).

Changes in the community structure

There has been gradual loss of numerous species of invertebrate animals found within each of the islands' vegetation communities.

Reduced productivity

The concentration of suspended and dissolved solids has increased, resulting in greater turbidity of freshwater bodies and coastal waters. This has modified these ecosystems by increasing turbidity and thus decreasing the amount of light penetrating surface layers and consequently reducing the productivity of freshwater and marine photosynthetic plants and corals.

Socio-economic impacts

Loss of opportunities from the tourism sector

The successful promotion of tourism is strongly correlated with the quality, ambience and aesthetic value of the environment. The degradation of the islands habitats will ultimately reduce the marketability of the islands. Tourism revenues are often directly impacted by habitat modification, particularly coral reefs, because of the loss of amenity value for activities, such as fishing, snorkelling, diving etc. Any damage to the ecosystems of the islands will impact on their entire economies due to the importance of the tourism sector, which is the primary source of foreign investment and income.

Loss of income from fishery and tourism

There has been a loss of economic benefits previously provided by the ecosystems. Degradation of the coral reef, mangrove and seagrass beds has reduced the productivity of the fisheries and subsequently the foreign currency received from this industry.

Loss of food security (fishing)

The ecosystems provide nutritional benefits and economic activities and the modification has reduced the capacity of the local populations to meet their basic human needs.

Cost of control of alien species and ecosystems restoration

There have been increased costs of controlling invasive species and costs of restoring modified ecosystems. There are then subsequent costs of artificially protecting the coastline.

Increased resource use conflicts

The modification has caused a loss in recreational value and affected the cultural integrity of local communities. Conflicts have arisen between tourism and other water-based activities, particularly fishing, due to greater competition for the diminished ecosystem resources.

Loss of land and coastal infrastructure due to lack of physical protection

The loss of physical protection from coral reefs, mangroves and seagrass beds has degraded land and coastal infrastructure.

Immediate causes

The immediate causes of habitat and community modification in the Small Islands sub-system are diverse with complicated interactions and synergies. Below are some of the major causes of the concern.

Erosion through deforestation and land clearance for agriculture

In tropical islands, like Dominica and Saint Lucia, deforestation and the cultivation of steep slopes causes considerable land degradation. For example, in the 1980s, large areas of prime rainforest were cleared in the small islands of the eastern Caribbean to make way for banana plantations. Today, many of these once productive banana fields have been abandoned, and left exposed to erosion processes (Colmore 1999). Private forested land is particularly prone to deforestation as owners are free to clear the land to accommodate farming, land sub-division for housing and other activities. Land degradation has increased the quantities of sediments entering aquatic systems via surface-run-off. This has modified these ecosystems by increasing turbidity and sedimentation.

Pollution

High sediment loads and agro-chemicals, and the discharge of raw or only partially treated sewage are stressing coastal and freshwater ecosystems. Eutrophication as a result of nutrient inputs from agriculture and urban wastes, and a reduction in algal grazers, has degraded many of the reefs in the region, due to a proliferation of algae blocking out sunlight and deoxygenating the water. For example, during the 1980s, many shallow reefs around Grenada & The Grenadines were degraded and became overgrown with algae, presumably resulting from a combination of sewage and agro-chemical pollution, and sedimentation caused by coastal development (Smith et al. 2000). Pollution from heavy metals and pesticides have been found in sediments and animals; only on Martinique and Guadeloupe, 1 500 to 2 000 tonnes of pesticides are imported per year (Smith et al. 2000).

Coastal development

There has been unplanned and uncontrolled development of settlements on the islands, which has destroyed habitats directly through the clearance of land and indirectly through the propagation of pollution, due to the absence of facilities to adequately treat sewage (including grey water), and dispose of solid wastes. Furthermore, these settlements are often constructed at locations vulnerable to events such as landslides, floods, and storm surges, which were previously stabilised and protected by terrestrial flora, coral reefs, seagrass beds, mangroves, beaches, or wetlands. The removal of these coastal habitats for urban development removes natural wave breakers and therefore increases erosion with associated impacts of greater turbidity and sedimentation in freshwater bodies and coastal waters.

Tourism is also affecting the health of coastal ecosystems through the construction of developments in close proximity to the shoreline,

Figure 15 Fishermen carry large fish traps out to their boats on the shore at Vauclin, Martinique.
(Photo: Corbis)

harbour dredging, the destruction of mangroves, anchoring on reefs and seagrass beds, and pollution. The issue of construction in coastal areas is illustrated in Antigua & Barbuda where 39 of the 55 hotels have a beach-front location (GEF/CEHI/CARICOM/UNEP 2001).

Significant areas of wildlife habitat in both terrestrial and marine ecosystems have been eliminated to accommodate development. In recent years, the clearing of natural vegetation and alteration of beaches has facilitated the development of the tourism industry, while divers and boat operators have damaged coral reefs. The US Virgin Island have lost over 50% of the territory's mangrove habitat during the last 70 years due to land clearance and land fill operations to create development sites or provide access to water (DPNR/DEP & USDA/NRCS 1998).

Introduction of alien species

Several fish species have been introduced to the sub-system via aquaculture, which has upset the existing ecological balance of sensitive habitats such as coral reefs. Seagrass beds are known to have been affected by predation from invasive urchins but there is a lack of data concerning the impacts.

Overfishing and destructive fishing practices

Overfishing and the use of destructive fishing methods such as explosives, poisons and inappropriate nets and traps (Figure 15) have negatively affected key ecosystems such as coral reefs, seagrass beds and mangroves. In for example the Cayman Islands, the increasing use of large, small-meshed fish traps has caused localised depletion, and four spawning aggregations of Nassau grouper (*Epinephelus striatus*) are intensively fished with hand-lines, resulting in a decline in the average size and catch-per-unit-effort.

Root causes

It is evident that attempts to protect marine habitats without addressing social, cultural and economic issues are likely to result in the continued unsustainable use of resources and extinction of species. What is therefore needed is an integrated approach to natural resource management and biodiversity conservation, which takes into account the realities of the below mentioned root causes.

Legal

Commendable efforts have been made to protect and preserve the coastal and marine resources of the Caribbean islands through a series of international conventions and subsequent legislative frameworks. However, national legislation inadequately incorporates conservation measures and the administration of the relevant legislation is the responsibility of several governmental agencies with weak institutional provisions for the coordination of environmental initiatives across the various sectors. This compromises the effectiveness of relevant legal and policy instruments. There is also a lack of regulations to provide the necessary guidance for managers and enforcers to implement legislation. Overall, there is an urgent need for appropriate legislation and to build capacity in the relevant institutions in order to better coordinate and enforce relevant initiatives regarding the environment.

Demographic

The majority of the islands populations inhabit the coastline where there are greater economic opportunities and ecosystem services. Population growth has increased the demand for appropriate lands, for agriculture, commercial, residential and tourism purposes. These factors have increased the pressure on coastal ecosystems, and consequently modified habitats through the sprawl of urban areas and the development of economic activities.

Economic

Poverty and unemployment

Endemic poverty and high unemployment is a catalyst for environmental degradation. For their short-term survival the population exploits natural resources at an unsustainable level. There are a lack of opportunities to diversify livelihood strategies when ecosystems services become stressed. The needs and requirements of individuals and communities are not given equal importance at the policy and decision-making level. Furthermore, governments in order to alleviate poverty, formulate development agendas to stimulate economic growth and provide employment, rather than ensuring sustainable development.

Knowledge

Lack of understanding of environmental concepts and absence of public awareness and educational programmes

There is limited understanding from the public to policy makers of the importance in maintaining aquatic ecosystems for the long-term sustainability of their services. There is a lack of realisation of the importance natural systems play in protecting human interests, for example, the filtering of sediments and other pollutants by mangroves that would otherwise diminish water quality in near-shore environments. Communities do not recognise that the resources, upon which their survival depends, are being depleted at an irreversible rate. This can be attributed in part to the absence of public awareness and education programmes to encourage communities to conserve ecosystems, and mechanisms to valuate environmental goods and services. These are necessary to change perceptions and attitudes towards conservation and environmental responsibility.

Insufficient collection and management of data

Insufficient attention is given to the collection and management of relevant data, resulting in a severe lack of information regarding coastal processes (e.g. wave data, current data, shoreline dynamics) to make informed planning and management decisions. Furthermore, Geographic Information Systems (GIS) are not being utilised in coastal zone management. Due to financial difficulties in the region, scientific and technical research does not receive sufficient funding and has not been perceived as a priority by the countries of the Small Islands sub-system. The region has an absence of performance indicators for monitoring and evaluation, with inadequate human resources and weak logistical assistance (e.g. scientific technologies, vehicles). There is an absence of centralised and coordinated regional, and limited national databases.

Technological

Inadequate measures to control pollution

Currently there are inadequate services to treat and dispose sewage. While industrial discharges are currently a relatively minor problem in most of the Small Islands sub-system, the continued discharge of untreated and unregulated effluent will likely pose severe problems to marine habitats in the future if control measures are not put in place. Agricultural run-off and human organic waste products are the more serious priority issues of concern. In many of the islands there is only very limited capacity to handle and treat wastewater, and much of it enters freshwater basins and/or coastal areas directly untreated or only partially treated.

This situation can only be addressed effectively through linking of various sector projects to long-term planning and development strategies. Such programmes must be regularly evaluated through development and effective implementation of monitoring programmes. Fundamentally the issue of agricultural pollution and run-off focuses back on the need to move away from an economy which has traditionally depended on revenues and incomes from high crop returns (often depending on monocultures such as bananas) within limited land space and to look for other forms of associated income (such as certified organic produce) as well as to the need to diversify the economy to make it less vulnerable. It also reflects the need for land

use and water resources management policies that identify the most appropriate uses for limited land resources.

Governance

Inappropriate development strategies

All of the countries in the Small Islands sub-system have a narrow economic base with many of the islands reliant on either export-agriculture or tourism as a source of government revenue and private sector income. In many islands agriculture is the primary sector of the economy and is based on a monoculture, such as sugar and bananas. This has saturated the market, and required greater land to be allocated to these crops as commodity prices have fallen, and increased dependence on agro-chemicals to maintain harvest levels. Inevitably, market forces punish such a single crop-dependency and prices fall, which may lead to a relative collapse in the economy.

In recent years, many of the islands have seen tourism as the main opportunity to replace the lost income from agricultural crops. Again there is a dependency developing on a single principle source of income, which will inevitably prove to be risky and potentially dangerous strategy in the long-term.

Environmentally these trends are also unsustainable. The intensification of agriculture, further clearance of land for expanded planting, and the need for additional water for irrigation translates into the destruction of habitats, changes in the water table and hydrological regime, and increased levels of toxic chemicals and nutrients in watershed and coastal waters. The accumulation of which results in severe degradation of coastal and marine habitats.

The transformation of economies towards greater dependence on tourism has resulted in other pressures. The need for land for development (particularly around coastlines) along with the demand for building materials and increased pressures on infrastructure (energy, waste disposal, food supplies, etc.) inevitably leads to environmental damage and ecosystem stress. Consideration of these environmental concerns is given lower priority than the drive for economic expansion. As a consequence, vitally important and sensitive ecological transition areas (mangroves, wetlands, river deltas and coastal hinterlands) are sacrificed to become development areas while rivers and coastlines are destroyed in the search for building materials.

Development strategies have made unrealistic demands on the limited resources of the countries, including energy provisions, waste recovery and disposal services, transport and water infrastructure, and food requirements. This has ultimately impacted on the environment.

Lack of long-term cross-sectorial development planning

Development planning in the Small Islands sub-system is highly fragmented, focusing exclusively on sector planning with little or no national coordination or long-term perspective. The absence of a coordination mechanism results in the many management strategies of the different governmental departments conflicting rather than cooperating to resolve problems and enable balanced cross-sectorial development. Too often, action to achieve objectives in one policy area hinders progress in another. In addition, the absence of a long-term perspective has resulted in development that is skewed towards certain communities and/or sectors in the economy, resulting in an inequitable distribution of resources and benefits.

Lack of stakeholder participation

Public participation has been lacking in current approaches to planning. This has resulted in the population feeling a sense of indifference to development activities despite it being them that are most affected by the associated impacts.

Figure 16 Queen angelfish (*Holcanthus ciliaris*).
(Photo: D. F. Colvard, The Coral Reef Alliance)

Lack of coordination

Environmental and land use management is fragmented, with ill-defined and often conflicting responsibilities between government agencies and stakeholders. There are no institutional arrangements coordinating environmental initiatives across the various sectors and levels of government. This compromises the effectiveness of relevant policy instruments. Several agencies, both governmental and non-governmental, are responsible for the conservation of natural and cultural resources. This has inhibited the development of a comprehensive framework for the effective conservation and management of these resources. There is presently a trend to enact further environmental legislation, which is overlapping and increases

the complexity of the legislative framework. This creates confusion and legislation is rarely enforced.

Lack of enforcement

One factor contributing to the severity of the problem is that although all of the islands have established some aquatic preserves to protect valuable habitat, the authorities lack the necessary manpower and funding to enforce the regulations (GEF/CEHI/CARICOM/UNEP 2001). Existing zoning, erosion control and fishing regulations are not providing sufficient protection against natural and human stresses. These have caused extensive mortality on reefs on US Virgin Islands around St. John and St. Croix.

The enforcement of legislation is not only constrained by a lack of resources, but also by perceptions and attitudes held by national law enforcement agencies. Environmental offences are given relatively low priority in comparison to other crimes.

Several islands have established marine reserves and protected areas under national legislation but very few have been actively managed. The main objective of creating these reserves was to protect important habitats such as turtle nesting sites and fish nursery and breeding grounds. However, enforcement of the laws governing marine reserves has proven difficult due to their remoteness, a weak enforcement capacity, and as a result of some land-based reserves being privately owned with no legal demarcation of the reserves' boundaries. Although there has been a trend to increase the number of protected areas, there are generally inadequate management and enforcement systems in place to ensure that these areas are serving their intended purpose.

Inadequate human resources

Human and technical resources currently lack capacity to effectively implement environmental policies and projects. National human resource needs should be assessed, as a prerequisite to deciding appropriate training programmes. Irrespective of the nature of policy interventions, it will be critical that capacity building and strengthening of existing human and technical resources be done. The nature of the capacity building should be determined at the national level through comprehensive needs assessments. However, efforts should be made to ensure that training programmes should focus more in-country and in-region to allow maximum exposure to stakeholders. Furthermore, these programmes should be linked to national government's own needs and fit into their long-term personnel planning if they have to be sustainable and effective.

Political commitment and action

Lack of political commitment to implement policies in the Small Islands sub-system is often a reflection of prioritisation at the national level and the need to address apparently more pressing national concerns. The challenge to the success of the selected policy interventions will be to ensure that the linkages between the protection of coastal and marine ecosystem habitats and economic and social priorities are identified, and that holistic, integrated approaches are used in their resolution.

Natural causes

Due to the location of the Small Islands region, the islands are exposed to hurricanes that produce extreme wave and surge conditions that can potentially destroy the coastal habitats. Additionally, sea level rise is causing the inundation of low-lying land and increasing coastal erosion with associated problems of sedimentation in coastal habitats. Periods of severe drought over the past two decades in Antigua and Barbuda are assumed to have impacted bird populations, as have the almost annual hurricanes that have hit the country since 1995 (Office of the Prime Minister 2001).

There was a major coral bleaching event in 1998 when sea surface temperatures exceeded 29°C during September and October (Smith et al. 2000). However, cases of coral mortality were relatively minor, with most corals that were bleached fully recovering. A further threat to the coral reefs arises from massive volcanic eruptions, particularly in Montserrat (for example in 1995 and 1996) where large quantities of ash were deposited on reefs (Smith et al. 2000).

Conclusions

Due the geographical location of the Eastern Caribbean Islands, the Small Islands sub-system is in the convergence area of multiple marine impacts, some of them with local and other with transboundary sources. Small islands of the Caribbean possess fragile, limited and highly vulnerable coastal and marine habitats, which are been affected by transboundary pollution in particular, sedimentation from continental land masses and maritime traffic among another due global change. These aspects must all be addressed through regional and international cooperation, monitoring and enforcement.

Policy options

This section aims to identify feasible policy options that target key components identified in the Causal chain analysis in order to minimise future impacts on the transboundary aquatic environment. Recommended policy options were identified through a pragmatic process that evaluated a wide range of potential policy options proposed by regional experts and key political actors according to a number of criteria that were appropriate for the institutional context, such as political and social acceptability, costs and benefits and capacity for implementation. The policy options presented in the report require additional detailed analysis that is beyond the scope of the GIWA and, as a consequence, they are not formal recommendations to governments but rather contributions to broader policy processes in the region.

The policy options analysis aims to describe the habitat and community modification issues that need to be resolved or mitigated, and will describe alternative courses of action that may be taken by policy-makers in the Small Islands sub-system.

There has been progressive destruction and modification of habitats in the Small Islands sub-system, as a result of human activities including deforestation, land clearance for agriculture, tourism development, the introduction of alien species and urbanisation. Pollution has been caused by the modification of habitats, such as increased sedimentation following deforestation, but can conversely alter ecosystems from a multitude of sources. The region is particularly vulnerable to natural hazards such as hurricanes, sea level rise, flooding and volcanic eruptions, which frequently disturb habitats. These factors have degraded important aquatic ecosystems such as mangroves, seagrass beds and coral reefs, with associated environmental impacts, such as decreased species diversity and abundance, and socio-economic impacts, for example, a decline in the fisheries.

The Causal chain analysis identified the root causes of this habitat and community modification. It was found that rapid economic growth is the priority of the region's governments, which it has failed to balance with the conservation and protection of ecosystems, in order to achieve sustainable development. This can be attributed to institutional weaknesses that have facilitated a lack of cross-sectorial coordination and uncontrolled development of the coastal zone. Stakeholders are not involved during the planning and implementation of development projects, and therefore the needs of the local community are not considered. For example, there has been inadequate valuation of the essential income and nutritional benefits that habitats provide for local communities, prior to land clearance for development.

Regional conventions such as the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (the Cartagena Convention), Convention on Wetlands of International Importance Especially as Waterfowl Habitat, the United Nations Convention on the Law of the Sea, Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, among others (se also Annex IV), and national legislation related to these international agreements, aiming at managing natural resources, have not been entirely implemented due to the lack of capacity of enforcement agencies and management which is fragmented, with ill-defined and often conflicting responsibilities between government agencies and stakeholders. National laws related to the environment are not harmonised and there is an absence of integrated management of the coastal zone at the national and regional level. There is a lack of monitoring programmes and appropriate technologies to adequately assess the current, and predict the future, status of the ecosystems in the region, that would allow informed decision-making.

A fundamental hindrance to sustainable development is the lack of understanding, from the public to policy makers, of the importance

of conserving aquatic ecosystems. This may stem from unsatisfactory incorporation of environmental issues in educational curriculum, and the lack of public awareness programmes.

Political leaders and policy makers must be made aware of the linkages between considerations such as poverty, unemployment and environmental issues. As part of the development strategies, the small islands depended on monocultures, used fertilisers and pesticides, and became non-competitive with other countries which have more natural products offer. The consequences of theses practices were evident in the economy collapse, that was resolved in a certain way with the tourism income. However, again there is a dependency developing on a single principle source of income, which will inevitably prove to be risky and potentially dangerous in the long-term. Additionally the environmental impact of tourism is not estimated in medium and long-term.

These practices have caused destruction of national habitats, alterations in water tables and flow regimes, increased levels of toxic chemicals and nutrients in drainage basins and coastal areas, and damage to coastal and marine habitats. Current attempts to relocate economies toward tourism inevitably results in other pressures. Moreover there is the need for land for development (particularly around coastlines) along with the demand for building materials and increased pressures on infrastructure and the environment (energy, waste disposal, food supplies, etc.). As a consequence, vitally important and sensitive ecological transition areas (mangroves, wetlands, river deltas and coastal hinterlands) are sacrificed to become development areas while rivers and coastlines are destroyed in the search for building materials. Basins are disrupted and water resources damaged and reduced.

In order to protect the marine biodiversity of the Small Islands sub-system, conservation must operate at the island-specific ecosystem level. There are selected narrower targets (e.g. endemic and endangered species) that warrant conservation attention. However, the most effective protection that will provide coverage for the greatest number of species will require an ecosystem approach. A combination of national and regional interventions will therefore be required to address the root causes identified by the Casual chain analysis. This is especially relevant for the Eastern Caribbean islands, which have: (i) a arge number of geographically small ecoregions; (ii) relatively small number of locally and regionally threatened and endangered, unique or regionally endemic species, especially sparse in relation to the number of potential habitats or marine ecosystems; and (iii) especially high costs of land implying politically sensitive decision-making in the selection and management of protected terrestrial and marine areas.

Policy option 1: Strengthening of resource management institutions

This policy option aims to design and implement a strategic plan, in order to strengthen the institutions, to harmonise the formulation and implementation of environmental policies, to ameliorate its human resource performance, and establish legal instruments for mitigating and reversing degradation trends in the Small Islands sub-system.

Justification

A principal root cause identified for the Small Islands sub-system is the inability of governments to achieve economic growth whilst enforcing environmental policies (see Root cause: Inappropriate development

Figure 17 Lesser Antilles.
From bottom to top through the center are: Grenada, St. Vincent (with Barbados to its east), St. Lucia, Fort-de-France, Dominica, Guadeloupe, Montserrat (slightly west of center line), Antigua, and Barbuda.
(Photo: NASA)

strategies). There is a need to recognise that some policies are compatible and some are conflicting and identify the trade-offs in order to harmonise development strategies.

A prerequisite to the successful design of a strategic plan is to address the Root cause of Insufficient data collection and management. Information is essential for informed decision-making and must be timely available to relevant policy makers, through information sharing networks.

The sustainable development of small islands is often hampered by the lack of appropriate data collection and management systems. In the absence of adequate data, decisions are made that may have irreversible consequences and that threaten the resource base over the medium to long-term. In accordance with the WSSD Plan of Implementation, paragraph 19 (WSSD 2002), to address the Root cause of Lack of understanding of environmental concepts, there is a need to "encourage relevant authorities at all levels to take sustainable development considerations into account in decision-making, including on national and local development planning". In order to achieve this, capacity building is needed in relevant authorities so that they can utilise data management services.

Actions at national level

- Promote professional training of personnel responsible for the formulation and implementation of relevant policies to harmonise economic growth and natural resource use.
- Encourage dialogue between enterprises and the communities in which they operate and other stakeholders (WSSD 2002, Paragraph 18b).
- Design and implement, with the participation of all the stakeholders involved in coastal zone management, a coastal and marine management plan. This would take a cross-sectorial approach to the development of economic activities.
- Harmonise state policy regarding marine and coastal resources management, to clarify institutional functions and to identify gaps in legislation.
- Incorporate ratified conventions and international agreements into the national legal framework.
- Establish legal borders of protected areas (see Root cause: Lack of enforcement).
- Promote public awareness and education; incorporate general environmental issues into the formal education system, and public educative campaigns though the media.
- In accordance with WSSD (2002) paragraph 58g the sub-system should develop community-based initiatives on sustainable tourism and build the capacities necessary to diversify tourism products, while protecting culture and traditions and effectively conserving and managing natural resources.

Actions at regional level

- Reach an agreement among the governments in the Small Islands sub-system, for the creation of special protection areas and development areas.
- Update regional cooperation agreements between the countries with a view to ensuring sustainable management of the international waters of the Small Islands sub-system.
- Reform and establish new institutional mechanisms for cooperation and consultation so that aquatic resources can be a catalyst for balanced regional development. For example, the sharing of information and best practices for the management and planning of the region's protected areas.
- Rehabilitate and develop a permanent network, to monitor water, the environment and the way they are exploited, and to provide better knowledge of the way in which the hydro systems function.
- Initiate an agreement for international environmental standards regarding effluent discharges and water quality (both marine and freshwater).
- Design and implement data collection and management system to make informed planning and management decisions. Essential links should be created between research programmes, biodiversity programmes, the fight against habitat degradation and modifications in international waters. This should include the further use of Geographic Information Systems (GIS) in coastal zone management.
- Promote and facilitate at the national level and regional level the ratification/accession to the Cartagena Convention and its protocols; the Oil Spills Protocol, the Specially Protected Areas and Wildlife (SPAW) Protocol and the Protocol on Land-Based Sources.

Actions at global level

To implement with special emphasis World Summit on Sustainable Development (WSSD 2002) from recommendations according to the Framework for Action on Biodiversity and Ecosystem Management, especially:

- Building capacities and technology sharing and scaling up outstanding examples of best practices of rural communities throughout the developing world.
- Building capacities at the local level and empowering local communities to take action as it is at the local level where stress on biodiversity occurs.

- Building partnerships among governments, business, farmers, and local communities as this is the best way to mainstream biodiversity concerns into economic and social activity.
- Look for international cooperation sources that support the establishment of natural resources control and monitoring teams.
- Identify networks of scientific information exchange about natural resources rational use.

Performance of the policy option

Effectiveness

Option impact

The policy option directly addresses the root causes of Inappropriate development strategies and insufficient collection and management of data, by strengthening the capacity of regional and national institutions, and initiating the collection, management and exchange of data. This will allow the design of a strategic coastal management plan.

The primary regional benefits of the option would be stronger institutions for the decision making process at the regional, national and local level. This should result in coordinated decision making, local communities more empowered to manage their environment and effective mechanisms to implement regional policies at the local level for managing natural resources and reversing the trend of habitat degradation.

Institutional strengthening will encourage inter-sectoral harmonisation of economic and environmental policies, thereby facilitating sustainable development and better preparing the islands to attract donor support and investment. There will be improved coordination and environmental planning as the mechanisms established will allow the harmonisation of economic activities and the enhancement of human resources should give rise to the effective implementation of further environmental initiatives. A strategic development plan will enable the countries of the Small Islands sub-system to evaluate, on a continuous and scientific basis, the break-down of costs, benefits and environmental impacts of proposed development works.

This policy will open dialogue between authorities and communities through a stakeholder participatory process, which will involve communities in monitoring and management of natural resources. Stakeholders will be actively encouraged to participate through links to national institutions that will bring them into the decision-making process.

Result if positive conditions

The results are: (i) plan for institutional, human, and legal strengthening; (ii) national planning in coastal and marine zone; (iii) regional planning in coastal and marine zones; (iv) greater participation of stakeholders including the economic sectors and civil society in decision-making, through more efficient communication mechanisms; (v) monitoring and control networks; (vi) versatile information systems, in agreement with society demands; (vii) improved population awareness of the need to conserve natural resources; (viii) harmonisation of legal instruments at national level; (ix) harmonisation of legislation at regional level; (x) establishment of protected areas enforced by legislation; and (xi) strategies for human resource training.

Success probability

The governments have shown a commitment to sustainable development, and have now began to realise the necessity of preserving their environment especially for the success of tourism which has become increasingly important in the region. It is therefore anticipated that there will be greater willingness to incorporate environmental policies in national agendas and implement the principles outlined in the policy option. However, there are many difficulties and it is unknown whether governments will forfeit short-term economic gains for sustainable development. Periods of economic instability may jeopardise public and political commitment to such a policy option, as poverty and unemployment forces the population to exploit resources at an unsustainable rate for their short-term survival. There will be a need to work within existing regional mechanisms to ensure long-term capacity to harmonise national polices at the regional level. The success probability is moderate, due to obstacles, risks and difficulties.

Obstacles and risks

The principal risks and obstacles to fulfilling the aims of this option are: (i) difficulty in harmonising inter-institutional environmental and economic policies; (ii) coordination of diverse institutional functions; (iii) lack of political will to harmonise plans and projects; (iv) information availability; (v) deficient communication channels at local, national and regional levels; (vi) difficulties in making national legislative and regulatory changes in order to harmonise at the national and regional level; vii) financial feasibility; and viii) willingness of all stakeholders to participate.

Efficiency

Benefits

The benefits of the policy option will be: (i) improvement of environmental goods and services management and control, as

consequence of strong institutions; (ii) development of participative democracy in the decision-making process; (iii) efficient and efficacious harmonisation of national and inter-sectoral public policies; (iv) population more environmentally aware; and (v) greater capacity in institutions for improved decision making at all levels.

Costs

Financial costs will be incurred from the: (i) professional improvement programmes; (ii) harmonisation of national legal instruments; (iii) design and development of environmental monitoring and control networks; (iv) design and development of information systems, data bases and GIS; (v) construction of national and regional coastal zone management plans; (vi) development of environmental education programmes and use of the media; and (vii) analyse institutional functions and capacity.

Benefits and costs quantitative estimations

There are some references about that on other studies funded by UNEP, Inter-American Development Bank (BID), World Bank and GEF.

Equity

Net winners and losers

Winners are the Caribbean, the region's states and inhabitants of the region as a result of an enhanced quality of life and the long-term security of environmental goods and services. Losers are sectors that unsustainably exploit resources and degrade the environment for their short-term benefit, for example, some agro-business and tourist enterprises.

Funding

The national governments at all levels, the sectors involved on environmental resources management and international organisations interested in environment preservation.

Justification of selected options

The option's benefits have high possibilities of being higher than the losses since one of the principal root causes of environmental damage in the Small Islands sub-system is weak governance, related to weak institutional capacity for an adequate organisation of sustainable development environmental and economical policies. It is predicted that the benefits provided following the successful implementation of the policy option would justify the economic costs. Strengthening the capacity of institutions is a prerequisite for implementation of further initiatives, will enable effective management of natural resources and will move the region towards more sustainable development. There should be a high return on capital invested in the medium to long-term, as economic activities will be stimulated, particularly tourism, as a result of a healthier ecosystems.

Compensation instruments

Compensation instruments must be applied in the case that environmental restrictions severely affect employment or inhabitant's income in the area (as in the case of agriculture and tourism industries). In that case, the possibility to establish professional and technological cooperation programmes should be studied.

Political viability

Net allies and opponents

Groups that are likely to support the policy instruments include: base communities, non-governmental organisations, international organisations, state entities (Martinique, Water Society of Martinique; Monserrat, Monserrat Water Authority and the Land Development Authority; Netherlands Antilles, Ministry of Development and Cooperation; Saint Kitts and Nevis, Ministry of Communications Works and Public Utilities; St Lucia Ministry of Tourism, Mobilization and Public Services; Water and Sewerage Authority; Ministry of Planning, Personnel, Establishment and Training; St Vincent and Grenadines, Ministry of Health and the Environment, Ministry of Agriculture, Industry and Labour, Central Water and Sewage Authority, the Physical Planning and Development Board; Trinidad and Tobago, Ministry of Planning and Development, Ministry of Food Production and Marine Exploitation, Water Sewage Authority; Antigua & Barbuda, Ministry of Tourism and Environment, Development Control Authority; Aruba, Aruba Water Agency; Barbados, Barbados Water Authority; Turks & Caicos, Departments of Water Supply and Environmental Health)

Opponents are: economic sectors, farmers, fisheries, and tourism enterprises. They come from powerful economic sectors, especially farmers, that have not taken into account exploitation costs in the productive processes; their fear is probably related to the increase of their final product price when they assume the exploitation costs, situation that could decrease their competitive capacity in markets where consumers do not care about environmental degradation, and some enterprises of tourism and mining.

It is possible that some actions to obstruct the development of these initiatives may be taken through political influence, since the options implementation needs investment, political will and awareness, as well as public administration changes.

Possibility to implement the instrument

There are presently institutional arrangements for the land-use management at the national level, which the policy option could be implemented through. However environmental management is fragmented between many institutions within each country, without a single institution to act as a focal point. Institutional reform may be necessary, which may not be politically feasible.

Conflict resolution

It is necessary to guarantee the participation of all stakeholders involved in coastal activities and to design conflict resolution mechanisms. Through a consultative process with relevant stakeholders a regional coastal management plan can be formulated.

Management capacity

Capacity and resources to develop the recommendation

The Caribbean Community and Common Market (CARICOM) is the principal regional programme to facilitate this policy option. In addition, some countries have programmes based on sustainable development principles, for example, in Barbados, mining activities are being regulated and renewable energy technologies developed. These programmes can be used to promote the compatibility of economic growth and environmental protection to other countries in the region.

Capacity building requirement

The islands need: (i) better understanding and application of sustainable development by state personnel and local communities; (ii) more inter-institutional coordination is needed at national and regional level to determine control and management measures; (iii) enhanced mechanisms for civil society participation in decisions-making; (iv) personnel training in monitoring and data management; and (v) improvements in dissemination and availability of scientific research.

Political commitment

Governments must remain committed to achieving sustainable development by withstanding pressures from industrial sectors lobbying for fewer environmental regulations and not being deterred by the capital investment required.

Policy option 2: Strategic regional plan for integrated coastal and marine management

This policy option aims to formulate and implement a Strategic Regional Plan of Integrated Coastal and Marine Management, to allow and support the combination and execution of different planning forms that include physical, environmental, socio-economic, administrative and land use planning, ensuring the environmental stability.

Justification

There are close inter-linkages between marine ecosystem management and overall land and water use planning and development for small islands. Coastal and marine management therefore needs to integrate land and water use policies and management including land tenure and rights of access, appropriate zoning based on land capability, implementation of coastal zone management plans and policies, carrying capacity assessments, determination of limits of acceptable change for critical marine ecosystems, legal demarcation of marine reserves and protected areas, and restoration and/or enhancement of critical terrestrial and coastal habitats.

The planning and implementation of a Strategic Regional Plan for Integrated Coastal and Marine Management, will require institutional capacity building, training and improved information technology/ data collection and analysis for natural resources management, greater stakeholder participation from planning to implementation, and greater consideration of the real value (economic valuation) of coastal and marine resources to social and economic development. It is therefore recommended that Policy option 1: Strengthening of resource management institutions be implemented before a Strategic Plan is created.

In this policy option a more integrated approach to national development planning will be required; involving all relevant sectors and stakeholders as the primary toll to achieve sustainable development for the Caribbean Small Islands. It is recommended that mechanisms be put in place to rationalise and harmonise the existing institutional, policy and legislative instruments relevant to the management of marine ecosystems within and across sectors. This will require a more integrated approach to national development planning involving all relevant sectors and stakeholders as the primary tool to achieving sustainable development for Caribbean Small Islands.

Actions at local level

- Consult all stakeholders: public sector, private sector, NGOs and civil society to formulate national long-term vision, objectives and goals for sustainable development.
- Identify most appropriate mechanism(s) for integration and coordination of sector policies, programmes and plans.
- Design and implement a comprehensive land and water resource management policy.
- Promote the registration of land ownership, tenure and rights of access especially on the use of coastal lands and on the conservation of protected areas on private lands.
- Develop appropriate incentives and coordinating mechanisms to facilitate co-management of resources especially those requiring protection that are located on private lands.
- Develop methodology for prioritisation of policies, projects and plans – need for training in policy analysis.
- Encourage legal demarcation of marine reserves and protected areas.
- Create further public awareness and education programmes at all levels.
- Ensure a high level of political endorsement and ministerial commitment.
- Establish permanent national coordinating committees and appropriate technical sub-committees e.g. National Sustainable Development Councils. This committee should have a specific legal mandate to coordinate the Integrated Development Planning (IDP) process.
- Conduct/update policy and legislative evaluations of sector policies and strategies to identify gaps, overlaps and conflicts as well as laws and regulations to update and harmonise as appropriate.
- Identify, as appropriate, at the national level, alternative economic livelihoods, technologies, methods and practices to those that presently impact negatively on the coastal and marine environment.
- Formulate National Sustainable Development Strategies (NSDS) to guide future sector policy development and ensure integration of sector activities based on vision, long-term objectives and immediate priorities.
- Develop and apply vulnerability indices for Caribbean Small Island states.
- Support ratification and effective implementation of the Land-Based Sources of Marine Pollution protocol of the Cartagena Conventions by all countries of the Wider Caribbean Region (specific barriers to implementation such as policy, institutional, technical, legal, and capacity building requirements would have to be addressed at the national and/or regional levels).
- Meet obligations of other relevant regional and international environmental agreements including MARPOL 73/78 Convention, BASEL Convention on Hazardous wastes, London Dumping Convention, Cartagena Convention and the Specially Protected Areas and Wildlife (SPAW) and Oil Spills Protocols, and the IMO Civil Liabilities and Fund Convention. (Specific barriers to implementation are: Policy, Institutional, Technical, Legal; and capacity building requirements would have to be addressed at the national and/or regional levels).
- Establish linkages and be complementary to existing projects such as the GEF Caribbean International Waters project on Integrating Management of Watersheds and Coastal Areas in Small Island Developing States in the Caribbean and the proposed GEF/OECS Biodiversity project on Sustainable Livelihoods.

Actions at regional level

- Identify appropriate regional economic, environmental and social indicators of sustainable development.
- Produce a register of institutions and human resources concerned with environmental and coastal management.
- Strengthen spatial decision making systems i.e. the use of GIS, satellite imagery etc. in assessing land capability, land zoning, and pollution impacts including changes in the coast line and identifying limits of acceptable change for selected coastal and marine resources.
- Identify and map areas of high risk for development because of the potential impact on coastal and marine habitats and ecosystems.
- Conduct a comprehensive inventory of, the type, location, extent and status of marine resources and analyse the impacts of coastal activities. These parameters should be incorporated into a GIS to be utilised in the decision-making process.
- Develop and/or strengthen sub-regional and regional monitoring and enforcement mechanisms to detect incidences of pollution and/or habitat modification e.g. Caribbean Port State Control.
- Develop and/or strengthen sub-regional and regional mechanisms for data gathering, compilation, analysis and sharing of information on pollution incidents, maritime traffic and damage to coastal and marine ecosystems between countries of the region.
- Support ongoing efforts to conduct regional/sub-regional assessments and inventories of the type, location, extent, status and potential threats to existing coastal and marine biodiversity and ecosystems. This should include development of environmental sensitivity mapping of these areas and an assessment of the economic value of these resources to the region.
- Conduct public awareness and education programmes at all levels.

- Assure effective implementation of the obligations of relevant conventions and protocols such as the Land-Based Sources of Marine Pollution Protocol (LBSMP) of the Cartagena Convention and improved compliance, will be an effective mechanism for controlling transboundary impacts including the discharge of untreated sewage and other non-point sources of pollution from continental land masses.
- Strengthen Agenda 21 commitments, Chapter 36 related to public participation.
- Promote and facilitate at the national level and regional level the ratification/accession to the Cartagena Convention, the Oil Spills Protocol, the Specially Protected Areas and Wildlife Protocol and the Protocol on Land-Based Sources.
- Implement with special interest the World Summit on Sustainable Development (WSSD 2002) recommendations, paragraphs 73 and 74. Paragraph 73 recognises the importance of regional actions towards sustainable development and takes into account the region's singularities, shared visions and cultural diversity. It is targeted towards the adoption of concrete actions in different areas of sustainable development, such as biodiversity, water resources, vulnerabilities and sustainable cities, social aspects, including health and poverty, economic aspects, including energy, and institutional arrangements, including capacity-building, indicators and participation of civil society, taking into account ethics for sustainable development. Paragraph 74 envisages the development of actions among countries in the region that may foster south-south cooperation and may count with the support of groups of countries, as well as multilateral and regional organisations, including financial institutions.

Actions at global level

- Support implementation of sub-regional and regional sustainable development policies such as Organization of Eastern Caribbean States (OECS) St. George's Declaration of Principles of Environmental Sustainability and Barbados SIDS Program of Action. This Declaration constitutes the basis of the relations of peace, fiendship and cooperation between Dominica, Grenada and Saint Lucia, regarding different subjects realted to the Caribbean region. Appropriate regional agencies and mechanisms should be created and/or strengthened to facilitate this.
- Support the proposal by Caribbean countries to the United Nations to declare the Caribbean Sea as a Special Area in the context of sustainable development.

Performance of the policy option

Effectiveness

Option impact

This policy option could have a high impact since it is related to one of the principal needs of the small islands: to make a general management plan that allows to organise economical activities and define environmental protection areas on the basis of a legal framework. Additionally, the establishment of such a plan will clearly define the responsibilities of the relevant authorities and the principal mechanisms to coordinate the formulation and implementation of policies. Finally, this option will embrace public participation and consultation in decisions-making.

Result levels on positive, normal and negative conditions

The results are: (i) regional strategic plan for marine and coastal resources management; (ii) efficient land and water resource management policies; (iii) efficient co-management of resources; (iv) legal demarcation of marine reserves and protected areas; (v) increased stakeholder participation; (vi) development of clean technologies; (vii) system for data collection; and (viii) control and monitoring networks.

Success probability

The success probability is moderated, due to the obstacles, risks and difficulties noted below. For the policy option to be successful many of these difficulties will have to be addressed, and trade-offs made, through a consultative process.

Obstacles and risks

The obstacles and risks are: (i) difficulties in integrating the political interests and diverse socio-economic and environment characteristics of each country in the region; (ii) potential conflicts among national stakeholders involved in natural resources management, as well as among the environmental authorities of the region; (iii) limited economic resources; (iv) complex design of inter-sectorial efficient coordination mechanisms at local and regional levels; (v) fragmented and limited legislation; (vi) lack of information regarding natural resources and the status of ecosystems; and (vii) limited technological capacity for environmental resources monitoring and management.

Efficiency

Benefits:

The benefits are: (i) a decrease in further habitat modification; (ii) greater sustainable use of resources; (iii) sustained economic development; (iv) development of participative democracy; (v) efficient and efficacious harmonisation of national and inter-sectoral public policies; (vi) improvement of the sub-regional integration and resources

optimisation; and (vii) legal harmonisation of instruments and definition of institutional competences and responsibilities among political institutions involved in natural resources management and control.

Costs

The costs are: (i) design and implementation of Strategic Regional Plan for integrated coastal and marine zones management; (ii) design and development of educative campaign for public awareness; (iii) design and development of information systems, and data bases; and (iv) use of GIS, satellite imagery, etc.

Quantitative estimations of benefits and costs

There are some references about projects funded by the Biocommerce Initiative of UNCTAD (Los Andes Promotion Corporation), the Andes Promotion Corporation, among others. The Biotrade initiative was launched by UNCTAD during the third Conference of the Parties (COP III) of the Convention Biological Diversity in Buenos Aires on 1996. Its objective is to stimulate trade and investment on biological resources driving sustainable development. With this aim, Biotrade is looking for to ameliorate underdeveloped countries´ capacity on biodiversity sustainable use, traiding new goods and services, with more aggregated value for national and international markets (IAvH 2000).

Equity

Winners and losers

Winners are the involved states and the communities that participate in the projects. Losers are sectors not making investments in green products since they will have less income if green products become more desirable, sectors that exploit the resources unreasonably, traditional producers, agricultural products producers, tourism and mining enterprises.

Funding

The national governments at all levels, communities, private sectors involved in the sub-system's environmental resources, and international organisations interested on environment preservation and promotion of green markets.

Justification of the selected option

The principal advantage of adopting this policy option is that it gives more possibilities of environmental resources conservation, since it integrates marine and coastal resources management in one plan, which is the principal tool to clearly establish governmental stakeholders competences involved in natural resources management and control. In the same way, through a regional plan there is optimisation of resources, especially monitoring technologies and human resources. In this kind of plan there is active civil society stakeholders participation, then, this option supports democratic participation processes strengthening.

Compensation instruments

Considering that it is possible to have a socio-economical impact, the policy can study the possibility to train the communities on use and research of cleaner technologies, in order to find more competitiveness in green markets. The compensation instruments facing a possible socio-economical impact of using and trading green products, could include stakeholders training to be more competitive in the new market of green products; there could be also training on use and research on cleaner technologies to complement the offer of green products; governmental funding for green products and green markets is another possibility.

Political viability

Net allies and opponents:

Groups that are likely to support the policy instruments inlcude: base communities, non-governmental organisations, international organisations, State entities (Martinique, Water Society of Martinique; Monserrat, Monserrat Water Authority and the Land Development Authority; Netherlands Antilles, Ministry of Development and Cooperation; Saint Kitts and Nevis, Ministry of Communications Works and Public Utilities; St Lucia Ministry of Tourism, Mobilization and Public Services; Water and Sewerage Authority; Ministry of Planning, Personnel, Establishment and Training; St Vincent and Grenadines, Ministry of Health and the Environment, Ministry of Agriculture, Industry and Labour, Central Water and Sewage Authority, the Physical Planning and Development Board; Trinidad and Tobago, Ministry of Planning and Development, Ministry of Food Production and Marine Exploitation, Water Sewage Authority; Antigua & Barbuda, Ministry of Tourism and Environment, Development Control Authority; Aruba, Aruba Water Agency; Barbados, Barbados Water Authority; Turks & Caicos, Departments of Water Supply and Environmental Health)

Opponents are: economic sectors, farmers, fisheries, enterprises of tourism. Affected are economical sectors, such as agriculture, mining, fisheries, and enterprises of tourism.

It is possible that some actions to obstruct the development of this initiative may be taken, through political and economical influence.

Possibility to implement the instrument

Studies in the region have reported the need to establish a hydrological and land regional management plan (CATHALAC 1999). Furthermore, the experts of the small islands have observed that Integrated

Management of Coastal and Marine Zones could be a good strategy for ameliorating resources administration and conservation.

Conflict resolution

To avoid disputes and resolve conflict: (i) awareness campaign to increase involvement of stakeholders in the design of the strategic plan; and (ii) a consultative process where stakeholders can voice concerns.

Result if positive conditions

At the political level it is expected that the plan will integrate the islands´ coastal and marine management policies. At the sub-regional level, better coordination for efficient implementation of regional marine and coastal environmental policies. At the environmental level reduction in environmental degradation is expected, through change of agricultural, mining and tourism sectors that offer sustainable environmental goods and services. At the socio-economic level better income and better socio-economic development.

Management capacity

Capacity and resources required to develop the recommendation: (i) establish a data base to identify human and institutional personnel that is in charge in each island of marine and coastal resource regulation; (ii) ameliorate the quality of the information systems related to resources control and monitoring; (iii) further sustainable production initiatives to reduce poverty levels; and (iv) design inter-institutional and inter-governmental coordination mechanisms.

Required institutional reforms

(i) Develop appropriate incentives and coordinating mechanisms to facilitate co-management of resources; (ii) more inter-institutional coordination is needed at national and regional level to determine control and management measures; (iii) enhanced mechanisms for civil society participation in decisions-making; (iv) human resource training for improved monitoring, data management and implementation of plan; and (v) greater dissemination and accessibility to scientific research.

Political commitment

Lack of political interest on the need to preserve natural resources and to take necessary action to make it; little financial resources to cover the costs of the policy; different systems of government and public administration that could affect the efficiency of intergovernmental coordination mechanisms.

The policy option will require significant political commitment from all of the region's countries. This may prove problematic as there the policy requires considerable investment, and the countries of the region have various political and legislative frameworks regarding the environment which may prove difficult to integrate.

Conclusions

Although this section made only a preliminary analysis of conceptual ideas and actions, it is considered that both policy options are promising. It is evident that the countries of the region are finding it difficult to harmonise the need for economic growth with the protection and conservation of their limited resources. The implementation of Policy option 1 will build capacity in relevant institutions, in order to better implement environmental policies and establish legal instruments for mitigating and reversing degradation trends in the Small Islands sub-system. This will promote sectoral harmonisation in the management of natural resources.

Policy option 2 aims to create a Strategic Regional Plan for Integrated Coastal and Marine Management. Integration of environmental management at the regional level would mutually benefit all of the countries in the sub-system, due to the transboundary nature of many environmental problems. The plan will organise economic activities and define environmental protection areas on the basis of a legal framework. The responsibilities of the relevant authorities and the principal mechanisms to coordinate the formulation and implementation of policies will be defined in the Strategic Plan. The use of environmental management resources will be optimised, through the sharing of information, human resources and monitoring techniques.

It is recommended that more detailed analysis be undertaken in order to develop the policy options further. It is anticipated that by addressing the root causes identified in the Causal chain analysis through the implementation of these policy options, the management of the region's aquatic resources will be significantly enhanced.

References

Alm, A., Blommestein, E. and Broadus, J.M. (1993). Climatic changes and socio-economic impacts. In: Maul, G.A. (ed.) Climatic Change in the Intra-Americas Sea Edward Arnold, London, United Kingdom. p 333-349.

Anguilla Goverment (2002). Anguilla Census 2001. People data, Demography & Culture, Persons by Broad Age Groups Censuses 1960, 1974,1 984, 1992 and 2001. Retrieved March 2004 from: http://www.gov.ai/statistics/census/Demography%20&%20Culture%20tables.htm

Bernal, P. and Cisin-Sain, B. (ed.) (2001). The global conference on oceans and coasts. Reports of the conference working groups. December 3-7, 2001. UNESCO. Paris.

Bjorn, K. (1997). Caribbean coral reef, seagrass and mangrove sites. UNESCO, France.

Bryant, D., Burke, L., McManus, J.W. and Spalding, M. (1998). Reefs at Risk: A map-based indicator of threats to the world's coral reefs. World Resource institute. Retrieved June 2003 from: http://wri.igc.org/reefsatrisk/

Burke, L. and Maidens, J. (2004). Reefs at Risk in the Caribbean. World Resource Institute. Washington, DC.

Bush, P. G. (1998). Grand Cayman, British West Indies. In Kjerfve, B. (ed.) Caribbean coral reef, seagrass and mangrove sites. UNESCO, Paris. p 35-41.

BVI (British Virgin Islands) (2002). About the British Virgin Islands. Retrieved May 2003 from: http://www.britishvirginislands.com/info.htm

Caribbean Epidemiology Centre (2000). Annual Report 2000. Retrieved June 2003 from: http://www.carec.org/annrep00/index.html

Caribbean Tourism Organization (2002). Economic Tables 2. CTO Tourism Statistics & Statistical Publications. Retrieved Aug. 2004 from: http://www.onecaribbean.org/information/documentview.php?rowid=371

Caribbean Tourism Organization (2003). Key Tourism Statistics Volume 1, Issue 1. CTO Tourism Statistics & Statistical Publications. Retrieved Aug. 2004 from: http://www.onecaribbean.org/information/documentview.php?rowid=1059.

Caribbean Tourism Organization (2004). Stay Over and Cruise Arrivals - 2003 YTD1. CTO Tourism Statistics & Statistical Publications. Retrieved Aug. 2004 from: http://www.onecaribbean.org/information/documentview.php?rowid=571.

CATHALAC (1999). Vision on Water, Life and the Environment for the 21st Century. Regional Consultations. Central America and Caribbean. Water Center for the Humid Tropics of Latin America and the Caribbean. Panama City, Republic of Panama.

Causey, B., Delaney, J., Díaz, E., Dodge, D., Garcia, J.R., Higgins, J., Jaap, W., Matos, A.C., Schamahl, G.P., Rogers, C., Miller, M.W. and Turgeon, D.D. (2000). Status of Coral Reefs in the US Caribbean and Gulf of Mexico: Florida, Texas, Puerto Rico, US Virgin Islands and Mavassa. In: Wilkinson, I. and Australian Institute of Marine Sciences AIMS (eds.) Status of Coral Reefs of the World: 2000. GCRMN Report, Australian Institute of Marine Science, Townsville. .

Causey, B., Delaney, J., Díaz, E., Dodge, D., Garcia, J.R., Higgins, J., Jaap, W., Matos, A.C., Schamahl, G.P., Rogers, C., Miller, M.W. and Turgeon, D.D. (2002) . Status of Coral Reefs in the U.S. Caribbean and Gulf of Mexico: Florida, Texas, Puerto Rico, US Virgin Islands, Navassa. In: C.R. Wilkinson (ed.) Status of coral reefs of the world:2002. GCRMN Report, Australian Institute of Marine Science, Townsville. Chapter 14, p 251-276.

CEHI (2003). Environmental health. Caribbean Environment Health Institute. Retrieved May 2003 from: http://198.173.244.33/infosources/publications/cch/envheal.pdf

Center for Research on the Epidemiology of Disasters (2004). EM-DAT: The OFDA/CRED International Disaster Database. Retrieved August 2004 from http://www.em-dat.net/.

CEP (2003). Caribbean Environmental Programme. Convenio para la protección y desarrollo del medio marino en la región del gran Caribe (convenio de Cartagena). Retrieved May 2003 from: http://www.cep.unep.org/pubs/legislation/cartxt_esp.html (In Spanish)

CEPS/OECS (2002). OECS Tourism. Retrieved May 2003 from: http://www.cpechrd.org/oecstourism.htm

CIA (2001). The World Factbook 2001. Retrieved March 2004 from: http://www.cia.gov/cia/download2001.htm

CIA (2004). The World Factbook 2004. Trinidad and Tobago. Environment current issues. Retrieved March 2004 from: http://www.cia.gov/cia/publications/factbook/geos/td.html

Cicin-Sain, B., Bernal, P., Vandeweerd, V., Belfiore, S. and Goldstein, K. (2002). A Guide to Oceans, Coasts, and Islands at the World Summit on Sustainable Development. Center for the Study of Marine Policy, Newark, Delaware.

Colmore, S. (1999). Bananas, biodiversity and beauty. Our Planet. Small Islands. Retrieved June 2003 from: http://www.ourplanet.com/imgversn/103/11_bio.htm

Cooper, B. and Bowen, V. (2001). Integrating management of watersheds & coastal areas in small developing states of the Caribbean. National report for Antigua & Barbuda. Environment Division, Ministry of Tourism and Environment, Antigua & Barbuda.

Cox, C. (n.d). Perspective on rural land management and soil and water conservation in St. Lucia. Ministry of Agriculture, Forestry and Fisheries, St. Lucia. Retrieved Oct. 2004 from: http://www.slumaffe.org/rural_land_management.pdf

CPACC (2000). Caribbean Planning and Adaptation to Global Climate Change. Regional Project Implementation Unit Lazaretto Complex St. Michael, Barbados. Retrived May 2003 from: http://www.cpacc.org/aboutframe.htm

Department of Fisheries St. Lucia (2003a). Beach Profile Database. Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries. Saint Lucia.

Department of Fisheries St. Lucia (2003b). Coastal Resources Inventory System. Department of Fisheries, Ministry of Agriculture, Forestry and Fisheries. Saint Lucia.

DPNR/DEP and USDA/NRCS (1998). Unified Watershed Assessment Report - United States Virgin Islands. Virgin Islands Department of Planning and Natural Resources in cooperation with USDA Natural Resources Conservation Service, Caribbean Area, St. Croix, USVI.

DPNR/DEP (2002). The 2002 Integrated Water Quality Monitoring and Assessment Report. Submitted by the Division of Environmental Protection, Department of Planning and Natural Resources, Government of the Virgin Islands of the United States.

DPU (2002). The Development Planning Unit, Government of British Virgin Islands. Populations and demographics. Retrieved February 2004 from: http://dpu.gov.vg/AboutOurCountry/People.htm

Dutch Caribbean (2000). The Netherlands Antilles. Retrieved May 2003 from: http://www.dutch-caribbean.net/

ECLAC (2000). The Vulnerability of Small Island Developing States of the Caribbean, LC/CAR/G.588. Port of Spain, Trinidad and Tobago.

EPA (2004). Hovensa, LLC. Retrieved Aug. 2004 from: http://www.epa.gov/region02/waste/fshoven.pdf

Family Education Network (2003). Guadeloupe. Retrieved May 2003 from: http://www.infoplease.com/ipa/A0107545.html

FAO (2000). Information about countries of the world. Retrieved May 2003 from: http://www.fao.org

FAO FISHSTAT (2003). FAO Yearbook 2003, Fishery Statistics, Commodities 2002, Vol.95. Retrieved August 2004 from http://www.fao.org/fi/statist/fisoft/fishplus.asp

Farell, B. (1997). Natural and anthropogenic causes of beachfront erosion in St. Kitts. In: Cambers G. (ed). Managing beach resources in the smaller Caribbean islands. UNESCO, Puerto Rico. p 18-22.

Farquhar, D. and Joseph, G. (1997). Modern versus traditional uses in Antigua & Barbuda: a case study for the establishment of permanent landing sites, the Lignumvitae Bay experience. In: Cambers G. (ed.) Managing beach resources in the smaller Caribbean islands. UNESCO, Puerto Rico. p 167-170.

Gabrie, C. and Moyne-Pickard, G.C. (1999). La Martinique. French coral reef initiative IFRECOR. Retrieved May 2003 from: http://www.environnement.gouv.fr/ifrecor/domtom/matdma.htm

GEF/CEHI/CARICOM/UNEP (2001). Integrating watershed and coastal area management in Small Island Developing States of the Caribbean. Retrieved June 2003 from: http://www.cep.unep.org/programmes/amep/GEF-IWCAM/SynthesisReport/FinalRegSynthesis.doc

GESAMP (2001). Protegiendo los océanos frente a las actividades realizadas en tierra- fuentes y actividades de origen terrestre que afectan la calidad y los usos del medio marino, costero y dulceacuícolas asociados. Estudio e informes No. 71. Grupo Mixto De Aspectos Sobre Los Aspectos Científicos De La Protección Del Medio Marino y ACOPS. (In Spanish).

Goreau, T.J., Cervino, J., Goreau, M., Smith, G., Hayes, R., Richardson, L., Williams, E., Nagelkerken, I., Porter, J., Porter, K., Garzon-Ferreira, J., Quirolo, C., McField, M., Gil, D., Bruckner, A., Santavy, D., Peters, E., Littler, M., Littler, D., Patterson, K., Mueller, E. and Campbell, J. (1997). Rapid Spread of Diseases in Caribbean Coral Reefs. Costa Rica AMLC Draft September 17.

Government of Saint Lucia (2001). Compendium of Environmental Statistics. The Government Statistics Department and the Sustainable Development & Environment Department of the Ministry of Physical Development, Environment and Housing.

Governement of Saint Lucia (2002). Coastal zone management in Saint Lucia: Policy, guidelines and selected projects. Ministry of Agriculture, Forestry and Fisheries of Saint Lucia.

Gyory, J., Mariano A.J. and Ryan E.H. (2004). The Caribbean Current. RSMAS Rosenstiel School of Marine Sciences (University of Miami). Retrieved May 2004 from: http://oceancurrents.rsmas.miami.edu/caribbean/caribbean.html.

Hinrichsen, D. (1998). Coastal waters on the world. Trends, threats and strategies. Island Press, Washington.

Interknowledge Corp. (2002). Bonaire Dutch Caribbean. Retrieved May 2003 from: http://www.geographia.com/bonaire/

IavH (2000). Biocomercio: estrategias para el desarrollo sostenible de Colombia. Bogotá Instituto Humboldt. Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt. (In Spanish).

IOCARIBE (2002) International Oceanographic Commission for the Caribbean. IOCARIBE members. Retrieved Janyary 2003 from: http://ioc.unesco.org/iocaribe/

IPCC (1997). The Regional Impacts of Climate Change: An Assessment of Vulnerability. A Special Report of IPCC Working group II. Watson, R.T., Zinyowera, M.C. and Moss R.H. (eds). Cambridge University Press, UK. Chapter 9 Small Island States.

IPCC (1998). IPCC Special Report on the Regional Impacts of Climate Change: An Assessment of Vulnerability. Chapter 9: Small Island States. Retrieved May 2003 from: http://www.grida.no/climate/ipcc/regional/255.htm

Ismael, L. (1998). Small Island Developing States Programme of Action for Sustainable Development: Opportunities and Constraints. Keynote Address for Seminar on Small Island Developing States: Their Vulnerability, Their Program of Action for Sustainable Development, Their Opportunities for Post-Lomé. Brussels 1-2 September. United Nations ECLAC Subregional Headquarters for the Caribbean.

IUCN (2003). United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea. The World Conservation Union, IUCN, Schwitzerland.

James, A. (1997). The impact of recent tropical storms and hurricanes on Dominica´s beaches. In: Cambers, G. (ed). Managing beach resources in the smaller Caribbean islands. UNESCO, Puerto Rico. p 36-41.

Khaka, E. (1998). Small islands, big problems. Our Planet, 9. 4 March. Retrieved May 2003 from: http://www.ourplanet.com/imgversn/94/khaka.html.

Landscan (2001). Oak Ridge National Laboratory (ORNL). Retrived Sept. 2003 from: http://www.ornl.gov/gist/landscan/index.html

Linton, D.M. and Warner, G.F. (2003). Biological indicators in the Caribbean coastal zone and their role in integrated coastal management. Ocean and coastal management 46:261-276.

Meyer, K. (1997). Bonaire, Netherlands Antilles. In: Kjerfe, B. (ed.) Caribbean coral reef, seagrass and mangrove sites. UNESCO, Paris. p 141-149.

Moyne-Pickard, G.C. (ed). (1999). La Martinique. French coral reef initiative IFRECOR. Retrieved May 2003 from: http://www.environnement.gouv.fr/ifrecor/domtom/matdma.htm

MPDEH (2001). Saint Lucia National Report to the World Summit of Development. Ministry of Planning, Development, Environment and Housing of Saint Lucia.

MPDEH (2002). Saint Lucia's Initial National Communication on CLimate Change. Retrieved June 2003 from: http://unfcc.int/resource/docs/natc/lucnc1.pdf

NIMA (2000). Atlas of Pilot Chart: North Atlantic Ocean Defense mapping Agency. National Imagery and Mapping Agency. Secretary of Defence, US. NVPUB106.

NOAA (2004). Historical North Atlantic and East/Central North Pacific Tropical Cyclone Tracks, 1851-2003. Retrieved May 2004 from http://hurricane.csc.noaa.gov/hurricanes/

Ocean Conservancy (2002). Cruise Control – A report on how cruise ships affect the marine environment. Ocean Conservancy. Retrieved Oct. 2004 from: http://www.oceanconservancy.org/site/DocServer/cruisecontrol.pdf?docID=141

OECS (2001). Organization of the Eastern Caribbean States Islands information. Retrived May 2003 from: http://www.caribisles.org/caribbean/

OECS/SSWSSD (2002). Organization of the Eastern Caribbean States and World Summit on Sustainable Development. Retrieved May 2003 from: http://www.sidsnet.org/docshare/other/WSSD2002/

Office of the Prime Minister (2001). Antigua and Barbuda's First National Report to the Convention on Biological Diversity. St. John's, Antigua and Barbuda. March 2001. Prepared under UNDP Project ANT/97/G31/1G Biodiversity Enabling Activity Project.

Organization of American States (2001). Draft synthesis on trends in freshwater and coastal area resources in Small Island Developing States of the Caribbean. Unit for Sustainable Development and Environment of the Organization of American States.

PAHO (1999). Basic Country Health Profiles for the Americas 1999, Summaries. Retrieved June 2003 from: http://165.158.1.110/english/sha/profiles.htm

PAHO (2000). Fish Mortality in Southeastern Caribbean Countries. Epidemiological Bulletin, 21:2. Pan American Health Organization.

PAHO (2002). Basic Country Health Profiles for the Americas 2002, Summaries Regional. Retrieved Oct. 2004 from: http://newweb.www.paho.org/English/DD/AIS/cp_index.htm

PCA (1999). Annual report. Pesticides Control Authority, Government of Jamaica. Retrived Aug. 2004 from: http://www.caribpesticides.net/countries/jm/annual_report99.pdf

PNUMA (1999). Evaluación sobre las Fuentes Terrestres y Actividades que Afectan al Medio Marino, Costero y de Aguas Dulces Asociadas en la Región del Gran Caribe. Informes y Estudios del Programa de Mares Regionales del PNUMA No 172. PNUMA,Oficina de Coordinación del PAM, Programa Ambiental del Caribe. (In Spanish).

Pors, L.P. and Nagelkerken, I.A. (1998). Curaçao Antilles. In: Kjerfe, B. (ed.) Caribbean coral reef, seagrass and mangrove sites. UNESCO, Paris. p 127-139.

Porter, M. (1997). Beach sand mining in Saint Vincent and the Grenadines after the landmark decision of 1994. In: Cambers, G. (ed.). Managing beach resources in the smaller Caribbean islands. UNESCO, Puerto Rico. p 119-132.

Roach J. (2003). Caribbean Corals in Dire Trouble, Study Finds. National Geographic News, July 22.

Saint Lucia Fisheries Department (2004). Fisheries Statistics. Retrieved March 2004 from: http://www.slumaffe.org/Fisheries_Department/Fisheries_Statistics/fisheries_statistics.html

Sheppard, C. (2000). Seas at the millennium: an environmental evaluation. Regional chapters: Europe, the Americas and West Africa. Pergamon. The Netherlands. Volume I.

Smith, A.H., Archibald, M., Bailey, T., Bouchon, C., Brathwaite, A., Comacho, R., Goerge, S., Guiste, H., Hasting, M., James, P., Jeffrey-Appleton, C., De Meyer, K., Miller, A., Nurse, L., Petrovic, C. and Phillip, P. (2000). Status of the Coral Reefs in the Eastern caribbean: The OECS; Trinidad & Tobago, Barbados, The Netherlands Antilles and the French Caribbean. In: Wilkinson, I. and Australian Institute of Marine Sciences (AIMS) (eds.) Status of Coral Reefs of the World: 2000. Australia.

Tobias, W., Gomez, R. and Kojis, B. (2000). Three year summary report, April 1st 1997- March 1999. Cooperative fishery statistics program, Bureau of fisheries, Division of fish and wildlife, Department of planning and natural resources. US Virgin Islands.

UNEP (1991). Status of Desertification and Implementation of the United Nations Plan of Action to Combat Desertification. United Nations Environment Programme. Nairobi, Kenya.

UNEP (1994). Regional Overview of Land-based Sources of Pollution in the Wider Caribbean Region. CEP Technical Report No. 33. UNEP, Caribbean Environment Programme, Kingston, Jamaica.

UNEP (1996). Status of protected area systems inthe wider Caribbean. CEP Technical Report No. 36. UNEP, Caribbean Environment Programme, Kingston, Jamaica.

UNEP (1997). Global Environmental Outlook - 1. United Nations Environment Programme Global State of the Environment Report. New York, Oxford, Oxford University Press.

UNEP (1999a). Conservation of biological diversity in the Orinoco Delta Biosphere Reserve and lower Orinoco River basin. Project VEN/98/G41/1G/99.

UNEP (1999b). Caribbean Environment Outlook. Earthprint, UNEP.

UNEP (2000a). GEO Barbados State of the Environment. Retrieved May 2003 from: http://www.rolac.unep.mx/dewalac/esp/barbados.pdf

UNEP (2000b). GEO Latin America and The Caribbean: Global Environment Outlook 2000. Regional Office for Latin America and The Caribbean. United Nation Environment Programme, Mexico City. .

UNEP (2003). Global program of action for the protection of marine environment from land base activities. United Nations Regional Programme Coordinating Unit. Caribbean Environmental Programme.

UNEP/CEP (1983). Convention for the Protection and Development of the Marine Environement of the Wider Caribbean Region (Cartagena Convention).

UNEP/IETC (1997). Sourcebook of alternative technologies for freshwater augmentation in Latin America and the Caribbean. UNEP International Environmental Technology Center. Washington, D.C.

UNEP/WCMC (2003). Protected Areas (IUCN Classification). Retrieved Sept 2003 from: http://geodata.grid.unep.ch/

USVI (1998). Unified watershed assessment report, United States Virgin Islands. Department of Planning and Natural Resources, Department of Agriculture, Natural Resources Conservation Service.

Windevohxel, N. (2003). Costas del caribe de Colombia-Venezuela. Capítulo 1. PROARCA-Costas. The Nature Conservancy, World Wildlife Foundation, University of Rhode Island. Retrieved February 2003 from: http://www.wetlands.org/inventory&/SAA/Body/01cos_caribe@.htm (In Spanish).

Woodley, J., Alcolado, P., Austin, T., Barnes, J., Claro-Madruga, R., Ebanks-Petrie, G., Estrada, R., Geraldes, F., Glasspool, A., Homer, F., Luckhurst, B., Phillips, E., Shim, D., Smith, R., Sullivan-Sealy, K., Vega, M., Ward, J. and Wiener, J. (2000). Status of Coral reefs in the Northern Caribbean and Western Atlantic. In: Wilkinson, I. and Australian Institute of Marine Sciences AIMS. 2000. Status of Coral Reefs of the World: 2000. Australia.

World Bank Caribbean Division (1994). OECS Tourism. Retrieved May 2003 from: http://www.cpechrd.org/oecstourism.htm.

World Bank Group (2000). World development indicators. The International Bank for Reconstruction and Development. Database CD-ROM ver. 4.2.

World Bank Group (2002). Data by country. Retrieved Sept. 2002 from: http://www.worldbank.org/cgi-bin/sendoff.cgi?page=%2Fdata%2Fcountrydata%2Faag%2Fatg_aag.pdf

World Bank Group (2003). Data and Statistics. Retrieved Feb. 2004 from: http://www.worldbank.org/data/countrydata/countrydata.html

World Resources Institute (2004). Sustainable Development Information Service. Environmental Strategies, Actions Plans and Assessments. Trinidad and Tobago: National report on environment and development : United Nations Conference on Environment and Development, Brazil, 1992. Retrieved March 2004 from: http://www.wri.org/wdces/tr92_453.html

WSSD (2002). Plan of Implementation of the World Summit on Sustainable Development, United Nations Division of Sustainable Development. Johannesburg, South Africa 26 August-4 September.

WTTC (2004). Caribbean Travel & Tourism Forgin Ahead. The 2004 Travel & Tourism Economic Research. World Travel and Tourism Council Regional reports. Retrieved Nov. 2004 from: http://www.wttc.org/2004tsa/tsapdf/Caribbean.pdf

WWF (2001). Aruba-Curazao-Bonaire cactus scrub (NT1302). Peer review in process. Retrieved May 2003 from: http://www.worldwildlife.org/wildworld/profiles/terretsrial/nt1302_full.html

Annexes

Annex I
List of contributing authors and organisations

Name	Institutional affiliation	Country	Field of work
Scientific project direction			
Captain Francisco Arias Isaza	INVEMAR General Director	Colombia	Integrated Coastal Zone Management
Paula Cristina Sierra-Correa	INVEMAR Coordinator of the Research Program for Coastal and Marine Management	Colombia	Integrated Coastal Zone Management
Project coordination and reports preparation			
Mariacatalina Bernal- Velasquez	INVEMAR Coordinator of the Research Line on Politics and Legislation	Colombia	Integrated Coastal Zone Management
Research group			
Luz Marelvis Londoño	INVEMAR Coordinator of the Research Line on Natural Resources Economical Valuation	Colombia	Environmental economy
Walberto Troncoso	INVEMAR Coordinator of the Research Line on Environmental Effects Monitoring	Colombia	Environmental quality
Special advice			
Aaron Hutchins	Department of Planning and Natural Resources	US Virgin Islands	Environmental quality
Christopher Corbin	Sustainable Development and Environment Unit	Saint Lucia	Environmental planning
Eugene Ariola	Coastal Zone Management Authority and Institute	Belize	Oceanography
Advice group			
Adelle Blair	Ministry of Tourism and Environment	Antigua & Barbuda	Environmental management
Abril Mendez	Autoridad Nacional del Ambiente. Servicio de Recursos Hídricos	Panama	Hydrological resources management
Bienvenido Marín Z.	INVEMAR Coordinator of the Research Program on Environmental Quality	Colombia	Environmental quality
Edin Emilio Montufar	Consejo nacional de Áreas Protegidas	Guatemala	Protected Areas Management
Edwin Causado	INVEMAR Researcher on the Research Program for Natural Resources Valuation	Colombia	Environmental economy
Federico Newmark Umbreit	INVEMAR Coordinator of the Research Program for Natural Resources Valuation	Colombia	Natural resources valuation
Janin Mendoza	Ministerio del Ambiente y los Recursos Naturales	Venezuela	Environmental quality
José Rincón	Autoridad Nacional del Ambiente. Servicio de Recursos Hídricos.	Panama	Hydrological resources management
José González Porto	INVEMAR Researcher on the Research Program for Natural Resources Valuation	Colombia	Natural resources and ecosystems economy
Jesús Garay	INVEMAR Subdirector of the Research Coordination	Colombia	Environmental Quality
Jaime Garzón F.	INVEMAR Coordinator of the Research Program on Marina and Coastal Biodiversity and Ecosystems	Colombia	Natural Resources Research
Lorna Inniss	Costal Zone Management Unit. Ministry of Physical Development and Environment	Barbados	Integrated Coastal Zones Management
Mario Coto Hidalgo	Ministerio del Ambiente y la Energía- Sistema Nacional de Conservación de Áreas de Conservación- Tortuguero	Costa Rica	Protected areas management
Rafael Romero Mayo	Universidad de Quintana Roo- Área de Estudios Socio-económicos y Políticos	México	Environmental quality

Ricardo Arthur	Costal Zone Management Unit Ministry of Physical Development and Environment	Barbados	Integrated Coastal Zones Management
Stacey Wells-Moultrie	Bahamas Environment, Science and Technology Commission BEST	The Bahamas	Geology
Other advisors from Colombia			
Juan Manuel Díaz	INVEMAR Coordinator of the Research Program on Biodiversity and Ecosystems (until December 2003)	Colombia	Natural resources and ecosystems research
Jacobo Blanco R.	INVEMAR Researcher on the Research Program for Natural Resources Valuation	Colombia	Fisheries monitoring
Diana I. Gómez	INVEMAR Researcher on the Research Program on Biodiversity and Ecosystems	Colombia	Ecosystems research
Juan Carlos Narvaez	INVEMAR Researcher on the Research Program for Natural Resources Valuation	Colombia	Fisheries monitoring
Efrain Viloria Maestre	INVEMAR Researcher on the Research Program for Natural Resources Valuation	Colombia	Fisheries monitoring
Jorge Acosta R.	INVEMAR Researcher on the Research Program of Environmental Quality	Colombia	Fisheries monitoring
Martha L. Gómez	INVEMAR Researcher on the Research Program of Environmental Quality	Colombia	Marine microbiology
Environmental experts	IDEAM Institute	Colombia	Climate monitoring
Consultants			
Amparo Ramos	Expert on International Governance	Colombia	Environmental law
Francisco Galán	Expert on Public Policies	Colombia	Environmental policy maker
Sharon Messing	Policy Scientist	Colombia	Environmental policy maker
Special participants			
Luc St-Pierre	UNEP-CAR/RCU; PNUMA-UCR/CAR	Jamaica	Marine and coastal resources management
Alan Duncan	UNESCO IOCARIBE	Trinidad & Tobago	Environmental management
William Hogland	Kalmar University	Sweden	Environmental engineering
Jesús Beltrán	CIMAB/ GIWA region 4 Caribbean Islands	Cuba	Environmental pollution
Antonio Villasol	CIMAB/ GIWA region 4 Caribbean Islands	Cuba	Environmental pollution
Joaquín Gutierrez	CIEGA-AMA/ GIWA region 4 Caribbean Islands	Cuba	Environmental pollution
Sharrah Moss	Bahamas Environment, Science and Technology Commission BEST/GIWA region 4 Caribbean Islands	The Bahamas	Environmental management
William Senior	Instituto de Oceanografía de Venezuela/ GIWA region 4 Caribbean Islands	Venezuela	Oceanography research
Other support			
Andrés Vidal	INVEMAR- Pontificia Universidad Javeriana Student	Colombia	Ecology
Carolina Cardoso	INVEMAR- Pontificia Universidad Javeriana Student	Colombia	Ecology
Carolina Segura	INVEMAR Information System Laboratory	Colombia	Ecology
General Services Coordination Group	INVEMAR	Colombia	Logistics
Helmut Hiller	INVEMAR- Pontificia Universidad Javeriana Student	Colombia	Ecology
Jeisson Reyes	INVEMAR- Pontificia Universidad Javeriana Student	Colombia	Ecology
Olga Montealegre	INVEMAR Researcher of the Research Program for Coastal Management	Colombia	Marine biology
Pilar Lozano	INVEMAR Information System Laboratory	Colombia	GIS
Research and Support Resources Subdirection (SRAI)	INVEMAR	Colombia	Administration
Caribbean Sea region coordinators			
Juan Carlos Belausteguigoitia	GIWA	Sweden	Coordinator for the Southern Hemisphere
Marcia Marques	GIWA	Brazil	Coordinator for Latin America and the Caribbean

Annex II
Detailed scoring tables

I: Freshwater shortage

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
1. Modification of stream flow	2	30	Freshwater shortage	2
2. Pollution of existing supplies	2	40		
3. Changes in the water table	2	30		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	33
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	33
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	34
Weight average score for Economic impacts		**3.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	30
Weight average score for Health impacts		**1.7**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	2	50
Degree of severity	Minimum – Severe 0 1 2 3	2	25
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	25
Weight average score for Other social and community impacts		**2.0**	

II: Pollution

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
4. Microbiological	3	20	Pollution	2.4
5. Eutrophication	2	5		
6. Chemical	2	20		
7. Suspended solids	3	20		
8. Solid wastes	2	20		
9. Thermal	1	5		
10. Radionuclide	0	0		
11. Spills	2	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	34
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	33
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	33
Weight average score for Economic impacts		**2.7**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	30
Weight average score for Health impacts		**2.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	2	40
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	30
Weight average score for Other social and community impacts		**2.0**	

III: Habitat and community modification

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
12. Loss of ecosystems	3	50	Habitat and community modification	3.0
13.Modification of ecosystems or ecotones, including community structure and/or species composition	3	50		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	40
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	30
Weight average score for Economic impacts		**3.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	33
Degree of severity	Minimum – Severe 0 1 2 3	1	34
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	33
Weight average score for Health impacts		**1.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	40
Degree of severity	Minimum – Severe 0 1 2 3	3	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	30
Weight average score for Other social and community impacts		**3.0**	

IV: Unsustainable exploitation of fish and other living resources

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
14. Overexploitation	3	35	Unsustainable exploitation of fish	1.9
15. Excessive by-catch and discards	1	10		
16. Destructive fishing practices	2	15		
17. Decreased viability of stock through pollution and disease	1	30		
18. Impact on biological and genetic diversity	1	10		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	2	30
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	2	40
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	30
Weight average score for Economic impacts		**2.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	20
Degree of severity	Minimum – Severe 0 1 2 3	2	40
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	40
Weight average score for Health impacts		**2.2**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	1	40
Degree of severity	Minimum – Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	2	30
Weight average score for Other social and community impacts		**1.6**	

V: Global change

Environmental issues	Score	Weight %	Environmental concern	Weight averaged score
19. Changes in the hydrological cycle	2	50	Global change	1.5
20. Sea level change	1	40		
21. Increased UV-B radiation as a result of ozone depletion	1	5		
22. Changes in ocean CO_2 source/sink function	1	5		

Criteria for Economic impacts	Raw score	Score	Weight %
Size of economic or public sectors affected	Very small – Very large 0 1 2 3	3	34
Degree of impact (cost, output changes etc.)	Minimum – Severe 0 1 2 3	3	33
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	33
Weight average score for Economic impacts		**3.0**	
Criteria for Health impacts	**Raw score**	**Score**	**Weight %**
Number of people affected	Very small – Very large 0 1 2 3	1	34
Degree of severity	Minimum – Severe 0 1 2 3	1	33
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	1	33
Weight average score for Health impacts		**1.0**	
Criteria for Other social and community impacts	**Raw score**	**Score**	**Weight %**
Number and/or size of community affected	Very small – Very large 0 1 2 3	3	34
Degree of severity	Minimum – Severe 0 1 2 3	3	33
Frequency/Duration	Occasion/Short – Continuous 0 1 2 3	3	33
Weight average score for Other social and community impacts		**3.0**	

Comparative environmental and socio-economic impacts of each GIWA concern

Concern	Types of impacts								Overall score	Rank
	Environmental score		Economic score		Human health score		Social and community score			
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)		
Freshwater shortage	2.0	1.9	3.0	2.8	1.7	1.5	2.0	1.7	**2.1**	**4**
Pollution	2.4	2.0	2.7	3.0	2.0	1.5	2.0	1.5	**2.1**	**3**
Habitat and community modification	3.0	2.4	3.0	2.8	1.0	1.0	3.0	2.8	**2.4**	**2**
Unsustainable exploitation of fish and other living resources	1.9	2.0	2.0	2.5	2.2	2.0	1.6	2.0	**2.0**	**5**
Global change	1.5	2.8	3.0	3.0	1.0	3.0	3.0	3.0	**2.5**	**1**

Annex III
Environmental characteristics

Environmental characterisitcs

Country	Area (km^2)	Coastline (km)	Natural resources and ecosystems	Land characteristics	Environment problems
Anguilla	71.3	61	Salt, fish, lobster.	Coral limestone formation, undulated surface, highest elevation at 758 m.	Sewage disposal.
Antigua & Barbuda	440	153	Coral reefs, salt ponds, mangrove swamps, sandy beaches.	Antigua: Mountains in southwest, flat central plains, rolling limestone hills in highlands. Numerous islands, creeks and inlets, sand bars and wetlands. Barbuda: coastline less varied, extensive reefs systems.	Habitat destruction, erosion, pollution and sewage.
Aruba	194	68.5	Cactuses, divi-divi tree, woodland.	Flat terrain, few hills, scant vegetation. Highest point: Mount Jamanota, 188 m.	Risk of oil pollution and garbage disposal.
Barbados	432	97	Petroleum, fish, natural gas. Mangrove wetland, seagrass beds, shallow hard coral reef offshore.	Low relief, higehst point: Mount Hillaby at 336 m. 88% covered by a pleistocene coral cap.	Erosion, solid waste disposal, marine pollution.
Bonaire	288	122	Salinas. Natural xerotrophic vegetation.	Shaped island. Strongly folded and faulted rocks of volcanic origin and silica rich sediments. Flat terrain, highest point: Brandaris Hill at 240 m. Poor soil.	
British Virgin Islands	153	80		Largely rolling hills and beaches. Tortola: highest point at 529 m in Mount Sagage.	Erosion, loss of mangroves, coral reefs and seagrass beds, marine pollution.
Cayman Islands	259	159	Coral reefs communities, mangove swamps, seagrass beds.	Located on a major submarine ridge. Low-lying limestone formations, older bluff core and mid-Tertiary limestone origin, younger iron shore formations. Plewistocene calcareous deposits, recent carbonate deposits. Highest point: Bluff at 43 m.	
Curaçao	443	150	Seagrass, mangroves. Drouight-resistant cacti and thron scrub.	Volcanic origin, formed 88 million years ago during the Caribbean Plate evolution. Deposits of later sedimenttary rocks. Limestone terraces. Generally flat, mostly consisting on steep cliffs and ruble beaches, a submarine terrace gradually slopes to 7-12 m depth.	
Dominica	750	146		Island rugged and mountainous, steep terrain and narrow coastal plain. The highest mountains in the Eastern caribbean are in Dominica, highest point: Morn Diablotin at 1 447 m. Large number of rivers and streams.	Deforestation, solid waste disposal and soil erosion.
Grenada	344	121		Terrain of volcanic origin with central mountains. Highest point: Mount Saint Catherine at 840 m.	Solid waste disposal, water shortage, erosion and marine pollution.
Guadeloupe	1 780	306	Cultivable land, beaches.	Volcanic origin for most of the islands; Grande-terre is low limestone formation. Interior mountains.	
Martinique	1 075	350	Coral reefs communities at more than 10m depth. Seagrass beds, mangroves.	Mountainous terrain, shaped coastline. Highest point: Montagne Pelee at 1 397m. Dormant volcano. Submarine valleys.	Solid waste disposal.
Montserrat	102	18		Volcanic origin. Comprises three mountians systems: Silver Hills, Cebter Hills, South Soufriere Hills. Heavily vegetated mountains; deep ghauts from peaks to the coast. Narrow coastal shelf. Rugged shoreline, with cliffs and rocky shores. Contains seven active volcanoes.	Improper land use, solid waste disposal and sewage. Overexplotation of marine resources.
Saint Kitts & Nevis	269	135	St Kitts: Sandy beaches with a mixture of coral sand, foraminifera and volcanic sand. Coral reefs, seagrass beds, mangroves, salt ponds, diverse aquatic life and coastline. Hawksbill and Green sea turtle. Resident and migratory birds. Nevis: Sandy beaches.	Volcanic origin. St Kitts: coast backed by lower glacis slopes, covered by deep sandy volcani ash. Low cliffes. Three volcanic centres: central north-west range, with Mount Liamuiga at 1 156 m. Nevis: freshwater lagoons, rocky shores, massive sea cliffs.	Solid waste disposal, coastal and marine pollution, erosion, deforestation.
Saint Lucia	617	158	Forest, sandy beaches, minerals (pumice), mineral springs, geothermal potential.	Volcanic origin. Mountainous terrain with some broad and fertile valleys. Highest point: Mount Gimie at 950 m.	Solid waste disposal, water pollution, loss of marine and terrestrial habitats, degradation of river basins.
Saint Vicent & The Granadines	389	84	Coral reefs, fishes.	St Vincent: Volcanic origin, dominated by central mountain range, covered with wet forest and series of radiatins spurs which rich into the coastline. Active volcano: La Soufriere, at 1 212 m. Grenadines: white sandy beaches, clear blue water, sheltered.	Pollution, deforestation, loss of habitats, erosion, lack of solid waste and sewage water management.
Trinidad & Tobago	5 130	362		Mountainous terrain, metamorphic and volcanic rocks. Rocky and rugged coastline. Highest point: El Cerro del Aripo at 940 m.	Deforestation, erosion and water pollution.
Turks & Caicos	430	389	Marshes, mangroves swamps. Spiny lobster, conch.	Low terrain, flat limestone. Highest point: Blue Hills at 49 m.	Sewage and solid waste disposal.
US Virgin Islands	350	188	Sea birds nesting, roosting areas, marine life.	Central mountain ranges and relatively small coastal plains. Highest point: Crwon Mountain in St Croix. The tycpical soil profile is thin clavey and overlies rock. There are no large freshwater lakes or ponds, and no perennial streams on any of the islands; intermittent streams can only be seen after heavy rainfall. The absence of large freshwater resources and perennial streams means that guts (watercourses) form the basis for watershed management in the territory.	Low freshwater storage capacity.

(Source: IOCARIBE 2002 , Office of the Prime Minister 2001, Cooper & Bowen 2001, Farquhar & Josef 1997, PAHO 1998, Meyer 1997, Interknowledge Corp. 2002, Bush 1998, Pors & Nagelkerken 1998, Dutch Caribbean 2000, James 1997, CIA 2001, Family Education Network 2003, BVI 2002, Gabrie & Moyne-Pickard 1999, Porter 1997, Farell 1997, DPNR/DEF & USDA/NRCS 1998, WWF 2001, PNUMA 1999, DPNR/DEP 2002).

Annex IV
List of important water-related programmes and assessments in the region

GEF-projects in the Caribbean region.

Antigua & Barbuda

National Biodiversity Strategy, Action Plan and First National Report to COP, Enabling Antigua and Barbuda to Prepare its First National Communication in Response to its Commitments to UNFCCC, National Capacity Needs Self-Assessment for Global Environmental Management.

Barbados

First National Report to the Convention on Biological Diversity, Enabling Barbados to Prepare its First National Communication in Response to its Commitments to UNFCCC, Climate Change Enabling Activity (Additional Financing for Capacity Building in Priority Areas).

Grenada

Development of a National Biodiversity Conservation Strategy, and Action Plan and Country Report to the CBD, Enabling Grenada to Prepare its Initial National Communication in Response to its Commitments to UNFCCC.

St Kitts & Nevis

National Biodiversity Strategies, Action Plan, and the Report to the Convention on Biological Diversity, Enabling St. Kitts and Nevis to Prepare its First National Communication in Response to its Commitments to UNFCCC.

St Lucia

Coastal/Wetland Ecosystem Conservation and Sustainable Livelihoods, National Biodiversity Strategies, Action Plan, and the First National Report to the Convention on Biological Diversity and Participation in the Pilot Phase of the CHM, Enabling St. Lucia to Prepare its First National Communication in Response to its Commitments to UNFCCC.

St Vincent & The Grenadines

National Biodiversity Strategies, Action Plan, and the Report to the Convention on Biological Diversity, Enabling St. Vincent and Grenadines to Prepare its First National Communication in Response to its Commitments to UNFCCC.

Trinidad & Tobago

National Biodiversity Strategy, Action Plan and First Report to the CBD, Protected Areas and Wildlife Management Project, Enabling Trinidad and Tobago to Prepare its First National Communication in Response to its Commitments to UNFCCC.

Regional projects

- Caribbean Renewable Energy Development Programme,
- Caribbean: Mainstreaming Adaptation to Climate Change,
- Caribbean Planning for Adaptation to Global Climate Change (CARICOM),
- Integrating Watershed and Coastal Area Management in Small Island Developing States of the Caribbean,
- Building Capacity for Conducting Vulnerbility and Adaptation Assessments in the Caribbean Region,
- Ship-Generated Waste Management,
- Building Wider Public and Private Constituences for the GEF in Latin America and the Caribbean: Regional Promotion of Global Environment Protection through the Electronic Media,
- Country Case Studies on Climate Change Impacts and Adaptations Assessment-Phase I,
- Development of National Implementation Plans for the Management of Persistent Organic Pollutants (POPs),
- Building the Inter-American Biodiversity Information Network (IABIN): A Regional Clearinghouse for the Americas, Reducing Pesticide Runoff to the Caribbean Sea,
- Demonstrations of Innovative Approaches to the Rehabilitation of Heavily Contaminated Bays in the Wider Caribbean,
- Reduction of Environmental Impact from Tropical Shrimp Trawling through Introduction of By-catch Technologies and Change of Management,
- Caribbean: Mainstreaming Adaptation to Climate Change.

Assessments

Archer, A.B., (1976). Marine Pollution Off Barbados' Coasts. Prepared for Meeting of the Smaller Caribbean Islands on Oil Spill Contingency Planning, San Juan, Puerto Rico, 16-20 June 1980 (Agenda Item 10). Sponsored by Organization of American States, Inter-governmental Maritime Consultative Organization, UNEP.

Atherley, K.A., D.A. Smith, and Nurse, L.A. (1993). An Integrated Coastal Zone Management Programme for Barbados. In: Proceedings for Coastal Zone '93:2653-2667.

Awosika, L., Boromthanarat, S., Comforth, R., Hendry, M., Koudstall, R., Ridgley, M., Sorenson, S., De Vrees, L. and Westmacott, S. (1993). Management Arrangements for the Development and Implementation of Coastal Zone Management Programmes. World Coast Conference Organising Committee. International Conference on Coastal Zone Management, The Netherlands, 1-5 November 1993.

Bass, S.M.J., (1993). Ecology and Economics in Small Islands: Constructing A Framework for Sustainable Development. In: Barbier, E.B. (ed.) Economics and Ecology: New Frontiers and Sustainable Development. Chapman & Hall, London.

Beller, W.S. (ed.) (1986). Proceedings of the Interoceanic Workshop on Sustainable Development and Environmental Management of Small Islands, Humacao, Puerto Rico, November 3-7, 1986. U.S. Man and the Biosphere Programme, Department of State, Washington, DC.

Cambers, G. (1992). Coastal Zone Management: Case Studies from the Caribbean. Latin America and the Caribbean Technical Department, Regional Studies Programme. Report No. 26. The World Bank.

Caribbean Coastal Marine Productivity CARICOM. Regional scientific program and network of marine laboratories, parks, and reserves to study land-sea interaction processes in the Wider Caribbean region.

Caribbean Community Secretariat (1992). CARICOM Regional Environment Programme. Georgetown, Guyana.

Caribbean Conservation Association and Island Resources Foundation, (1991). Antigua and Barbuda Environmental Profile. Prepared for Government of Antigua-Barbuda and the U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Conservation Association and Island Resources Foundation, 1991. Dominica Environmental Profile. Prepared for the Government of the Commonwealth of Dominica and the U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Conservation Association and Island Resources Foundation (1991). Environmental Agenda for the 1990's. A Synthesis of the Eastern Caribbean Country Environmental Profile Series. Prepared for U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Conservation Association and Island Resources Foundation (1991). Grenada Environmental Profile. Prepared for the Government of Grenada and the U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Conservation Association and Island Resources Foundation (1991). St. Kitts and Nevis Environmental Profile. Prepared for the Government of St. Kitts-Nevis and the U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Conservation Association and Island Resources Foundation (1991). St. Lucia Environmental Profile. Prepared for the Government of St. Lucia and the U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Conservation Association and Island Resources Foundation (1991). St. Vincent and the Grenadines Environmental Profile. Prepared for the Government of St. Vincent and the Grenadines and the U.S. Agency for International Development, Regional Development Office for the Caribbean/Barbados.

Caribbean Pollution Program of UNEP, CARIPOL.

Collymore, J., McDonald, F. and Brown, H. (1993). Natural and Environmental Disaster Preparedness in the Caribbean. Background Paper for the Regional Technical Meeting on the Sustainable Development of Small Island Developing States, Port-of-Spain, Trinidad and Tobago, July 12-16, 1993.

Cox, J and C. Embree, eds., 1990. Sustainable Development in the Caribbean. A Report on the Public Policy Implications of Sustainable Development in the Caribbean Region Conference, May 28-30, 1990, Kingston, Jamaica. Institute for Research on Public Policy, Halifax, NS, Canada.

Dalhousie Ocean Studies Programme (1984). Development and Ocean Management in the Eastern Caribbean: The Case of the Leeward Islands. Prepared as background material for a regional seminar held in Basseterre, St. Kitts, 7-9 June 1983, sponsored by CIDA. Dalhousie University, Halifax, NS, Canada.

Dixon, J.A., Scura, L.F. and van't Hof T. (1992). Meeting Ecological and Economic Goals: The Case of Marine Parks in the Caribbean. Prepared for the Second Conference on the Ecology and Economics of Biodiversity Loss of the Beijer Institute, July 29-31, 1992, Stockholm, and also presented at the Second Meeting of the International Society for Ecological Economics, Stockholm, August 3-6, 1992.

Food and Agriculture Organization FAO in Latin America and the Caribbean. Available at: http://www.fao.org/REGIONAL/LAmerica/proyecto/default.htm

Gamman, J.K. (1990). A Comparative Analysis of Public Policies Affecting Natural Resources and the Environment: Interest Group Politics in the Eastern Caribbean. Prepared under the DESFIL Programme of USAID by Development Alternatives, Inc., Washington, DC.

Goodwin, M., et al. (1985). Fishery Sector Assessment for the Eastern Caribbean: Antigua/Barbuda, Dominica, Grenada, Montserrat, St. Christopher/Nevis, St. Lucia, St. Vincent and the Grenadines. Prepared by Island Resources Foundation for USAID. St. Thomas, Virgin Islands.

Griffith, M. and J. Ashe (1993). "Sustainable Development of Coastal and Marine Areas in Small Island Developing States: A Basis for Integrated Coastal Management." Ocean and Coastal Management, 21(1993):269-284. Elsevier Science Publishers Ltd., England.

Hudson, B.J. (1986). Landscape as Resource for National Development: A Caribbean View. Geography:116-121.

Global Environment Outlook –GEO-3. Past, present and future perspectives. 2003

Governmental Oceanographic Commission, of UNESCO, IOCARIBE.

Intergovernmental Oceanographic Commission (1989). IOC-UNEP Regional Workshop to Review Priorities for Marine Pollution Monitoring, Research, Control and Abatement in the Wider Caribbean. San Jose, Costa Rica, 24-30 August 1989. Workshop Report No. 59. UNESCO.

Intergovernmental Oceanographic Commission (1993). IOC Workshop on Small Island Oceanography in Relation to Sustainable Economic Development and Coastal Area Management of Small Island Developing States. Fort-de-France, Martinique, 8-10 November 1993. Workshop Report No. 97. UNESCO.

Intergovernmental Oceanographic Commission, Reports of Governing and Major Subsidiary Bodies (1993). IOC Sub-commission for the Caribbean and Adjacent Regions. Fourth Session, Veracruz, Mexico, 2-7 December 1992. UNESCO, IOC/SC-IOCARIBE, Paris.

Intergovernmental Oceanographic Commission, Subcommission for the Caribbean and Adjacent Regions (IOCARIBE) (1991). Global Change and Coastal Land Loss: Management and Decision-making in Support of Sustainable Development Within the Caribbean and Adjacent Regions. A Programme Proposal. IOCARIBE, Cartagena, Colombia.

Intergovernmental Oceanographic Commission/United Nations Environment Programme (IOC/UNEP) (1992). First Meeting of the CEPPOL Group of Experts, Kingston, 12-14 May 1992. UNEP (OCA)/CAR WG.6/1.

Intergovernmental Oceanographic Commission/United Nations Environment Programme (IOC/UNEP) (1993). Second CEPPOL Seminar on Monitoring and Control of Sanitary Quality of Bathing and Shellfish-Growing Marine Waters in the Wider Caribbean, Kingston, Jamaica, 9-13 August 1993. CEP Technical Report No. 23. UNEP, Caribbean Environment Programme, Kingston, Jamaica.

Island Resources Foundation (1993). Anguilla Environmental Profile. Prepared for the Government of Anguilla and the United Nations Development Programme, Barbados.

Island Resources Foundation (1993). Montserrat Environmental Profile. Prepared for the Government of Montserrat and the United Nations Development Programme, Barbados.

Jernelov, A. and Marinov, U. (1990). An Approach to Environmental Impact Assessment for Projects Affecting the Marine Environment. UNEP, Regional Seas Reports and Studies, No. 122.

Lewsey, C.D. (1990). Reassessing Policy Alternatives for Sustainable Development in Coastal Areas: Implications for the CARICOM Caribbean. Paper presented at Conference on Public Policy Implications of Sustainable Development in the Caribbean, Kingston, Jamaica, May 28-30, 1990. Sponsored by the Government of Jamaica and the Institute for Research on Public Policy, Ottawa, Canada.

McElroy, J. (1978). Economic and Social Impacts of the Virgin Islands Coastal Zone Management Programme. Technical Supplement No. 4. Prepared for the Virgin Islands Planning Office, Coastal Zone Management Programme, St. Thomas, Virgin Islands.

Ogden, J.C. and Gladfelter, E.H. (1983). Coral Reefs, Seagrass Beds and Mangroves: Their Interaction in the Coastal Zones of the Caribbean. Report of a Workshop held at West Indies Laboratory, St. Croix, U.S. Virgin Islands, May 1982. UNESCO Reports in Marine Science No. 23. UNESCO Regional Office for Science and Technology for Latin America and the Caribbean, Montevideo, Uruguay.

Organization of American States and U.S. National Park Service (1988). Inventory of Caribbean Marine and Coastal Protected Areas. Department of Regional Development, OAS and Office of International Affairs, NPS, Washington, DC.

Richards, W.J. and Bohnsack, J.A. (1990). The Caribbean Sea: A Large Marine Ecosystem in Crisis. In: Sherman, K., Alexander L. and Gold, B. (eds.) Large Marine Ecosystems: Patterns, Processes and Yields. American Association for the Advancement of Science.

Rogers, C.S. et al. (1994). Coral Reef Monitoring Manual for the Caribbean and Western Atlantic. Virgin Islands National Park, St. John, Virgin Islands.

Salas, H.J. (1994). Submarine Outfalls. General Overview, Basic Design Concepts and Data Requirements for Latin America and the Caribbean. Prepared for UNEP's Second Meeting of Experts on Land-based Sources of Pollution in the Wider Caribbean Region, San Juan, Puerto Rico, 21-25 March 1994. UNEP(OCA)/CAR WG.14/INF.15.

Steel, J. (1993). South Atlantic and Caribbean Regional Marine Research Plan. North Carolina State University, Raleigh, NC, USA.

The Regional Impacts of Climate Change: Small Islands IPCC. Available at: http://www.grida.no/climate/ipcc/regional/239.htm

Tercer Congreso Latinoamericano De Manejo De Cuencas En Zonas De Montaña. Informes Nacionales De Colombia, Costa Rica, Guatemala, Honduras, Panama Y Venezuela.

Towle, E.L. and Rogers, C.S. (1989). Case Study on the Virgin Islands Biosphere Reserve. Contribution to the UNESCO/IUCN Workshop on the Application of the Biosphere Reserve Concept to Coastal Marine Areas, San Francisco, 14-20 August 1989. Island Resources Foundation Occasional Paper No. 50. St. Thomas, Virgin Islands.

Towle, E.L. and Volk, R. (1994). Case Study. From Theory to Practice with Virgin Islands Coastal Management: A Retrospective View. Prepared for InterAmerican Development Bank's 5th Consultative Meeting on the Environment, "NGOs and the IDB -- A Focus on Participation", Bridgetown, Barbados, 31 May, 1994.

United Nations Centre for Human Settlements (UNCHS) and United Nations Development Programme (UNDP) (1994). Programme for Environmentally Sustainable Land Use Planning and Settlements Development in the O.E.C.S. Bridgetown, Barbados.

United Nations Education, Scientific and Cultural Organization (UNESCO) (1983). Coastal Ecosystems of Latin America and the Caribbean. Objectives, Priorities and Activities of UNESCO's COMAR Project for the Latin American and Caribbean Region, Caracas, Venezuela, 15-19 November 1982. UNESCO Reports in Marine Science No. 24.

United Nations Education, Scientific and Cultural Organization (UNESCO) (1994). Island Agenda. An Overview of UNESCO's work on Island Environments, Territories and Societies. Division of Ecological Sciences, UNESCO, Paris.

United Nations Environment Programme (UNEP) (1987). Action Plan For The Caribbean Environment Programme. A Framework For Sustainable Development. UNEP Caribbean Regional Co-ordinating Unit, Kingston, Jamaica.

United Nations Environment Programme (UNEP) (1989a). Regional Overview of Environmental Problems and Priorities Affecting the Coastal and Marine Resources of the Wider Caribbean. CEP Technical Report No. 2. UNEP Caribbean Environment Programme, Kingston, Jamaica.

United Nations Environment Programme (UNEP) (1989b). Report of the Second Meeting of Experts for the Development of A Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. Kingston, 19-23 June 1989. UNEP(OCA)/CAR WG.3/5.

United Nations Environment Programme (UNEP) (1991). Action Plan for the Environment in Latin America and the Caribbean. UNEP, Regional Office for Latin America and the Caribbean.

United Nations Environment Programme (UNEP) (1992a). Environmental Quality Criteria for Coastal Zones in the Wider Caribbean Region. CEP Technical Report No. 14. UNEP, Caribbean Environment Programme, Kingston, Jamaica.

United Nations Environment Programme (UNEP) (1992b). Meeting of Experts on Land-Based Sources of Pollution, Veracruz, Mexico, 6-10 July 1992. UNEP (OCA)/CAR WG.9/4.

United Nations Environment Programme (UNEP) (1993a). Common Guidelines and Criteria to the Wider Caribbean Region for the Identification, Selection, Establishment, and Management of Protected Areas of National Interest. UNEP (OCA)/CAR WG.11/6. Second Meeting of the Interim Scientific and Technical Advisory Committee (ISTAC) to the Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (SPAW). French Guiana, 3-5 May 1993.

United Nations Environment Programme (UNEP) (1993b). Guidelines for Integrated Management of Coastal and Marine Areas with Special Reference to the Mediterranean Basin. UNEP, Mediterranean Action Plan, Priority Actions Programme, Ocean and Coastal Area Programme Activity Centre.

United Nations Environment Programme (UNEP) (1993c). Report on Interregional Meeting of Experts to Discuss Guidelines for Integrated Coastal and Marine Areas Management, Rome, 29 November-1 December, 1993. UNEP, Mediterranean Action Plan, Priority Actions Programme, Regional Activity Centre, Rome.

United Nations Environment Programme (UNEP) (1993d). Status of Implementation of the Regional Programme on Specially Protected Areas and Wildlife (SPAW). UNEP (OCA)/CAR WG.11/3. Second Meeting of the Interim Scientific and Technical Advisory Committee (ISTAC) to the Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (SPAW). French Guiana, 3-5 May 1993.

United Nations Environment Programme (UNEP) (1994a). Draft Recommendations on A Pollution Prevention, Reduction and Control Strategy for LBSMP in the Wider Caribbean Region. Second Meeting of Experts on Land-Based Sources of Pollution in the Wider Caribbean Region, San Juan, 21-25 March, 1994. UNEP(OCA)/CAR WG.14/CRP.3.

United Nations Environment Programme (UNEP) (1994b). Regional Overview of Land-based Sources of Pollution in the Wider Caribbean Region (Revised Version). Second Meeting of Experts on Land-based Sources of Pollution in the Wider Caribbean Region, San Juan, Puerto Rico, 21-25 March 1994. UNEP(OCA)/CAR WG.14/4.

United Nations Environment Programme/Economic Commission for Latin America and the Caribbean (1984). The State of Marine Pollution in the Wider Caribbean Region. UNEP Regional Seas Reports and Studies No. 36. UNEP.

U.S. Agency for International Development and U.S. Department of Commerce/NOAA (1987). Caribbean Marine Resources: Opportunities for Economic Development and Management. Washington, DC.

Williams, M.C. (1988). Coastal Zone Management Strategies: The Caribbean Experience. In: Edwards, F. (ed.) Environmentally Sound Tourism in the Caribbean. The Banff Centre, School of Management. University of Calgary Press.

Willms and Shier (1992). Institutional Strengthening Project. Final Report - Stage 1. Prepared for Coastal Conservation Project Unit, Ministry of Labour, Consumer Affairs and the Environment, Government of Barbados.

World Bank (1994). Initiatives for Regional Action on Caribbean Environmental Issues. Report No. 13045-LAC. Latin America and the Caribbean Region, The World Bank, Washington, DC.

WSSD (2002). World Summit on Sustainable Development Johannesburg, South Africa August 26-September 4, 2002. A Guide to Oceans, Coasts and Islands at the World Summit on Sustainable Development

Annex V
List of conventions and specific laws that affect water use in the region

Adjustments and Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer 29 June 1990

Adjustments and Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer 23-25 November 1992

Agreement Concerning Cooperation in Marine Fishing 28 July 1962

Agreement Concerning Cooperation in Taking Measures Against Pollution of the Sea by Oil 16 September 1971

Agreement Establishing the Inter-American Institute for Global Change Research 13 May 1992

Agreement establishing the South Pacific Regional Environment Programme (SPREP) 16 June 1993

Agreement establishing the Caribbean Development Bank (Kingston, 1969)

Agreement establishing the Fund for the Development of the Indigenous Peoples of Latin America and the Caribbean (Madrid, 1992)

Agreement on Regional Cooperation in Combating Pollution of the South-East Pacific by Hydrocarbons and Other Harmful Substances in Cases of Emergency 12 November 1981

Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982--done 28 July 1994

Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas 29 November 1993

Amendment to the Annex to the Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 3 November 1989

Amendment to the Annex to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 24 September 1980

Amendments to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter Concerning Settlement of Disputes 12 October 1978

Amendments to the International Convention for the Prevention of Pollution of the Sea by Oil Concerning the Protection of the Great Barrier Reef 12 October 1971

Annex III to the Protocol of 17 February 1978 relating to the International Convention for the Prevention of Pollution from Ships of 2 November 1973 (MARPOL 73/78), as amended on 30 October 1992

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal 22 March 1989

Convention for the Establishment of an Inter-American Tropical Tuna Commission 31 May 1949

Convention for the International Council for the Exploration of the Sea (as amended) 12 September 1964

Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (as amended) 15 February 1972

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena de Indias(Colombia), 1983)

Convention for the Conservation of the Biodiversity and the Protection of Wilderness Areas in Central America (Managua, 1992)

Convention for the Protection of the World Cultural and Natural Heritage 23 November 1972

Convention for the Suppression of Unlawful Acts Against the Safety of Maritime Navigation 10 March 1988

Convention on Biological Diversity 5 June 1992

Convention on Environmental Impact Assessment in a Transboundary Context 25 February 1991

Convention on Fishing and Conservation of the Living Resources of the High Seas 29 April 1958

Convention on International Trade in Endangered Species of Wild Fauna and Flora 3 March 1973

Convention on Long-Range Transboundary Air Pollution 13 November 1979

Convention on the Conservation of Migratory Species of Wild Animals 23 June 1979

Convention on the Continental Shelf 29 April 1958

Convention on the High Seas 29 April 1958

Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 29 December 1972

Convention on the Prevention of Marine Pollution from Land-based Sources 4 June 1974

Convention on the Regulation of Antarctic Mineral Resource Activities 2 June 1988

Convention on the Territorial Sea & the Contiguous Zone 29 April 58

Convention on the Transboundary Effects of Industrial Accidents 17 March 1992

Convention on Wetlands of International Importance Especially as Waterfowl Habitat 2 February 1971

Fisheries Convention 9 March 1964

International Agreement on the Use of INMARSAT Ship Earth Stations within the Territorial Sea and Ports 16 October 1985

International Convention for the Conservation of Atlantic Tunas 14 May 1966

International Convention for the Prevention of Pollution from Ships 2 November 1973

International Convention for the Prevention of Pollution of the Sea by Oil (as amended on 11 April 1962 and 21 October 1969) 12 May 1954

International Convention for the Protection of Birds 18 October 1950

International Convention for the Regulation of Whaling 2 December 1946

International Convention for the Safety of Life at Sea 17 June 1960

International Convention on Civil Liability for Oil Pollution Damage 29 November 1969

International Convention on Oil Pollution Preparedness, Response and Cooperation 29 November 1990

International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 18 December 1971

International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties 29 November 1969

International Tropical Timber Agreement 18 November 1983

International Tropical Timber Agreement 26 January 1994 Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution 24 April 1978

MARPOL Optional Annex Annex IV: Regulations for the Prevention of Pollution by Sewage from Ships

Montreal Protocol on Substances that Deplete the Ozone Layer 16 September 1987

(OECD) Assessment of Projects with Significant Impact on the Environment 8 May 1979

(OECD) Comprehensive Waste Management Policy 28 September 1976

(OECD) Control of Air Pollution from Fossil Fuel Combustion 20 June 1985

(OECD) Control of Eutrophication of Waters 14 November 1974

(OECD) Control of Transfrontier Movements of Wastes Destined for Recovery Operations 30 March 1992

(OECD) Declaration of Anticipatory Environmental Policies 8 May 1979

(OECD) Declaration on Environment Resources for the Future 20 June 1985

(OECD) Declaration on Environmental Policy 14 November 1974

(OECD) Energy and the Environment 14 November 1974

(OECD) Environment and Economics Guiding Principles Concerning International Economic Aspects of Environmental Policies 26 May 1972

(OECD) Implementation of the Polluter-Pays Principle 14 November 1974

(OECD) International Conference on Environment and Economics: Conclusions 21 July 1984

(OECD) Measures to Reduce All Man-Made Emissions of Mercury to The Environment 18 September 1973

(OECD) Recommendation of the Council on Further Measures for the Protection of the Environment by Control of Polychlorinated Biphenyls 13 February 1987

(OECD) Recommendation of the Council on the Reduction of Transfrontier Movements of Wastes 31 January 1991

(OECD) Strategies for Specific Water Pollutants Control 4 November 1974

(OECD) Waste Paper Recovery 30 January 1980

(OECD)Protection of the Environment by Control of Polychlorinated Biphenyls 13 September 1973

Optional Protocol of Signature Concerning the Compulsory Settlement of Disputes Arising out of the United Nations Conference on the Law of the Sea 29 April 1958

Protocol Concerning Cooperation in Combating Oil Spills in the Wider Caribbean Region (Cartagena de Indias, Colombia) 24 March 1983

Protocol Concerning Cooperation in Combating Pollution in Cases of Emergency 21 March 1981

Protocol Concerning Marine Pollution Resulting from Exploration and Exploitation of the Continental Shelf 29 March 1989

Protocol Concerning Regional Cooperation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency 14 February 1982

Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Kingston, 1990)

Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms Located on the Continental Shelf 10 March 1988

Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships 17 February 1978

Protocol Relating to Intervention on the High Seas in Cases of Pollution by Substances Other than Oil 2 November 1973

Protocol to Amend the Convention on Wetlands of International Importance Especially as Waterfowl Habitat 3 December 1982

Protocol to Amend the International Convention on Civil Liability for Oil Pollution Damage 25 May 1984

Protocol to Amend the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 25 May 1984

Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Long-Term Financing of Cooperative Programme for Monitoring and Evaluation of the Long-Range Transmissio ns of Air Pollutants in Europe (EMEP) 28 September 1984

Protocol to the International Convention on Civil Liability for Oil Pollution Damage 19 November 1976

Protocol to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage 19 November 1976

Rio Declaration 3-14 June 1992

Supplementary Protocol to the Agreement on Regional Co-Operation in Combating Pollution of the South-East Pacific by Hydrocarbons or Other Harmful Substances 22 July 1983

United Nations Convention on the Law of the Sea 10 December 1982

United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa 12 September 1994

United Nations Framework Convention on Climate Change 9 May 1992

Vienna Convention for the Protection of the Ozone Layer 22 March 1985

Vienna Convention on the Law of Treaties 23 May 1969

Wages, Hours of Work and Manning (Sea) Convention (Revised), 1958 (No. 109)

World Charter for Nature 1982

The Global International Waters Assessment

This report presents the results of the Global International Waters Assessment (GIWA) of the transboundary waters of the Caribbean Sea/Small Islands region. This and the subsequent chapter offer a background that describes the impetus behind the establishment of GIWA, its objectives and how the GIWA was implemented.

The need for a global international waters assessment

Globally, people are becoming increasingly aware of the degradation of the world's water bodies. Disasters from floods and droughts, frequently reported in the media, are considered to be linked with ongoing global climate change (IPCC 2001), accidents involving large ships pollute public beaches and threaten marine life and almost every commercial fish stock is exploited beyond sustainable limits - it is estimated that the global stocks of large predatory fish have declined to less that 10% of pre-industrial fishing levels (Myers & Worm 2003). Further, more than 1 billion people worldwide lack access to safe drinking water and 2 billion people lack proper sanitation which causes approximately 4 billion cases of diarrhoea each year and results in the death of 2.2 million people, mostly children younger than five (WHO-UNICEF 2002). Moreover, freshwater and marine habitats are destroyed by infrastructure developments, dams, roads, ports and human settlements (Brinson & Malvárez 2002, Kennish 2002). As a consequence, there is growing public concern regarding the declining quality and quantity of the world's aquatic resources because of human activities, which has resulted in mounting pressure on governments and decision makers to institute new and innovative policies to manage those resources in a sustainable way ensuring their availability for future generations.

Adequately managing the world's aquatic resources for the benefit of all is, for a variety of reasons, a very complex task. The liquid state of the most of the world's water means that, without the construction of reservoirs, dams and canals it is free to flow wherever the laws of nature dictate. Water is, therefore, a vector transporting not only a wide variety of valuable resources but also problems from one area to another. The effluents emanating from environmentally destructive activities in upstream drainage areas are propagated downstream and can affect other areas considerable distances away. In the case of transboundary river basins, such as the Nile, Amazon and Niger, the impacts are transported across national borders and can be observed in the numerous countries situated within their catchments. In the case of large oceanic currents, the impacts can even be propagated between continents (AMAP 1998). Therefore, the inextricable linkages within and between both freshwater and marine environments dictates that management of aquatic resources ought to be implemented through a drainage basin approach.

In addition, there is growing appreciation of the incongruence between the transboundary nature of many aquatic resources and the traditional introspective nationally focused approaches to managing those resources. Water, unlike laws and management plans, does not respect national borders and, as a consequence, if future management of water and aquatic resources is to be successful, then a shift in focus towards international cooperation and intergovernmental agreements is required (UN 1972). Furthermore, the complexity of managing the world's water resources is exacerbated by the dependence of a great variety of domestic and industrial activities on those resources. As a consequence, cross-sectoral multidisciplinary approaches that integrate environmental, socio-economic and development aspects into management must be adopted. Unfortunately however, the scientific information or capacity within each discipline is often not available or is inadequately translated for use by managers, decision makers and

policy developers. These inadequacies constitute a serious impediment to the implementation of urgently needed innovative policies.

Continual assessment of the prevailing and future threats to aquatic ecosystems and their implications for human populations is essential if governments and decision makers are going to be able to make strategic policy and management decisions that promote the sustainable use of those resources and respond to the growing concerns of the general public. Although many assessments of aquatic resources are being conducted by local, national, regional and international bodies, past assessments have often concentrated on specific themes, such as biodiversity or persistent toxic substances, or have focused only on marine or freshwaters. A globally coherent, drainage basin based assessment that embraces the inextricable links between transboundary freshwater and marine systems, and between environmental and societal issues, has never been conducted previously.

The Global Environment Facility (GEF)

The Global Environment Facility forges international co-operation and finances actions to address six critical threats to the global environment: biodiversity loss, climate change, degradation of international waters, ozone depletion, land degradation, and persistent organic pollutants (POPs).

The overall strategic thrust of GEF-funded international waters activities is to meet the incremental costs of: (a) assisting groups of countries to better understand the environmental concerns of their international waters and work collaboratively to address them; (b) building the capacity of existing institutions to utilise a more comprehensive approach for addressing transboundary water-related environmental concerns; and (c) implementing measures that address the priority transboundary environmental concerns. The goal is to assist countries to utilise the full range of technical, economic, financial, regulatory, and institutional measures needed to operationalise sustainable development strategies for international waters.

United Nations Environment Programme (UNEP)

United Nations Environment Programme, established in 1972, is the voice for the environment within the United Nations system. The mission of UNEP is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

UNEP work encompasses:

- Assessing global, regional and national environmental conditions and trends;
- Developing international and national environmental instruments;
- Strengthening institutions for the wise management of the environment;
- Facilitating the transfer of knowledge and technology for sustainable development;
- Encouraging new partnerships and mind-sets within civil society and the private sector.

University of Kalmar

University of Kalmar hosts the GIWA Co-ordination Office and provides scientific advice and administrative and technical assistance to GIWA. University of Kalmar is situated on the coast of the Baltic Sea. The city has a long tradition of higher education; teachers and marine officers have been educated in Kalmar since the middle of the 19th century. Today, natural science is a priority area which gives Kalmar a unique educational and research profile compared with other smaller universities in Sweden. Of particular relevance for GIWA is the established research in aquatic and environmental science. Issues linked to the concept of sustainable development are implemented by the research programme Natural Resources Management and Agenda 21 Research School.

Since its establishment GIWA has grown to become an integral part of University activities. The GIWA Co-ordination office and GIWA Core team are located at the Kalmarsund Laboratory, the university centre for water-related research. Senior scientists appointed by the University are actively involved in the GIWA peer-review and steering groups. As a result of the cooperation the University can offer courses and seminars related to GIWA objectives and international water issues.

International call for action

The need for a holistic assessment of transboundary waters in order to respond to growing public concerns and provide advice to governments and decision makers regarding the management of aquatic resources was recognised by several international bodies focusing on the global environment. In particular, the Global Environment Facility (GEF) observed that the International Waters (IW) component of the GEF suffered from the lack of a global assessment which made it difficult to prioritise international water projects, particularly considering the inadequate understanding of the nature and root causes of environmental problems. In 1996, at its fourth meeting in Nairobi, the GEF Scientific and Technical Advisory Panel (STAP), noted that: *"Lack of an International Waters Assessment comparable with that of the IPCC, the Global Biodiversity Assessment, and the Stratospheric Ozone Assessment, was a unique and serious impediment to the implementation of the International Waters Component of the GEF".*

The urgent need for an assessment of the causes of environmental degradation was also highlighted at the UN Special Session on the Environment (UNGASS) in 1997, where commitments were made regarding the work of the UN Commission on Sustainable Development (UNCSD) on freshwater in 1998 and seas in 1999. Also in 1997, two international Declarations, the Potomac Declaration: Towards enhanced ocean security into the third millennium, and the Stockholm Statement on interaction of land activities, freshwater and enclosed seas, specifically emphasised the need for an investigation of the root causes of degradation of the transboundary aquatic environment and options for addressing them. These processes led to the development of the Global International Waters Assessment (GIWA) that would be implemented by the United Nations Environment Programme (UNEP) in conjunction with the University of Kalmar, Sweden, on behalf of the GEF. The GIWA was inaugurated in Kalmar in October 1999 by the Executive Director of UNEP, Dr. Klaus Töpfer, and the late Swedish Minister of the Environment, Kjell Larsson. On this occasion Dr. Töpfer stated: *"GIWA is the framework of UNEP´s global water assessment strategy and will enable us to record and report on critical water resources for the planet for consideration of sustainable development management practices as part of our responsibilities under Agenda 21 agreements of the Rio conference*".

The importance of the GIWA has been further underpinned by the UN Millennium Development Goals adopted by the UN General Assembly in 2000 and the Declaration from the World Summit on Sustainable

Development in 2002. The development goals aimed to halve the proportion of people without access to safe drinking water and basic sanitation by the year 2015 (United Nations Millennium Declaration 2000). The WSSD also calls for integrated management of land, water and living resources (WSSD 2002) and, by 2010, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem should be implemented by all countries that are party to the declaration (FAO 2001).

The conceptual framework and objectives

Considering the general decline in the condition of the world's aquatic resources and the internationally recognised need for a globally coherent assessment of transboundary waters, the primary objectives of the GIWA are:

- To provide a prioritising mechanism that allows the GEF to focus their resources so that they are used in the most cost effective manner to achieve significant environmental benefits, at national, regional and global levels; and
- To highlight areas in which governments can develop and implement strategic policies to reduce environmental degradation and improve the management of aquatic resources.

In order to meet these objectives and address some of the current inadequacies in international aquatic resources management, the GIWA has incorporated four essential elements into its design:

- A broad transboundary approach that generates a truly regional perspective through the incorporation of expertise and existing information from all nations in the region and the assessment of all factors that influence the aquatic resources of the region;
- A drainage basin approach integrating freshwater and marine systems;
- A multidisciplinary approach integrating environmental and socio-economic information and expertise; and
- A coherent assessment that enables global comparison of the results.

The GIWA builds on previous assessments implemented within the GEF International Waters portfolio but has developed and adopted a broader definition of transboundary waters to include factors that influence the quality and quantity of global aquatic resources. For example, due to globalisation and international trade, the market for penaeid shrimps has widened and the prices soared. This, in turn, has encouraged entrepreneurs in South East Asia to expand aquaculture resulting in the large-scale deforestation of mangroves for ponds (Primavera 1997). Within the GIWA, these "non-hydrological" factors constitute as large a transboundary influence as more traditionally recognised problems, such as the construction of dams that regulate the flow of water into a neighbouring country, and are considered equally important. In addition, the GIWA recognises the importance of hydrological units that would not normally be considered transboundary but exert a significant influence on transboundary waters, such as the Yangtze River in China which discharges into the East China Sea (Daoji & Daler 2004) and the Volga River in Russia which is largely responsible for the condition of the Caspian Sea (Barannik et al. 2004). Furthermore, the GIWA is a truly regional assessment that has incorporated data from a wide range of sources and included expert knowledge and information from a wide range of sectors and from each country in the region. Therefore, the transboundary concept adopted by the GIWA extends to include impacts caused by globalisation, international trade, demographic changes and technological advances and recognises the need for international cooperation to address them.

International waters and transboundary issues

The term "international waters", as used for the purposes of the GEF Operational Strategy, includes the oceans, large marine ecosystems, enclosed or semi-enclosed seas and estuaries, as well as rivers, lakes, groundwater systems, and wetlands with transboundary drainage basins or common borders. The water-related ecosystems associated with these waters are considered integral parts of the systems.

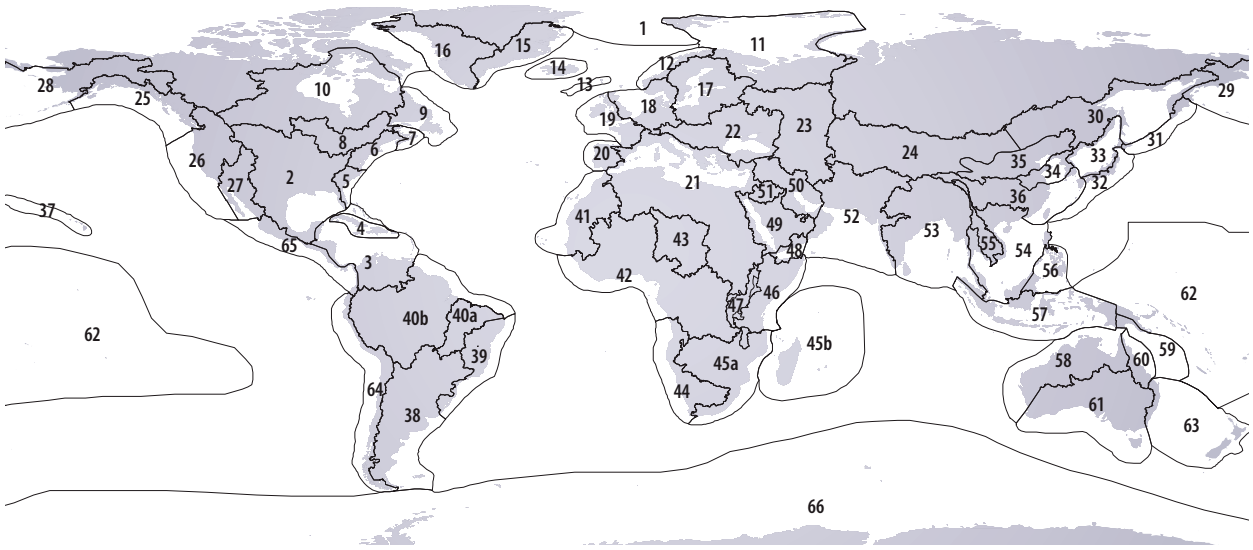
The term "transboundary issues" is used to describe the threats to the aquatic environment linked to globalisation, international trade, demographic changes and technological advancement, threats that are additional to those created through transboundary movement of water. Single country policies and actions are inadequate in order to cope with these challenges and this makes them transboundary in nature.

The international waters area includes numerous international conventions, treaties, and agreements. The architecture of marine agreements is especially complex, and a large number of bilateral and multilateral agreements exist for transboundary freshwater basins. Related conventions and agreements in other areas increase the complexity. These initiatives provide a new opportunity for cooperating nations to link many different programmes and instruments into regional comprehensive approaches to address international waters.

The organisational structure and implementation of the GIWA

The scale of the assessment

Initially, the scope of the GIWA was confined to transboundary waters in areas that included countries eligible to receive funds from the GEF. However, it was recognised that a truly global perspective would only be achieved if industrialised, GEF-ineligible regions of the world were also assessed. Financial resources to assess the GEF-eligible countries were obtained primarily from the GEF (68%), the Swedish International Development Cooperation Agency (Sida) (18%), and the Finnish Department for International Development Cooperation (FINNIDA)



1	*Arctic*	12	*Norwegian Sea (LME)*	24	*Aral Sea*	36	*East-China Sea (LME)*	46	*Somali Coastal Current (LME)*	58	*North Australian Shelf (LME)*
2	*Gulf of Mexico (LME)*	13	*Faroe plateau*	25	*Gulf of Alaska (LME)*	37	*Hawaiian Archipelago (LME)*	47	*East African Rift Valley Lakes*	59	*Coral Sea Basin*
3	*Caribbean Sea (LME)*	14	*Iceland Shelf (LME)*	26	*California Current (LME)*	38	*Patagonian Shelf (LME)*	48	*Gulf of Aden*	60	*Great Barrier Reef (LME)*
4	*Caribbean Islands*	15	*East Greenland Shelf (LME)*	27	*Gulf of California (LME)*	39	*Brazil Current (LME)*	49	*Red Sea (LME)*	61	*Great Australian Bight*
5	*Southeast Shelf (LME)*	16	*West Greenland Shelf (LME)*	28	*East Bering Sea (LME)*	40a	*Brazilian Northeast (LME)*	50	*The Gulf*	62	*Small Island States*
6	*Northeast Shelf (LME)*	17	*Baltic Sea (LME)*	29	*West Bering Sea (LME)*	40b	*Amazon*	51	*Jordan*	63	*Tasman Sea*
7	*Scotian Shelf (LME)*	18	*North Sea (LME)*	30	*Sea of Okhotsk (LME)*	41	*Canary Current (LME)*	52	*Arabian Sea (LME)*	64	*Humboldt Current (LME)*
8	*Gulf of St Lawrence*	19	*Celtic-Biscay Shelf (LME)*	31	*Oyashio Current (LME)*	42	*Guinea Current (LME)*	53	*Bay of Bengal S.E.*	65	*Eastern Equatorial Pacific*
9	*Newfoundland Shelf (LME)*	20	*Iberian Coastal (LME)*	32	*Kuroshio Current (LME)*	43	*Lake Chad*	54	*South China Sea (LME)*	66	*Antarctic (LME)*
10	*Baffin Bay, Labrador Sea, Canadian Archipelago*	21	*Mediterranean Sea (LME)*	33	*Sea of Japan/East Sea (LME)*	44	*Benguela Current (LME)*	55	*Mekong River*		
		22	*Black Sea (LME)*	34	*Yellow Sea (LME)*	45a	*Agulhas Current (LME)*	56	*Sulu-Celebes Sea (LME)*		
11	*Barents Sea (LME)*	23	*Caspian Sea*	35	*Bohai Sea*	45b	*Indian Ocean Islands*	57	*Indonesian Seas (LME)*		

Figure 1 The 66 transboundary regions assessed within the GIWA project.

(10%). Other contributions were made by Kalmar Municipality, the University of Kalmar and the Norwegian Government. The assessment of regions ineligible for GEF funds was conducted by various international and national organisations as in-kind contributions to the GIWA.

In order to be consistent with the transboundary nature of many of the world's aquatic resources and the focus of the GIWA, the geographical units being assessed have been designed according to the watersheds of discrete hydrographic systems rather than political borders (Figure 1). The geographic units of the assessment were determined during the preparatory phase of the project and resulted in the division of the world into 66 regions defined by the entire area of one or more catchments areas that drains into a single designated marine system. These marine systems often correspond to Large Marine Ecosystems (LMEs) (Sherman 1994, IOC 2002).

Large Marine Ecocsystems (LMEs)

Large Marine Ecosystems (LMEs) are regions of ocean space encompassing coastal areas from river basins and estuaries to the seaward boundaries of continental shelves and the outer margin of the major current systems. They are relatively large regions on the order of 200 000 km^2 or greater, characterised by distinct: (1) bathymetry, (2) hydrography, (3) productivity, and (4) trophically dependent populations.

The Large Marine Ecosystems strategy is a global effort for the assessment and management of international coastal waters. It developed in direct response to a declaration at the 1992 Rio Summit. As part of the strategy, the World Conservation Union (IUCN) and National Oceanic and Atmospheric Administration (NOAA) have joined in an action program to assist developing countries in planning and implementing an ecosystem-based strategy that is focused on LMEs as the principal assessment and management units for coastal ocean resources. The LME concept is also adopted by GEF that recommends the use of LMEs and their contributing freshwater basins as the geographic area for integrating changes in sectoral economic activities.

Considering the objectives of the GIWA and the elements incorporated into its design, a new methodology for the implementation of the assessment was developed during the initial phase of the project. The methodology focuses on five major environmental concerns which constitute the foundation of the GIWA assessment; Freshwater shortage, Pollution, Habitat and community modification, Overexploitation of fish and other living resources, and Global change. The GIWA methodology is outlined in the following chapter.

The global network

In each of the 66 regions, the assessment is conducted by a team of local experts that is headed by a Focal Point (Figure 2). The Focal Point can be an individual, institution or organisation that has been selected on the basis of their scientific reputation and experience implementing international assessment projects. The Focal Point is responsible for assembling members of the team and ensuring that it has the necessary expertise and experience in a variety of environmental and socio-economic disciplines to successfully conduct the regional assessment. The selection of team members is one of the most critical elements for the success of GIWA and, in order to ensure that the most relevant information is incorporated into the assessment, team members were selected from a wide variety of institutions such as universities, research institutes, government agencies, and the private sector. In addition, in order to ensure that the assessment produces a truly regional perspective, the teams should include representatives from each country that shares the region.

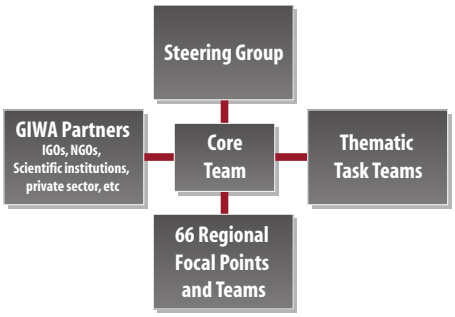


Figure 2 The organisation of the GIWA project.

In total, more than 1 000 experts have contributed to the implementation of the GIWA illustrating that the GIWA is a participatory exercise that relies on regional expertise. This participatory approach is essential because it instils a sense of local ownership of the project, which ensures the credibility of the findings and moreover, it has created a global network of experts and institutions that can collaborate and exchange experiences and expertise to help mitigate the continued degradation of the world's aquatic resources.

GIWA Regional reports

The GIWA was established in response to growing concern among the general public regarding the quality of the world's aquatic resources and the recognition of governments and the international community concerning the absence of a globally coherent international waters assessment. However, because a holistic, region-by-region, assessment of the condition of the world's transboundary water resources had never been undertaken, a methodology guiding the implementation of such an assessment did not exist. Therefore, in order to implement the GIWA, a new methodology that adopted a multidisciplinary, multi-sectoral, multi-national approach was developed and is now available for the implementation of future international assessments of aquatic resources.

UNEP Water Policy and Strategy

The primary goals of the UNEP water policy and strategy are:

(a) Achieving greater global understanding of freshwater, coastal and marine environments by conducting environmental assessments in priority areas;

(b) Raising awareness of the importance and consequences of unsustainable water use;

(c) Supporting the efforts of Governments in the preparation and implementation of integrated management of freshwater systems and their related coastal and marine environments;

(d) Providing support for the preparation of integrated management plans and programmes for aquatic environmental hot spots, based on the assessment results;

(e) Promoting the application by stakeholders of precautionary, preventive and anticipatory approaches.

The GIWA is comprised of a logical sequence of four integrated components. The first stage of the GIWA is called Scaling and is a process by which the geographic area examined in the assessment is defined and all the transboundary waters within that area are identified. Once the geographic scale of the assessment has been defined, the assessment teams conduct a process known as Scoping in which the magnitude of environmental and associated socio-economic impacts of Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources, and Global change is assessed in order to identify and prioritise the concerns that require the most urgent intervention. The assessment of these predefined concerns incorporates the best available information and the knowledge and experience of the multidisciplinary, multi-national assessment teams formed in each region. Once the priority concerns have been identified, the root causes of these concerns are identified during the third component of the GIWA, Causal chain analysis. The root causes are determined through a sequential process that identifies, in turn, the most significant immediate causes followed by the economic sectors that are primarily responsible for the immediate causes and finally, the societal root causes. At each stage in the Causal chain analysis, the most significant contributors are identified through an analysis of the best available information which is augmented by the expertise of the assessment team. The final component of the GIWA is the development of Policy options that focus on mitigating the impacts of the root causes identified by the Causal chain analysis.

The results of the GIWA assessment in each region are reported in regional reports that are published by UNEP. These reports are designed to provide a brief physical and socio-economic description of the most important features of the region against which the results of the assessment can be cast. The remaining sections of the report present the results of each stage of the assessment in an easily digestible form. Each regional report is reviewed by at least two independent external reviewers in order to ensure the scientific validity and applicability of each report. The 66 regional assessments of the GIWA will serve UNEP as an essential complement to the UNEP Water Policy and Strategy and UNEP's activities in the hydrosphere.

Global International Waters Assessment

References:

AMAP (1998). Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway.

Barannik, V., Borysova, O. and Stolberg, F. (2004). The Caspian Sea Region: Environmental Change. Ambio, 33:45-51.

Brinson, M.M. and Malvárez, A.I. (2002). Temperate freshwater wetlands: types, status, and threats. Environmental Conservation, 29:115-133.

Daoji, L. and Daler, D. (2004). Ocean Pollution from Land-based Sources: East China Sea, China. Ambio, 33:98-106.

FAO (2001). Reykjavik conference on responsible fisheries in the marine ecosystem. Iceland, 1-4 October 2001.

IOC (2002). IOC-IUCN-NOAA Consultative Meeting on Large Marine Ecosystems (LMEs). Fourth Session, 8-9 January 2002, Paris, France.

IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. In: Houghton, J.T., Ding, Y., Griggs, D.J., Noguer, M., van der Linden, P.J., Dai, X., Maskell, K. and Johnson, C.A. (eds). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kennish, M.J. (2002). Environmental threats and environmental future of estuaries. Environmental Conservation, 29:78-107.

Myers, R.A. and Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. Nature, 423:280-283.

Primavera, J.H. (1997) Socio-economic impacts of shrimp culture. Aquaculture Research, 28:815-827.

Sherman, K. (1994). Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. Marine Ecology Progress Series, 112:277-301.

United Nations conference on the human environment (1972). Report available on-line at http://www.unep.org

United Nations Millennium Declaration (2000). The Millennium Assembly of the United Nations, New York.

WHO-UNICEF (2002). Global Water Supply and Sanitation Assessment: 2000 Report.

WSSD (2002). World Summit on Sustainable Development. Johannesburg Summit 2002. Key Outcomes of the Summit, UN Department of Public Information, New York.

The GIWA methodology

The specific objectives of the GIWA were to conduct a holistic and globally comparable assessment of the world's transboundary aquatic resources that incorporated both environmental and socio-economic factors and recognised the inextricable links between freshwater and marine environments, in order to enable the GEF to focus their resources and to provide guidance and advice to governments and decision makers. The coalition of all these elements into a single coherent methodology that produces an assessment that achieves each of these objectives had not previously been done and posed a significant challenge.

The integration of each of these elements into the GIWA methodology was achieved through an iterative process guided by a specially convened Methods task team that was comprised of a number of international assessment and water experts. Before the final version of the methodology was adopted, preliminary versions underwent an extensive external peer review and were subjected to preliminary testing in selected regions. Advice obtained from the Methods task team and other international experts and the lessons learnt from preliminary testing were incorporated into the final version that was used to conduct each of the GIWA regional assessments.

Considering the enormous differences between regions in terms of the quality, quantity and availability of data, socio-economic setting and environmental conditions, the achievement of global comparability required an innovative approach. This was facilitated by focusing the assessment on the impacts of five pre-defined concerns namely; Freshwater shortage, Pollution, Habitat and community modification, Unsustainable exploitation of fish and other living resources and Global change, in transboundary waters. Considering the diverse range of elements encompassed by each concern, assessing the magnitude of the impacts caused by these concerns was facilitated by evaluating the impacts of 22 specific issues that were grouped within these concerns (see Table 1).

The assessment integrates environmental and socio-economic data from each country in the region to determine the severity of the impacts of each of the five concerns and their constituent issues on the entire region. The integration of this information was facilitated by implementing the assessment during two participatory workshops that typically involved 10 to 15 environmental and socio-economic experts from each country in the region. During these workshops, the regional teams performed preliminary analyses based on the collective knowledge and experience of these local experts. The results of these analyses were substantiated with the best available information to be presented in a regional report.

Table 1 Pre-defined GIWA concerns and their constituent issues addressed within the assessment.

Environmental issues	Major concerns
1. Modification of stream flow 2. Pollution of existing supplies 3. Changes in the water table	**I Freshwater shortage**
4. Microbiological 5. Eutrophication 6. Chemical 7. Suspended solids 8. Solid wastes 9. Thermal 10. Radionuclide 11. Spills	**II Pollution**
12. Loss of ecosystems 13. Modification of ecosystems or ecotones, including community structure and/or species composition	**III Habitat and community modification**
14. Overexploitation 15. Excessive by-catch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	**IV Unsustainable exploitation of fish and other living resources**
19. Changes in hydrological cycle 20. Sea level change 21. Increased uv-b radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	**V Global change**

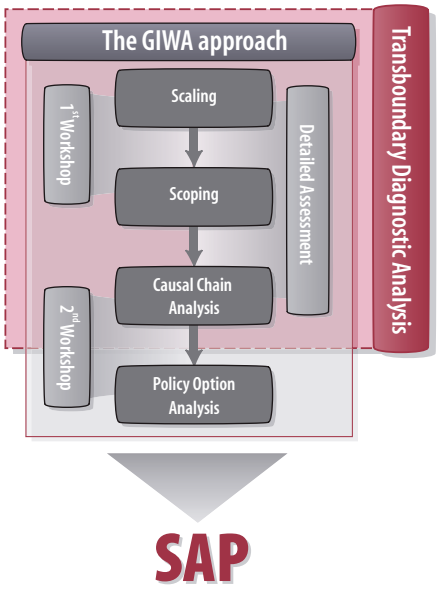


Figure 1 Illustration of the relationship between the GIWA approach and other projects implemented within the GEF International Waters (IW) portfolio.

The GIWA is a logical contiguous process that defines the geographic region to be assessed, identifies and prioritises particularly problems based on the magnitude of their impacts on the environment and human societies in the region, determines the root causes of those problems and, finally, assesses various policy options that addresses those root causes in order to reverse negative trends in the condition of the aquatic environment. These four steps, referred to as Scaling, Scoping, Causal chain analysis and Policy options analysis, are summarised below and are described in their entirety in two volumes: *GIWA Methodology Stage 1: Scaling and Scoping*; and *GIWA Methodology: Detailed Assessment, Causal Chain Analysis and Policy Options Analysis*. Generally, the components of the GIWA methodology are aligned with the framework adopted by the GEF for Transboundary Diagnostic Analyses (TDAs) and Strategic Action Programmes (SAPs) (Figure 1) and assume a broad spectrum of transboundary influences in addition to those associated with the physical movement of water across national borders.

Scaling – Defining the geographic extent of the region

Scaling is the first stage of the assessment and is the process by which the geographic scale of the assessment is defined. In order to facilitate the implementation of the GIWA, the globe was divided during the design phase of the project into 66 contiguous regions. Considering the transboundary nature of many aquatic resources and the transboundary focus of the GIWA, the boundaries of the regions did not comply with political boundaries but were instead, generally defined by a large but discrete drainage basin that also included the coastal marine waters into which the basin discharges. In many cases, the marine areas examined during the assessment coincided with the Large Marine Ecosystems (LMEs) defined by the US National Atmospheric and Oceanographic Administration (NOAA). As a consequence, scaling should be a relatively straight-forward task that involves the inspection of the boundaries that were proposed for the region during the preparatory phase of GIWA to ensure that they are appropriate and that there are no important overlaps or gaps with neighbouring regions. When the proposed boundaries were found to be inadequate, the boundaries of the region were revised according to the recommendations of experts from both within the region and from adjacent regions so as to ensure that any changes did not result in the exclusion of areas from the GIWA. Once the regional boundary was defined, regional teams identified all the transboundary elements of the aquatic environment within the region and determined if these elements could be assessed as a single coherent aquatic system or if there were two or more independent systems that should be assessed separately.

Scoping – Assessing the GIWA concerns

Scoping is an assessment of the severity of environmental and socio-economic impacts caused by each of the five pre-defined GIWA concerns and their constituent issues (Table 1). It is not designed to provide an exhaustive review of water-related problems that exist within each region, but rather it is a mechanism to identify the most urgent problems in the region and prioritise those for remedial actions. The priorities determined by Scoping are therefore one of the main outputs of the GIWA project.

Focusing the assessment on pre-defined concerns and issues ensured the comparability of the results between different regions. In addition, to ensure the long-term applicability of the options that are developed to mitigate these problems, Scoping not only assesses the current impacts of these concerns and issues but also the probable future impacts according to the "most likely scenario" which considered demographic, economic, technological and other relevant changes that will potentially influence the aquatic environment within the region by 2020.

The magnitude of the impacts caused by each issue on the environment and socio-economic indicators was assessed over the entire region using the best available information from a wide range of sources and the knowledge and experience of the each of the experts comprising the regional team. In order to enhance the comparability of the assessment between different regions and remove biases in the assessment caused by different perceptions of and ways to communicate the severity of impacts caused by particular issues, the

results were distilled and reported as standardised scores according to the following four point scale:

- 0 = no known impact
- 1 = slight impact
- 2 = moderate impact
- 3 = severe impact

The attributes of each score for each issue were described by a detailed set of pre-defined criteria that were used to guide experts in reporting the results of the assessment. For example, the criterion for assigning a score of 3 to the issue Loss of ecosystems or ecotones is: "*Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.*" The full list of criteria is presented at the end of the chapter, Table 5a-e. Although the scoring inevitably includes an arbitrary component, the use of predefined criteria facilitates comparison of impacts on a global scale and also encouraged consensus of opinion among experts.

The trade-off associated with assessing the impacts of each concern and their constituent issues at the scale of the entire region is that spatial resolution was sometimes low. Although the assessment provides a score indicating the severity of impacts of a particular issue or concern on the entire region, it does not mean that the entire region suffers the impacts of that problem. For example, eutrophication could be identified as a severe problem in a region, but this does not imply that all waters in the region suffer from severe eutrophication. It simply means that when the degree of eutrophication, the size of the area affected, the socio-economic impacts and the number of people affected is considered, the magnitude of the overall impacts meets the criteria defining a severe problem and that a regional action should be initiated in order to mitigate the impacts of the problem.

When each issue has been scored, it was weighted according to the relative contribution it made to the overall environmental impacts of the concern and a weighted average score for each of the five concerns was calculated (Table 2). Of course, if each issue was deemed to make equal contributions, then the score describing the overall impacts of the concern was simply the arithmetic mean of the scores allocated to each issue within the concern.
In addition, the socio-economic impacts of each of the five major concerns were assessed for the entire region. The socio-economic impacts were grouped into three categories; Economic impacts, Health impacts and Other social and community impacts (Table 3). For each category, an evaluation of the size, degree and frequency of the impact was performed and, once completed, a weighted average score describing the overall socio-economic impacts of each concern was calculated in the same manner as the overall environmental score.

Table 2 Example of environmental impact assessment of Freshwater shortage.

Environmental issues	Score	Weight %	Environmental concerns	Weight averaged score
1. Modification of stream flow	1	20	Freshwater shortage	1.50
2. Pollution of existing supplies	2	50		
3. Changes in the water table	1	30		

Table 3 Example of Health impacts assessment linked to one of the GIWA concerns.

Criteria for Health impacts	Raw score	Score	Weight %
Number of people affected	Very small ... Very large 0 1 2 3	2	50
Degree of severity	Minimum ... Severe 0 1 2 3	2	30
Frequency/Duration	Occasion/Short ... Continuous 0 1 2 3	2	20
Weight average score for Health impacts		**2**	

After all 22 issues and associated socio-economic impacts have been scored, weighted and averaged, the magnitude of likely future changes in the environmental and socio-economic impacts of each of the five concerns on the entire region is assessed according to the most likely scenario which describes the demographic, economic, technological and other relevant changes that might influence the aquatic environment within the region by 2020.

In order to prioritise among GIWA concerns within the region and identify those that will be subjected to causal chain and policy options analysis in the subsequent stages of the GIWA, the present and future scores of the environmental and socio-economic impacts of each concern are tabulated and an overall score calculated. In the example presented in Table 4, the scoping assessment indicated that concern III, Habitat and community modification, was the priority concern in this region. The outcome of this mathematic process was reconciled against the knowledge of experts and the best available information in order to ensure the validity of the conclusion.

In some cases however, this process and the subsequent participatory discussion did not yield consensus among the regional experts regarding the ranking of priorities. As a consequence, further analysis was required. In such cases, expert teams continued by assessing the relative importance of present and potential future impacts and assign weights to each. Afterwards, the teams assign weights indicating the relative contribution made by environmental and socio-economic factors to the overall impacts of the concern. The weighted average score for each concern is then recalculated taking into account

Table 4 Example of comparative environmental and socio-economic impacts of each major concern, presently and likely in year 2020.

Concern	Types of impacts								Overall score
	Environmental score		Economic score		Human health score		Social and community score		
	Present (a)	Future (b)	Present (c)	Future (d)	Present (e)	Future (f)	Present (g)	Future (h)	
Freshwater shortage	1.3	2.3	2.7	2.8	2.6	3.0	1.8	2.2	**2.3**
Pollution	1.5	2.0	2.0	2.3	1.8	2.3	2.0	2.3	**2.0**
Habitat and community modification	2.0	3.0	2.4	3.0	2.4	2.8	2.3	2.7	**2.6**
Unsustainable exploitation of fish and other living resources	1.8	2.2	2.0	2.1	2.0	2.1	2.4	2.5	**2.1**
Global change	0.8	1.0	1.5	1.7	1.5	1.5	1.0	1.0	**1.2**

the relative contributions of both present and future impacts and environmental and socio-economic factors. The outcome of these additional analyses was subjected to further discussion to identify overall priorities for the region.

Finally, the assessment recognises that each of the five GIWA concerns are not discrete but often interact. For example, pollution can destroy aquatic habitats that are essential for fish reproduction which, in turn, can cause declines in fish stocks and subsequent overexploitation. Once teams have ranked each of the concerns and determined the priorities for the region, the links between the concerns are highlighted in order to identify places where strategic interventions could be applied to yield the greatest benefits for the environment and human societies in the region.

Causal chain analysis

Causal Chain Analysis (CCA) traces the cause-effect pathways from the socio-economic and environmental impacts back to their root causes. The GIWA CCA aims to identify the most important causes of each concern prioritised during the scoping assessment in order to direct policy measures at the most appropriate target in order to prevent further degradation of the regional aquatic environment.

Root causes are not always easy to identify because they are often spatially or temporally separated from the actual problems they cause. The GIWA CCA was developed to help identify and understand the root causes of environmental and socio-economic problems in international waters and is conducted by identifying the human activities that cause the problem and then the factors that determine the ways in which these activities are undertaken. However, because there is no universal theory describing how root causes interact to create natural resource management problems and due to the great variation of local circumstances under which the methodology will be applied, the GIWA CCA is not a rigidly structured assessment but should be regarded as a framework to guide the analysis, rather than as a set of detailed instructions. Secondly, in an ideal setting, a causal chain would be produced by a multidisciplinary group of specialists that would statistically examine each successive cause and study its links to the problem and to other causes. However, this approach (even if feasible) would use far more resources and time than those available to GIWA[1]. For this reason, it has been necessary to develop a relatively simple and practical analytical model for gathering information to assemble meaningful causal chains.

Conceptual model

A causal chain is a series of statements that link the causes of a problem with its effects. Recognising the great diversity of local settings and the resulting difficulty in developing broadly applicable policy strategies, the GIWA CCA focuses on a particular system and then only on those issues that were prioritised during the scoping assessment. The starting point of a particular causal chain is one of the issues selected during the Scaling and Scoping stages and its related environmental and socio-economic impacts. The next element in the GIWA chain is the immediate cause; defined as the physical, biological or chemical variable that produces the GIWA issue. For example, for the issue of eutrophication the immediate causes may be, inter alia:

- Enhanced nutrient inputs;
- Increased recycling/mobilisation;
- Trapping of nutrients (e.g. in river impoundments);
- Run-off and stormwaters

Once the relevant immediate cause(s) for the particular system has (have) been identified, the sectors of human activity that contribute most significantly to the immediate cause have to be determined. Assuming that the most important immediate cause in our example had been increased nutrient concentrations, then it is logical that the most likely sources of those nutrients would be the agricultural, urban or industrial sectors. After identifying the sectors that are primarily

[1] This does not mean that the methodology ignores statistical or quantitative studies; as has already been pointed out, the available evidence that justifies the assumption of causal links should be provided in the assessment.

responsible for the immediate causes, the root causes acting on those sectors must be determined. For example, if agriculture was found to be primarily responsible for the increased nutrient concentrations, the root causes could potentially be:

- Economic (e.g. subsidies to fertilisers and agricultural products);
- Legal (e.g. inadequate regulation);
- Failures in governance (e.g. poor enforcement); or
- Technology or knowledge related (e.g. lack of affordable substitutes for fertilisers or lack of knowledge as to their application).

Once the most relevant root causes have been identified, an explanation, which includes available data and information, of how they are responsible for the primary environmental and socio-economic problems in the region should be provided.

Policy option analysis

Despite considerable effort of many Governments and other organisations to address transboundary water problems, the evidence indicates that there is still much to be done in this endeavour. An important characteristic of GIWA's Policy Option Analysis (POA) is that its recommendations are firmly based on a better understanding of the root causes of the problems. Freshwater scarcity, water pollution, overexploitation of living resources and habitat destruction are very complex phenomena. Policy options that are grounded on a better understanding of these phenomena will contribute to create more effective societal responses to the extremely complex water related transboundary problems. The core of POA in the assessment consists of two tasks:

Construct policy options

Policy options are simply different courses of action, which are not always mutually exclusive, to solve or mitigate environmental and socio-economic problems in the region. Although a multitude of different policy options could be constructed to address each root cause identified in the CCA, only those few policy options that have the greatest likelihood of success were analysed in the GIWA.

Select and apply the criteria on which the policy options will be evaluated

Although there are many criteria that could be used to evaluate any policy option, GIWA focuses on:

- Effectiveness (certainty of result)
- Efficiency (maximisation of net benefits)
- Equity (fairness of distributional impacts)
- Practical criteria (political acceptability, implementation feasibility).

The policy options recommended by the GIWA are only contributions to the larger policy process and, as such, the GIWA methodology developed to test the performance of various options under the different circumstances has been kept simple and broadly applicable.

Global International Waters Assessment

Table 5a: Scoring criteria for environmental impacts of Freshwater shortage

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 1: Modification of stream flow "An increase or decrease in the discharge of streams and rivers as a result of human interventions on a local/ regional scale (see Issue 19 for flow alterations resulting from global change) over the last 3-4 decades."	■ No evidence of modification of stream flow.	■ There is a measurably changing trend in annual river discharge at gauging stations in a major river or tributary (basin > 40 000 km^2); or ■ There is a measurable decrease in the area of wetlands (other than as a consequence of conversion or embankment construction); or ■ There is a measurable change in the interannual mean salinity of estuaries or coastal lagoons and/or change in the mean position of estuarine salt wedge or mixing zone; or ■ Change in the occurrence of exceptional discharges (e.g. due to upstream damming.	■ Significant downward or upward trend (more than 20% of the long term mean) in annual discharges in a major river or tributary draining a basin of >250 000 km^2; or ■ Loss of >20% of flood plain or deltaic wetlands through causes other than conversion or artificial embankments; or ■ Significant loss of riparian vegetation (e.g. trees, flood plain vegetation); or ■ Significant saline intrusion into previously freshwater rivers or lagoons.	■ Annual discharge of a river altered by more than 50% of long term mean; or ■ Loss of >50% of riparian or deltaic wetlands over a period of not less than 40 years (through causes other than conversion or artificial embankment); or ■ Significant increased siltation or erosion due to changing in flow regime (other than normal fluctuations in flood plain rivers); or ■ Loss of one or more anadromous or catadromous fish species for reasons other than physical barriers to migration, pollution or overfishing.
Issue 2: Pollution of existing supplies "Pollution of surface and ground fresh waters supplies as a result of point or diffuse sources"	■ No evidence of pollution of surface and ground waters.	■ Any monitored water in the region does not meet WHO or national drinking water criteria, other than for natural reasons; or ■ There have been reports of one or more fish kills in the system due to pollution within the past five years.	■ Water supplies does not meet WHO or national drinking water standards in more than 30% of the region; or ■ There are one or more reports of fish kills due to pollution in any river draining a basin of >250 000 km^2 .	■ River draining more than 10% of the basin have suffered polysaprobic conditions, no longer support fish, or have suffered severe oxygen depletion ■ Severe pollution of other sources of freshwater (e.g. groundwater)
Issue 3: Changes in the water table "Changes in aquifers as a direct or indirect consequence of human activity"	■ No evidence that abstraction of water from aquifers exceeds natural replenishment.	■ Several wells have been deepened because of excessive aquifer draw-down; or ■ Several springs have dried up; or ■ Several wells show some salinisation.	■ Clear evidence of declining base flow in rivers in semi-arid areas; or ■ Loss of plant species in the past decade, that depend on the presence of ground water; or ■ Wells have been deepened over areas of hundreds of km^2;or ■ Salinisation over significant areas of the region.	■ Aquifers are suffering salinisation over regional scale; or ■ Perennial springs have dried up over regionally significant areas; or ■ Some aquifers have become exhausted

Table 5b: Scoring criteria for environmental impacts of Pollution

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 4: Microbiological pollution "The adverse effects of microbial constituents of human sewage released to water bodies."	■ Normal incidence of bacterial related gastroenteric disorders in fisheries product consumers and no fisheries closures or advisories.	■ There is minor increase in incidence of bacterial related gastroenteric disorders in fisheries product consumers but no fisheries closures or advisories.	■ Public health authorities aware of marked increase in the incidence of bacterial related gastroenteric disorders in fisheries product consumers; or ■ There are limited area closures or advisories reducing the exploitation or marketability of fisheries products.	■ There are large closure areas or very restrictive advisories affecting the marketability of fisheries products; or ■ There exists widespread public or tourist awareness of hazards resulting in major reductions in the exploitation or marketability of fisheries products.
Issue 5: Eutrophication "Artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients, including cultural eutrophication in lakes."	■ No visible effects on the abundance and distributions of natural living resource distributions in the area; and ■ No increased frequency of hypoxia[1] or fish mortality events or harmful algal blooms associated with enhanced primary production; and ■ No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality; and ■ No evident abnormality in the frequency of algal blooms.	■ Increased abundance of epiphytic algae; or ■ A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets; or ■ Measurable shallowing of the depth range of macrophytes.	■ Increased filamentous algal production resulting in algal mats; or ■ Medium frequency (up to once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.	■ High frequency (>1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms; or ■ Significant changes in the littoral community; or ■ Presence of hydrogen sulphide in historically well oxygenated areas.

Issue 6: Chemical pollution "The adverse effects of chemical contaminants released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic or persistent or bioaccumulating."	■ No known or historical levels of chemical contaminants except background levels of naturally occurring substances; and ■ No fisheries closures or advisories due to chemical pollution; and ■ No incidence of fisheries product tainting; and ■ No unusual fish mortality events. If there is no available data use the following criteria: ■ No use of pesticides; and ■ No sources of dioxins and furans; and ■ No regional use of PCBs; and ■ No bleached kraft pulp mills using chlorine bleaching; and ■ No use or sources of other contaminants.	■ Some chemical contaminants are detectable but below threshold limits defined for the country or region; or ■ Restricted area advisories regarding chemical contamination of fisheries products. If there is no available data use the following criteria: ■ Some use of pesticides in small areas; or ■ Presence of small sources of dioxins or furans (e.g., small incineration plants or bleached kraft/pulp mills using chlorine); or ■ Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns; or ■ Presence of other contaminants.	■ Some chemical contaminants are above threshold limits defined for the country or region; or ■ Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures; or ■ High mortalities of aquatic species near outfalls. If there is no available data use the following criteria: ■ Large-scale use of pesticides in agriculture and forestry; or ■ Presence of major sources of dioxins or furans such as large municipal or industrial incinerators or large bleached kraft pulp mills; or ■ Considerable quantities of waste PCBs in the area with inadequate regulation or has invoked some public concerns; or ■ Presence of considerable quantities of other contaminants.	■ Chemical contaminants are above threshold limits defined for the country or region; and ■ Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by area closures of fisheries; or ■ Large-scale mortalities of aquatic species. If there is no available data use the following criteria: ■ Indications of health effects resulting from use of pesticides; or ■ Known emissions of dioxins or furans from incinerators or chlorine bleaching of pulp; or ■ Known contamination of the environment or foodstuffs by PCBs; or ■ Known contamination of the environment or foodstuffs by other contaminants.
Issue 7: Suspended solids "The adverse effects of modified rates of release of suspended particulate matter to water bodies resulting from human activities"	■ No visible reduction in water transparency; and ■ No evidence of turbidity plumes or increased siltation; and ■ No evidence of progressive riverbank, beach, other coastal or deltaic erosion.	■ Evidently increased or reduced turbidity in streams and/or receiving riverine and marine environments but without major changes in associated sedimentation or erosion rates, mortality or diversity of flora and fauna; or ■ Some evidence of changes in benthic or pelagic biodiversity in some areas due to sediment blanketing or increased turbidity.	■ Markedly increased or reduced turbidity in small areas of streams and/or receiving riverine and marine environments; or ■ Extensive evidence of changes in sedimentation or erosion rates; or ■ Changes in benthic or pelagic biodiversity in areas due to sediment blanketing or increased turbidity.	■ Major changes in turbidity over wide or ecologically significant areas resulting in markedly changed biodiversity or mortality in benthic species due to excessive sedimentation with or without concomitant changes in the nature of deposited sediments (i.e., grain-size composition/redox); or ■ Major change in pelagic biodiversity or mortality due to excessive turbidity.
Issue 8: Solid wastes "Adverse effects associated with the introduction of solid waste materials into water bodies or their environs."	■ No noticeable interference with trawling activities; and ■ No noticeable interference with the recreational use of beaches due to litter; and ■ No reported entanglement of aquatic organisms with debris.	■ Some evidence of marine-derived litter on beaches; or ■ Occasional recovery of solid wastes through trawling activities; but ■ Without noticeable interference with trawling and recreational activities in coastal areas.	■ Widespread litter on beaches giving rise to public concerns regarding the recreational use of beaches; or ■ High frequencies of benthic litter recovery and interference with trawling activities; or ■ Frequent reports of entanglement/ suffocation of species by litter.	■ Incidence of litter on beaches sufficient to deter the public from recreational activities; or ■ Trawling activities untenable because of benthic litter and gear entanglement; or ■ Widespread entanglement and/or suffocation of aquatic species by litter.
Issue 9: Thermal "The adverse effects of the release of aqueous effluents at temperatures exceeding ambient temperature in the receiving water body."	■ No thermal discharges or evidence of thermal effluent effects.	■ Presence of thermal discharges but without noticeable effects beyond the mixing zone and no significant interference with migration of species.	■ Presence of thermal discharges with large mixing zones having reduced productivity or altered biodiversity; or ■ Evidence of reduced migration of species due to thermal plume.	■ Presence of thermal discharges with large mixing zones with associated mortalities, substantially reduced productivity or noticeable changes in biodiversity; or ■ Marked reduction in the migration of species due to thermal plumes.
Issue 10: Radionuclide "The adverse effects of the release of radioactive contaminants and wastes into the aquatic environment from human activities."	■ No radionuclide discharges or nuclear activities in the region.	■ Minor releases or fallout of radionuclides but with well regulated or well-managed conditions complying with the Basic Safety Standards.	■ Minor releases or fallout of radionuclides under poorly regulated conditions that do not provide an adequate basis for public health assurance or the protection of aquatic organisms but without situations or levels likely to warrant large scale intervention by a national or international authority.	■ Substantial releases or fallout of radionuclides resulting in excessive exposures to humans or animals in relation to those recommended under the Basic Safety Standards; or ■ Some indication of situations or exposures warranting intervention by a national or international authority.
Issue 11: Spills "The adverse effects of accidental episodic releases of contaminants and materials to the aquatic environment as a result of human activities."	■ No evidence of present or previous spills of hazardous material; or ■ No evidence of increased aquatic or avian species mortality due to spills.	■ Some evidence of minor spills of hazardous materials in small areas with insignificant small-scale adverse effects one aquatic or avian species.	■ Evidence of widespread contamination by hazardous or aesthetically displeasing materials assumed to be from spillage (e.g. oil slicks) but with limited evidence of widespread adverse effects on resources or amenities; or ■ Some evidence of aquatic or avian species mortality through increased presence of contaminated or poisoned carcasses on beaches.	■ Widespread contamination by hazardous or aesthetically displeasing materials from frequent spills resulting in major interference with aquatic resource exploitation or coastal recreational amenities; or ■ Significant mortality of aquatic or avian species as evidenced by large numbers of contaminated carcasses on beaches.

Table 5c: Scoring criteria for environmental impacts of Habitat and community modification

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 12: Loss of ecosystems or ecotones "The complete destruction of aquatic habitats. For the purpose of GIWA methodology, recent loss will be measured as a loss of pre-defined habitats over the last 2-3 decades."	■ There is no evidence of loss of ecosystems or habitats.	■ There are indications of fragmentation of at least one of the habitats.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by up to 30 % during the last 2-3 decades.	■ Permanent destruction of at least one habitat is occurring such as to have reduced their surface area by >30% during the last 2-3 decades.
Issue 13: Modification of ecosystems or ecotones, including community structure and/or species composition "Modification of pre-defined habitats in terms of extinction of native species, occurrence of introduced species and changing in ecosystem function and services over the last 2-3 decades."	■ No evidence of change in species complement due to species extinction or introduction; and ■ No changing in ecosystem function and services.	■ Evidence of change in species complement due to species extinction or introduction	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure	■ Evidence of change in species complement due to species extinction or introduction; and ■ Evidence of change in population structure or change in functional group composition or structure; and ■ Evidence of change in ecosystem services[2].

[2] Constanza, R. et al. (1997). The value of the world ecosystem services and natural capital, Nature 387:253-260.

Table 5d: Scoring criteria for environmental impacts of Unsustainable exploitation of fish and other living resources

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 14: Overexploitation "The capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock."	■ No harvesting exists catching fish (with commercial gear for sale or subsistence).	■ Commercial harvesting exists but there is no evidence of over-exploitation.	■ One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits.	■ More than one stock is exploited beyond MSY or is outside safe biological limits.
Issue 15: Excessive by-catch and discards "By-catch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refers to dead fish or other animals that are returned to the sea."	■ Current harvesting practices show no evidence of excessive by-catch and/or discards.	■ Up to 30% of the fisheries yield (by weight) consists of by-catch and/or discards.	■ 30-60% of the fisheries yield consists of by-catch and/or discards.	■ Over 60% of the fisheries yield is by-catch and/or discards; or ■ Noticeable incidence of capture of endangered species.
Issue 16: Destructive fishing practices "Fishing practices that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities."	■ No evidence of habitat destruction due to fisheries practices.	■ Habitat destruction resulting in changes in distribution of fish or shellfish stocks; or ■ Trawling of any one area of the seabed is occurring less than once per year.	■ Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment; or ■ Trawling of any one area of the seabed is occurring 1-10 times per year; or ■ Incidental use of explosives or poisons for fishing.	■ Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment; or ■ Trawling of any one area of the seabed is occurring more than 10 times per year; or ■ Widespread use of explosives or poisons for fishing.
Issue 17: Decreased viability of stocks through contamination and disease "Contamination or diseases of feral (wild) stocks of fish or invertebrates that are a direct or indirect consequence of human action."	■ No evidence of increased incidence of fish or shellfish diseases.	■ Increased reports of diseases without major impacts on the stock.	■ Declining populations of one or more species as a result of diseases or contamination.	■ Collapse of stocks as a result of diseases or contamination.
Issue 18: Impact on biological and genetic diversity "Changes in genetic and species diversity of aquatic environments resulting from the introduction of alien or genetically modified species as an intentional or unintentional result of human activities including aquaculture and restocking."	■ No evidence of deliberate or accidental introductions of alien species; and ■ No evidence of deliberate or accidental introductions of alien stocks; and ■ No evidence of deliberate or accidental introductions of genetically modified species.	■ Alien species introduced intentionally or accidentally without major changes in the community structure; or ■ Alien stocks introduced intentionally or accidentally without major changes in the community structure; or ■ Genetically modified species introduced intentionally or accidentally without major changes in the community structure.	■ Measurable decline in the population of native species or local stocks as a result of introductions (intentional or accidental); or ■ Some changes in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).	■ Extinction of native species or local stocks as a result of introductions (intentional or accidental); or ■ Major changes (>20%) in the genetic composition of stocks (e.g. as a result of escapes from aquaculture replacing the wild stock).

Table 5e: Scoring criteria for environmental impacts of Global change

Issue	Score 0 = no known impact	Score 1 = slight impact	Score 2 = moderate impact	Score 3 = severe impact
Issue 19: Changes in hydrological cycle and ocean circulation "Changes in the local/regional water balance and changes in ocean and coastal circulation or current regime over the last 2-3 decades arising from the wider problem of global change including ENSO."	■ No evidence of changes in hydrological cycle and ocean/coastal current due to global change.	■ Change in hydrological cycles due to global change causing changes in the distribution and density of riparian terrestrial or aquatic plants without influencing overall levels of productivity; or ■ Some evidence of changes in ocean or coastal currents due to global change but without a strong effect on ecosystem diversity or productivity.	■ Significant trend in changing terrestrial or sea ice cover (by comparison with a long-term time series) without major downstream effects on river/ocean circulation or biological diversity; or ■ Extreme events such as flood and drought are increasing; or ■ Aquatic productivity has been altered as a result of global phenomena such as ENSO events.	■ Loss of an entire habitat through desiccation or submergence as a result of global change; or ■ Change in the tree or lichen lines; or ■ Major impacts on habitats or biodiversity as the result of increasing frequency of extreme events; or ■ Changing in ocean or coastal currents or upwelling regimes such that plant or animal populations are unable to recover to their historical or stable levels; or ■ Significant changes in thermohaline circulation.
Issue 20: Sea level change "Changes in the last 2-3 decades in the annual/seasonal mean sea level as a result of global change."	■ No evidence of sea level change.	■ Some evidences of sea level change without major loss of populations of organisms.	■ Changed pattern of coastal erosion due to sea level rise has became evident; or ■ Increase in coastal flooding events partly attributed to sea-level rise or changing prevailing atmospheric forcing such as atmospheric pressure or wind field (other than storm surges).	■ Major loss of coastal land areas due to sea-level change or sea-level induced erosion; or ■ Major loss of coastal or intertidal populations due to sea-level change or sea level induced erosion.
Issue 21: Increased UV-B radiation as a result of ozone depletion "Increased UV-B flux as a result polar ozone depletion over the last 2-3 decades."	■ No evidence of increasing effects of UV/B radiation on marine or freshwater organisms.	■ Some measurable effects of UV/B radiation on behavior or appearance of some aquatic species without affecting the viability of the population.	■ Aquatic community structure is measurably altered as a consequence of UV/B radiation; or ■ One or more aquatic populations are declining.	■ Measured/assessed effects of UV/B irradiation are leading to massive loss of aquatic communities or a significant change in biological diversity.
Issue 22: Changes in ocean CO_2 source/sink function "Changes in the capacity of aquatic systems, ocean as well as freshwater, to generate or absorb atmospheric CO_2 as a direct or indirect consequence of global change over the last 2-3 decades."	■ No measurable or assessed changes in CO_2 source/sink function of aquatic system.	■ Some reasonable suspicions that current global change is impacting the aquatic system sufficiently to alter its source/sink function for CO_2.	■ Some evidences that the impacts of global change have altered the source/sink function for CO_2 of aquatic systems in the region by at least 10%.	■ Evidences that the changes in source/sink function of the aquatic systems in the region are sufficient to cause measurable change in global CO_2 balance.

The Global International Waters Assessment (GIWA) is a holistic, globally comparable assessment of all the world's transboundary waters that recognises the inextricable links between freshwater and coastal marine environment and integrates environmental and socio-economic information to determine the impacts of a broad suite of influences on the world's aquatic environment.

Broad Transboundary Approach

The GIWA not only assesses the problems caused by human activities manifested by the physical movement of transboundary waters, but also the impacts of other non-hydrological influences that determine how humans use transboundary waters.

Regional Assessment - Global Perspective

The GIWA provides a global perspective of the world's transboundary waters by assessing 66 regions that encompass all major drainage basins and adjacent large marine ecosystems. The GIWA Assessment of each region incorporates information and expertise from all countries sharing the transboundary water resources.

Global Comparability

In each region, the assessment focuses on 5 broad concerns that are comprised of 22 specific water related issues.

Integration of Information and Ecosystems

The GIWA recognises the inextricable links between freshwater and coastal marine environment and assesses them together as one integrated unit.

The GIWA recognises that the integration of socio-economic and environmental information and expertise is essential to obtain a holistic picture of the interactions between the environmental and societal aspects of transboundary waters.

Priorities, Root Causes and Options for the Future

The GIWA indicates priority concerns in each region, determines their societal root causes and develops options to mitigate the impacts of those concerns in the future.

This Report

This report presents the GIWA assessment of the Small Islands sub-system of the Caribbean Sea region – an area particularly vulnerable to human activities owing to the fragility of the island ecosystems and their limited carrying capacities. Habitat and community modification, as a result of anthropogenic pressures, was found to cause the most severe transboundary environmental and socio-economic impacts in the sub-system. The governments regard rapid economic growth as a priority, which they have failed to balance with the conservation and protection of important ecosystems. The Causal chain analysis discusses the root causes of habitat and community modification by investigating the cause-effect pathways of the concern. Policy options are proposed that aim to provide solutions to these fundamental issues, in order to enhance the management of the region's aquatic environment.

UNEP

GEF

HÖGSKOLAN KALMAR UNIVERSITY