Caribbean Sea Ecosystem Assessment (CARSEA)

A contribution to the Millennium Ecosystem Assessment
prepared by the Caribbean Sea Ecosystem Assessment Team

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Foreword

We are very pleased to have the opportunity to combine our thoughts and concerns in a joint Foreword to this Report of the Caribbean Sea Ecosystem Assessment (CARSEA). This pleasure is, however, accompanied by a palpable anxiety about the findings of this Assessment, given the significance that this ecosystem has for the economic, social, and cultural well-being of the diversity of nations which make up the Wider Caribbean region, that this Report so clearly establishes.

It is recognition of this significance that led, through the initiative and efforts of the Association of Caribbean States at the United Nations, to the adoption in December 2006 of a United Nations Resolution titled "Towards the sustainable development of the Caribbean Sea for present and future generations."

The Caribbean Sea Ecosystem Assessment contributes to the advancement of that process. We hope that this Report will give additional impetus to the efforts that must now urgently be made by all the States of the Wider Caribbean region, for whom the marine environment is the most important natural resource—to catalyse the required policies and political actions; to harmonize their governance and legislative frameworks; to synergise their numerous programmes and activities; and to mobilize the necessary financial, scientific, and civic resources—if the region is to give effect to the United Nations Resolution and move towards the ultimate objective of sustaining the economic, ecological, and cultural services of this invaluable common patrimony.

The Follow-up Commission for the Caribbean Sea Initiative, already established by the Ministerial Council of the Association of Caribbean States, now provides an appropriate framework for governance for sustainability, within which such comprehensive and integrative efforts might be effectively orchestrated. It accommodates all Member States of the Association, reflecting the Wider Caribbean region. It draws upon expertise from academia and civic society. It unifies and carries forward the parallel activities within the United Nations and within this Assessment. It maintains a permanent contact between leaders, officials, academia, and civic society for confidence-building and acquaintance, which are prerequisites to, in the words of former President A. N. R. Robinson of Trinidad and Tobago, "turn the Caribbean Sea into a lake." It is our hope that our collective and continuing work through this Commission, while primarily related to sustainability of the Caribbean Sea, might also make a material contribution to helping us to overcome the barriers of history that have operated to divide the countries and peoples of the Wider Caribbean region. The Caribbean Sea unifies us all.

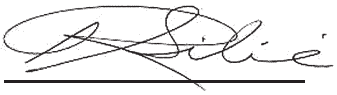
This Report indicates the need for continuing scientific research to fill gaps in our knowledge base, for building capacities for integrated assessments of this kind that would provide the evidential basis for policy, and for enhancing official and public understanding of how vital is the need to use and manage the region's natural capital sustainably. We hope that the region's organizations will rise to the challenge of meeting these needs.

The assessment was the result of a very fruitful collaboration between The University of the West Indies and The Cropper Foundation, involving the three campuses of the regional University and many other colleagues from academic, technical, and civic organizations from the Wider Caribbean region. From the outset it was envisaged that the assessment would contribute to the work that was already in train on behalf of the Caribbean Sea by the Caribbean Community, the Association of Caribbean States, and the Caribbean office of the United Nations Economic Commission for Latin America and the Caribbean. It has been an excellent demonstration of how the resources of the Region's academic organizations might directly contribute to needs of its policy-making and political community, as well as how inter-governmental, academic, and civic society bodies might combine their contributions for the public good.

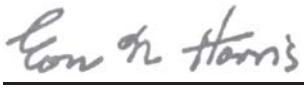
As an international waterway, the Caribbean Sea serves countries and peoples far beyond its shores. They in turn influence its condition and affect its future by their policies, practices, and technology. They share in the responsibility to protect and conserve its resources. The Caribbean Sea also contributes to the well-being of very large numbers of individuals from numerous parts of the world, who visit the region for recreation and leisure. They have a stake in its health, integrity, and sustainability. This ecosystem is *par excellence* worthy of a high level of extra-regional co-operation in, and support to, the region's efforts to have it used and managed sustainably. His excellency Edwin W. Carrington, Secretary-General of the Caribbean Community, at the Partnership Activity on ocean governance held on 14th January 2005 in Mauritius, recognized that the management of the Caribbean Sea poses major challenges and must be pursued on the basis of the broadest possible collaboration, including states and entities of the Pacific and Indian oceans that face similar challenges and have a level of experience in dealing with these issues.

It is therefore appropriate that this assessment should have emanated from the Millennium Ecosystem Assessment (a global multi-stakeholder process launched by the United Nations Secretary-General in 2001), and been supported by other sources of international support acknowledged in this Report. Such collaboration augurs well for the enterprise on which we must all embark to move "towards the sustainable development of the Caribbean Sea for present and future generations."

As we seek to bring together our respective communities and organizational resources to respond to the implications of this Caribbean Sea Ecosystem Assessment and to give effect to the United Nations Resolution, we express the hope that we might see much more of such collaboration in the future—within the Wider Caribbean region and globally—to move towards sustainable development of the region. The Association of Caribbean States and The University of the West Indies will continue their collaborative efforts to have the region achieve the desired responses, promoting a high level of local expertise and assisting the countries in developing a regional and practical approach. In this undertaking, we are buoyed up by the reiteration by the Heads of Government of the Caribbean Community, on the occasion of the 28th meeting of their Conference, of their "support to the initiative to have the Caribbean Sea recognised as a Special Area in the context of sustainable development so as to protect and preserve this essential and valuable shared natural resource."



Rubén Silié Valdéz
Secretary-General
Association of Caribbean States
1 August 2007



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The lead organizations deeply appreciate and acknowledge the contributions of the entire team comprising:

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Acronyms

ACS	Association of Caribbean States
AMLC	Association of Marine Laboratories of the Caribbean
CaMPAM	Caribbean Marine Protected Area Management
CANARI	Caribbean Natural Resources Institute
CARICOM	Caribbean Community
CARICOMP	Caribbean Monitoring and Management Programme
CARSEA	Caribbean Sea Ecosystem Assessment
CBD	Convention on Biological Diversity
CCA	Caribbean Conservation Association
CCCCC	Caribbean Community Climate Change Centre
CEHI	Caribbean Environmental Health Institute
CFMC	Caribbean Fisheries Management Council (Puerto Rico)
CFRAMP	CARICOM Fisheries Resource Assessment and Management Programme
CITES	Convention on International Trade in Endangered Species
CLME	Caribbean Large Marine Ecosystem
CPUE	Catch per Unit of Effort
CRFM	Caribbean Regional Fisheries Mechanism
CTO	Caribbean Tourism Organisation
EEZ	Exclusive Economic Zone
ENSO	El Niño/ Southern Oscillation
FAO	Food and Agriculture Organization (of the United Nations)
FDI	Foreign Direct Investment
FIB	Fishing-In-balance Index
FIDI	Fishery Information, Data, and Statistical Unit
FIG	International Federation of Surveyors
FISHSTAT	Fisheries database of the FAO
FTAA	Free Trade Area of the Americas
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Global Environmental Outlook
GIWA	Global International Waters Assessment
GPA	Global Programme of Action

GSDI	Global Spatial Data Infrastructure Association
HIMAT–INGEOMINAS	Instituto Colombiano de Hidrología, Meteorología y Adecuacíon de Tierras – Instituto Colombiano de Geología y Minería
ICCAT	International Commission for Conservation of Atlantic Tunas
ICES	International Council for Exploration of the Sea
ICLARM	International Center for Living Aquatic Resources Management
IDB	Inter-American Development Bank
IDRC	International Development Research Centre (of Canada)
IMA	Institute of Marine Affairs
INPA	National Institute of Fishery and Aquaculture, Colombia
INVEMAR	Instituto de Investigaciones Marinas y Costeras
IPCC	Inter-governmental Panel on Climate Change
IT	Information technology
ITCZ	Inter-tropical Convergence Zone
LAC	Latin America and the Caribbean
LBS	Protocol on Land-based Sources of Pollution
LME	Large Marine Ecosystem
LOICZ	Land–Ocean Interactions in the Coastal Zone
LPWG	Large Pelagic Fisheries Working Group (of CRFM)
MA	Millennium Ecosystem Assessment
MARPOL	International Convention for the Prevention of Pollution from Ships 1973 as amended by the Protocol of 1978 relating thereto
MPA	Marine Protected Area
NCL	Norwegian Cruise Lines
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service (of the U.S.A.)
NOAA	National Oceanic and Atmospheric Administration (of the U.S.A.)
OAS	Organization of American States
OECD	Organisation for Economic Co-operation and Development
OECS	Organization of Eastern Caribbean States
OECS ESDU	Organization of Eastern Caribbean States Environment and Sustainable Development Unit
OEF	Oxford Economic Forecasting
RAC	Regional Activity Centre
RSWG	Reef and Slope Fisheries Working Group (of CRFM)

SAUP	Seas Around us Project
SCPWG	Small Coastal Pelagic Fisheries Working Group (of CRFM)
SEDU	Small Island Developing States
SEFC	South East Fisheries Center
SEFSC	Southeast Fisheries Science Center (of NOAA)
SIDS	Small Island Developing States
SPAW	Specially Protected Areas and Wildlife
T&T	Travel and Tourism
TAR	Third Assessment Report (of the IPCC)
TNC	The Nature Conservancy
TSA	Tourism Satellite Accounting (of the WTTC)
UBC	University of British Columbia
U.K.	United Kingdom
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP GEO LAC	United Nations Environment Programme's Global Environment Outlook for Latin America and the Caribbean
UNEP ROLAC	United Nations Environment Programme Regional Office for Latin America and the Caribbean
U.S.	United States
U.S. $	United States Dollars
U.S.A.	United States of America
USAID	United States Agency for International Development
USGS	United States Geological Survey
UWI	The University of the West Indies
WCA	West Central Atlantic
WECAFC	Western Central Atlantic Fisheries Commission (of the FAO)
WTO	World Trade Organization
WTTC	World Travel and Tourism Council

Executive Summary

Introduction — the Argument in Brief

The peoples of the Caribbean are defined by the Sea whose shores they inhabit. In the rich diversity of cultures and nations making up the region, the one uniting factor is the marine ecosystem on which each ultimately depends.

If that ecosystem is under threat, so are the livelihoods of millions of people. The economic activity of the Caribbean is based to a very great extent on the bounty of the Sea and the natural beauty which attracts visitors from around the world which, in turn, require the healthy functioning of complex physical and biological processes. The coral reefs and the seagrass beds, the white-sand beaches and the fish shoals of the open ocean: these are natural capital assets whose loss or degradation has huge implications for the development of the region.

Apart from the economic importance of the ecosystem, it shapes the lives of all the inhabitants of the Caribbean in ways which defy statistical analysis. The Sea and its coasts form the stage on which the cultural, spiritual, and recreational life of the region is played out.

It may be united by its sea, but the Caribbean region is divided by its history. Five hundred years of settlement by Europeans, Africans, Asians, and people from other parts of the Americas has bequeathed to the region a patchwork of independent states and numerous colonies administered by governments in a different hemisphere. This presents unique challenges to the establishment of the co-operative policies needed to manage this ecosystem for the common good, and to achieve the most secure long-term future for the Caribbean peoples.

The situation is made even more complex by the influence on the Caribbean Sea ecosystem of decisions in parts of the world with no direct territorial link to the region: from the use of the waters for fishing by Asian fleets and by international shipping, including the transport of nuclear waste en route to the Panama Canal and oil shipments from the Middle East to refineries in the Gulf of Mexico; to the pollution and sediments carried by rivers from deep inside the South American continent; and even the energy choices of societies throughout the world which have major implications for the Caribbean Sea through the pace of global warming.

All of these factors combine to create an urgent need for a new overview of the state of the Caribbean Sea; an analysis of the forces driving change and the implications for the well-being of the Caribbean peoples; and a review of the options available to policy-makers in the region and beyond. This Caribbean Sea Ecosystem Assessment (CARSEA) attempts to fulfil that need.

In common with the practice of the Millennium Ecosystem Assessment (MA) of which it is a part, CARSEA first sets out a detailed picture of the condition and trends of the ecosystem; it then develops a number of scenarios aiming to simulate the likely outcome of different plausible future paths for the region; and finally it reviews the responses available to decision-makers.

The main points of the assessment will be summarized in the following pages. More detailed analysis and references to the sources on which it is based are available in the body of the document.

Three key messages can be highlighted at the outset. First, some of the vital services which human communities derive from the Caribbean Sea ecosystem are being placed in jeopardy, often by the very activities and industries whose long-term future depends on the continuing provision of those services.

Second, a reduction in the stresses being placed on the natural functions of the Caribbean Sea will require new ways of working together amongst the disparate political authorities making up the region.

Finally, the combination of dependence on the integrity of its marine ecosystem and vulnerability to global forces beyond its control puts the Caribbean in a special position which merits recognition and concrete action by the international community.

The Sea and its People

The semi-enclosed Caribbean Large Marine Ecosystem (CLME) is a distinct ecological region, bounded to the North by the Bahamas and the Florida Keys, to the East by the Windward Islands, to the South by the South American continent, and to the West by the isthmus of Central America. Covering an area of more than 2.5 million square kilometres, it is the second largest sea in the world. For the purposes of this assessment, the Caribbean is taken as these waters, the islands within the Sea and bordering it, and the river basins of continental territories draining into the Sea.

The Caribbean, home to more than 116 million people,[1] is divided among 22 independent states, of which 9 are continental countries of South and Central America, and the remainder islands and archipelagos. In addition, four colonial authorities—the United States (U.S.), the United Kingdom (U.K.), France, and the Netherlands—still exercise political control over 17 island territories in the region.

The complex political structure, produced by the historic struggles for control of the resources of the Caribbean, and reflecting a wide cultural diversity arising from that history, has left the region with a series of overlapping regional authorities exercising varying degrees of policy co-ordination over parts of the Sea. This creates a significant problem in the exercise of a holistic approach to the management of the Caribbean Sea ecosystem.

What unites the people inhabiting this region is a common dependence on two particular products of the marine ecosystem, known in the terminology of the MA as ecosystem services. Because of the dominant role of fishing and tourism in the Caribbean economy, this assessment concentrates mainly on the implications for these two services of current trends and future options.

Why Fishing and Tourism?

A few facts and figures help to justify the choice of these two services.

New data provided for this assessment confirm that relative to its size, the island population of the Caribbean is more dependent on income from tourism than that of any other part of the world. In 2004, more than 2.4 million people were employed either directly or indirectly in travel and tourism, accounting for 15.5% of total employment, a proportion nearly twice as high as the global average. The sector contributed U.S. $28.4 billion to the Gross Domestic Product (GDP), 13% of the total, and U.S. $19 billion or 16% of exported services and merchandise. Over one-fifth (21.7%) of all capital investment was linked to tourism, well over twice the global average.

Twenty-five million tourists choose to holiday in the Caribbean each year, in large part in pursuit of a dream of sensuous relaxation shaped by its natural features—palm-fringed beaches, blue-green lagoons with crystal-clear water, opportunities to see multi-coloured fish swimming amongst coral reefs. Dependence on tourism, therefore, also implies dependence on the capacity of nature to continue providing the conditions which make the Caribbean such a popular destination. In cases such as the diving industry, this connection is so close that degradation of ecosystem quality can be measured directly in lost income.

Fishing is also a significant provider of jobs and income in the Caribbean. It is estimated that more than 200,000 people in the region are directly employed, either full-time or part-time, as fishers. In addition, some 100,000 work in processing and marketing of fish, with additional job opportunities in net-making, boat-building, and other supporting industries. Assuming each person employed has five dependents, more than 1.5 million people in the Caribbean rely for their livelihood on commercial fishing. The activity also brings in approximately U.S. $1.2 billion annually in export earnings, with the U.S. the principal destination.

However, the true importance of fishing is not fully reflected in these figures. In a region where most of the population has access to the Sea, fish provide a vital resource for poor communities in ways which do not always appear on the national accounts. It is estimated, for example, that fish products account for on average 7% of the protein consumed by people in the Caribbean region. Anything which damages the productivity of the marine food chain is therefore a significant threat both to the health and to the wealth of these societies.

State of the Ecosystem — Signs of Trouble

Damaged infrastructure

The functioning of the Caribbean Sea ecosystem and the delivery of its services are heavily reliant on the condition of four interdependent coastal formations: beaches, coral reefs, mangroves, and seagrass beds. The white-sand beaches beloved of tourists are formed partly from the fragments of coral skeleton; the coral reefs themselves are both a rich source of food and a magnet for visitors; seagrass beds act as nurseries for many species of fish and shellfish; and mangroves help to provide nutrients for a range of marine life, shield coastal communities from the full force of wind and waves, purify wastes from land-based sources that enter the coastal zone, and attract eco-tourists to their vibrant wildlife.

Each of these formations is showing signs of significant damage as a result of human activities, with serious implications for the future capacity of the ecosystem to provide income from tourism and fishing. The best documented example is for corals: recent studies suggest that some 80% of living coral in the reefs of the Caribbean

[1]Defined as those living within 100 km of the Caribbean coast.

has been lost in the past 20 years. This unprecedented rate of degradation has seen some reefs change from 50% cover with live coral organisms, to just 10%. It has been estimated that the continued decline of coral reefs could cost the region between U.S. $350 million and U.S. $870 million per year by 2050.

A number of factors, each interacting with the other, are causing the degradation of coral reefs. They include increased sedimentation from rivers discharging into the Caribbean; excess nutrients due to pollution from farmland runoff and sewage, including from cruise ships; overfishing; diseases affecting creatures such as sea fans and sea urchins critical to the ecological balance of the reef; physical damage through dynamiting and dredging; and "bleaching" of corals, in which rising sea temperatures upset the symbiotic balance between coral polyps and the algae on which they feed.

The decline of coral reefs has reduced their ability to act as a protective barrier, and this may be one reason for increased levels of beach erosion. It has recently been estimated that 70% of Caribbean beaches are eroding at rates of between 0.25 and 9 metres per year. The cost of artificially replacing this sand, in a process known as beach nourishment, can run into millions of dollars.

Seagrass beds and mangrove forests have each seen widespread declines through direct removal to make way for various types of coastal development: seagrass is often cleared to "improve" bathing beaches, while mangroves have made way for commercial and housing construction, and for shrimp-farming ponds.

Fish stocks under pressure

In common with ocean regions across the world, the Caribbean has seen dramatic change over the past 30 years in the efficiency and intensity with which fish stocks have been targeted. Greatly increased demand, combined with the use of new types of catching gear, have helped to exert unprecedented pressure on this key resource of the ecosystem.

A number of factors set the Caribbean apart and present particular problems in protecting fish stocks for future generations. One is the sheer variety of fish and invertebrates involved in commercial fishing. It has been estimated that 680 species of bony fish, including 49 types of shark, are targeted in the region. This makes it extremely difficult to monitor the state of particular stocks, and to manage them sustainably. For example, of the 197 fish stocks falling under the jurisdiction of the Caribbean Fisheries Management Council (CFMC), the status of 175 (88%) was unknown or undefined.

Another problem arises from the lack of a unified political authority with responsibility for the resources of the Caribbean. Fish are no respecters of national boundaries, and the failure to regulate adequately those stocks shared by different states has led to damaging disputes between Caribbean countries in competition for shared resources. In addition, existing arrangements enable fishing fleets from throughout the world to engage in a "free for all," placing added pressure on the marine life of the Sea. It is the tragedy of the commons.

Lack of reliable data makes it difficult to give a complete picture of the condition of this particular service of the Caribbean Sea ecosystem. Some trends, however, give cause for concern. All the major commercially important species and groups of species in the region are reported to be fully developed or over-exploited. In the case of one valuable stock, the conch, the pressure has been serious enough to put it on the list of threatened species held by the Convention on International Trade in Endangered Species (CITES).

New analysis of historical trends carried out for this assessment suggests that fish landings in the Caribbean rose to unprecedented levels during the 1990s, reaching a peak of nearly 500,000 tonnes in 1998, but subsequently went into sharp decline.

The reasons for variations in the size of catches are complex, involving both human and environmental factors, but some indicators do point to the impacts of overfishing. A recent study of fishing data for four of the Windward Islands, for example, found that while overall catches increased in the period from 1980 to 1999, the increase in the effort used to catch those fish was very much greater. The ratio of fish caught for each "unit of effort" is estimated to have declined by up to 70% over these two decades, an indication that fish are becoming more difficult to find.

There are also signs that Caribbean fish stocks are suffering from the phenomenon known as "fishing down the food web," in which longer-lived, predatory fish become more scarce, and stocks become dominated by shorter-lived, plankton-eating species. This reduction in the average trophic level, as it is termed, may not affect catches in the short term, but signals long-term trouble for the ecosystem.

Drivers of Change

It is a central part of the assessment of any ecosystem to identify the key factors leading to changes which can affect the services provided by the natural systems of a region or locality. Known as drivers, these can either be direct

(such as pollution) or indirect (such as population increase leading to pollution); they can be local drivers (such as habitat destruction) or external ones (such as global climate change).

By analysing these drivers, it becomes possible to understand better the full consequences of particular policies or activities on the well-being of our societies, and to suggest the type and scale of changes which may be required to reduce the stress on ecosystems.

It is important to note that ecosystem change is often the result of two or more of these factors working together—for example, a healthy coral reef may be able to withstand the introduction of a disease organism, but that same disease could have a devastating impact on another reef already weakened by the effects of nutrient pollution or overfishing.

The main drivers affecting the Caribbean Sea are set out in Table 3.1. Here are some of the key examples in each category:

Local, direct

Changes in coastal land and sea use in the Caribbean have been the single greatest cause of ecosystem damage. Flat land along the coastline and reclaimed from the Sea has been used for industry and commerce, and in a wide range of tourism developments such as hotels, apartments, and golf courses. The consequence has been severe depletion of habitats such as seagrass beds and mangroves, damage to coral reefs, and the destabilization of beaches.

Sewage pollution from land sources and from cruise ships has been the most pervasive form of contamination of the coastal environment. Apart from affecting bathing beaches and thereby the tourism potential for particular areas, the elevated nutrient levels from such pollution can overstimulate the growth of algae, causing fish kills and coral damage.

Overfishing through the increasingly widespread use of certain types of gear is putting unprecedented strain on the fish stocks of the Caribbean.

Local, indirect

Urbanization of coastal communities has been the major factor underlying the direct pressures on the Caribbean Sea ecosystem.

High tourism dependency has led to a massive amount of capital investment in coastal infrastructure, which has, in turn, damaged the capacity of the ecosystem to provide services to the region.

Lack of co-ordinated governance in the region has led to a competitive rather than co-operative approach to issues such as fish stocks and tourism management, to the detriment of the ecosystem.

External, direct

Global climate change can potentially have a profound impact on the Caribbean Sea ecosystem. Increased intensity and frequency of tropical storms have devastated the tourism industry of some islands, and the overall scale of destruction has been exacerbated due to the increased population along the coasts. Rising sea temperatures, meanwhile, have increased the incidence of coral "bleaching."

River discharge from the Magdalena, Orinoco, and Amazon basins can cause significant damage to the marine environment of the Caribbean, through an excess of sediments or contamination resulting from deforestation or pollution in distant regions.

Alien species introductions are thought to have caused ecological damage when marine creatures were carried in the ballast tanks of ships, and even dust particles from the Sahara Desert are implicated in spreading disease organisms to Caribbean reef species.

External, indirect

International shipping rules under the United Nations Convention on the Law of the Sea (UNCLOS) grant foreign vessels the right of "innocent passage" through Caribbean waters, exposing the ecosystem to extra pressures of pollution, overfishing, and even the risk of radioactive contamination from shipments of nuclear material.

The combined impact of these drivers is that the poorest economies and communities of the Caribbean are prone to suffer the consequences of changes to the marine ecosystem, while enjoying few of the benefits that accrue from exploitation of its resources. For example: the least-developed countries and territories are especially vulnerable to the damage caused by more destructive storms; small-scale fishing communities are unable to compete fairly with better-equipped fleets for scarce stocks; local people are sometimes prevented from enjoying coastal resources as space is taken up by "enclave tourism" and other uses benefiting more prosperous sections of society; and lack of co-ordinated governance prevents more of the profits from tourism from being returned to local economies.

Scenarios

As part of the development of this assessment, four scenarios illustrating possible futures for the Caribbean region up to 2050 were drawn up and analysed. These are not intended as predictions of what will happen, but rather as tools to assess the consequences of certain plausible alternative pathways. Using our knowledge about the drivers of ecosystem change, scenarios can help to map out potential prospects for services such as tourism and fishing, depending on the values and priorities exercised by people inside and outside the Caribbean region in the coming decades.

The "storylines" and outcomes of the scenarios are shown in Chapter 5 of this report.

A challenging general message emerges from these scenarios. They suggest that in the short and medium term, there may be little difference in terms of tangible costs and benefits to the population, between approaches which favour greater environmental care and regional co-operation, and those which prioritize unrestricted development and the dominance of international market forces in the Caribbean.

The outcomes only begin to diverge towards the middle part of this century, when continued neglect of ecosystems could start to create such degraded environments that the Caribbean would lose its appeal for many tourists, and fish stocks might start to collapse. It is at this point that alternative scenarios start to reap benefits, for example, where a more controlled approach to "niche" tourism (in the scenario *Quality over Quantity*) has produced a sustainable, higher-value industry less susceptible to sudden shocks or surprises.

The challenge for policy-makers is that to avoid serious negative consequences for the future, decisions, whose benefits may only be realized well beyond the normal time-cycles of politics, will need to be taken now.

In other words, the changes required to secure a better long-term future for the Caribbean will require courage and vision. The good news is that these changes will incur no significant costs, and even in the short term will enhance the quality of life of many in the region.

The Policy Response — Options for Change

In 2006, the United Nations General Assembly passed the final of a series of resolutions recognizing the importance, uniqueness, and vulnerability of the Caribbean Sea, and stressing the need to take an integrated approach to its management. The interest of the Association of Caribbean States (ACS) is to achieve an additional resolution which would declare the Sea a "special zone" in the context of sustainable development.

It is not part of the remit of this assessment to take a position on whether such a resolution is justified or necessary, although the information contained within CARSEA should help to inform the debate on this issue. It is important that the campaign over many years to achieve this status for the Caribbean should be seen as a means to an end, not an end in itself. This assessment has found very little evidence of action to implement the integrated management of the sea mentioned in the existing resolutions.

There has been no shortage of programmes and ad hoc initiatives aimed at addressing particular problems afflicting the marine environment of the Caribbean (for a summary of these programmes, see Annex 3b). Some have had impressive results and can serve as models for future action.

However, these initiatives have been set up and operated by different governments, inter-governmental groups, and nongovernmental organizations, with little or no co-ordination between them. They are also frequently directed at a specific sector or activity, and lack an overview of the ways in which programmes may conflict with one another, or produce better results with greater collaboration. As this assessment has shown, the interconnected nature of the ecosystem services of the Caribbean Sea, and of the threats they face, require a much broader outlook.

Among the priorities for improvement of policy must be a better system of managing fisheries in the region, recognizing the value of the Sea as a complete ecosystem rather than a series of interlocking national territories; and capturing more of the value of tourism in the region, to be reinvested in measures to protect the natural beauty and diverse cultures without which there would be no tourists.

To address the shortcomings of current management of the Caribbean Sea ecosystem, strong arguments have emerged during the CARSEA process for a new technical commission or council, with responsibility for the entire region (i.e., the Wider Caribbean) to be set up. Its precise title, status, and remit are matters for open debate, but some of its essential functions would be:

- To monitor and assess the condition of the Caribbean Sea as an ecosystem, and to use that information to inform policy in the region.
- To assess the effectiveness of existing programmes at all levels, and to offer advice as to how they may be improved and better co-ordinated.

- To initiate studies on specific policy options available to decision-makers in the region, for example, economic policy instruments to enhance the protection of ecosystem functions.
- To act as a catalyst to achieve better co-ordination between the disparate institutions whose decisions affect the Caribbean Sea, and to promote greater co-operation with states outside the region, whose activities have an impact on its ecosystem.
- To provide continuing analysis of the impacts of policies and programmes, so that the correct lessons can be fed back into better design of future measures.

To avoid adding to the complexity of the existing governance of the Caribbean, it is not suggested that this body should be a new institution, but rather that it should reside within one or other of the existing inter-governmental groups. It is to be note that the ACS has responded to this idea by setting up a Follow-up Commission for its Caribbean Sea Initiative.

Its nature requires that it be advisory rather than executive, and for the commission to address the problems facing the Caribbean Sea and its peoples, decision-makers must be prepared to value and act on its advice—or, if they ignore it, to be accountable to the citizens whom they represent.

Better information and more co-ordinated institutions are an essential first step to a brighter future for the region. Ultimately, however, it will be up to those in positions of responsibility in the Caribbean and beyond to use that information and those institutions to ensure that the natural wealth of this unique Sea is passed on to future generations.

Caribbean Sea Ecosystem Assessment (CARSEA)

A contribution to the Millennium Ecosystem Assessment
prepared by the Caribbean Sea Ecosystem Assessment Team

1.0 INTRODUCTION

1.1 Rationale

The Caribbean Large Marine Ecosystem (CLME) is the second largest sea in the world, covering an area of approximately 2,515,900 km^2 (NOAA 2003), and comprising some of the territorial waters and coastal areas of 39 bordering countries and territories.[2] The well-being of the 116 million people living within 100 km of the sea (Burke and Maidens 2004) is highly dependent on the services it provides as an ecosystem. Critical among these is the unique character of its coastlines and open waters, making it a desirable place to live and to visit: in the terminology of the Millennium Ecosystem Assessment (MA, www.millenniumassessment.org), this desirability translates into a range of cultural services based on the recreational and aesthetic value of the land and seascape. The economies of the Caribbean islands are especially dependent on these functions of the marine environment that support tourism. Another key ecosystem service linked to well-being in the region is the availability of fish and marine invertebrates, a provisioning service within the MA definitions.

The Caribbean Sea has also been critically assessed and ranked by expert consensus as having the highest priority for conservation of any marine eco-region in the whole of Latin America and the Caribbean (Sullivan Sealey and Bustamante 1999). The two ecologically distinct small island groups of the region, the Bahamian and the Lesser Antilles, each have very high percentages of endemic species,[3] many of which are endangered. Also the Caribbean islands as a whole have been classified as a biodiversity hot spot, meriting global priority for conservation purposes (Myers et al. 2000).[4] Although this classification reflects the diversity and vulnerability of land-based flora and fauna, the many interactions between marine life and island habitats make it highly relevant to the global importance of the Caribbean Sea ecosystem.

However, the management of the Caribbean Sea is characterized by uncoordinated efforts without any holistic integrated management plan. This fragmentation involves not only the 22 independent countries in the region, including 9 from mainland South and Central America, but also 17 territories administered by colonial authorities from North America and Europe—the United States of America (U.S.A.), France, the United Kingdom (U.K.), and the Netherlands (see Box 1.1). The Caribbean Sea is also used and impacted by many states and their economic interests which lie outside the geographical boundaries of the Sea (for example, Japan, Korea, France, U.K., and the U.S.A.).

At present, there appears to be a mismatch between the managerial capabilities of authorities in the region, and the scale of important problems related to overfishing, pollution, and unsustainable tourism. Management is organized primarily at the level of individual countries or political blocs, while what is required is to deal with marine environmental problems at the scale of the entire ecosystem. This disjuncture suggests the need for broader, more inclusive, and better co-ordinated managerial arrangements.

The Caribbean Sea Ecosystem Assessment (CARSEA) attempts to deal with the multiplicity of issues associated

[2]A precise definition of what is meant by the Caribbean is set out in Section 1.2.

[3]Species which occur no where else in the world.

[4]The Caribbean Islands meet the criteria of a hot spot because they have less than 30% remaining of primary vegetation (the Caribbean figure is 11.3%) and contain, as endemics, at least 0.5%, i.e., 1,500 of the world's known vascular plant species (the Caribbean figure is 2.3%). The number of endemic vertebrate species, 779, accounts for 2.9% of the world's total. Myers et al. ranked the Caribbean as the fifth 'hottest' hot spot according to various criteria, after Madagascar, Phillippines, Sundaland, and Brazil's Atlantic Forest.

BOX 1.1: Countries and Territories Bordering the Caribbean Sea

Anguilla (U.K.)	*Montserrat (U.K.)*
Antigua and Barbuda	*Martinique (France)*[5]
Aruba (Netherlands)	Panama*
Bahamas	*Puerto Rico (U.S.A.)*
Barbados	Mexico*
Belize*	*Netherland Antilles (Neth.)*: *Curaçao, Bonaire, St. Maarten, St. Eustatius, Saba*
British Virgin Islands (U.K.)	
Cayman Islands (U.K.)	
Colombia*	Nicaragua*
Costa Rica*	*St. Barthélemy (France)*†
Cuba	St. Kitts/Nevis
Dominica	St. Lucia
Dominican Republic	*St. Martin (France)*
Grenada	St. Vincent and the Grenadines
Guadeloupe (France)	
Guatemala*	Trinidad and Tobago
Haiti	*Turks and Caicos (U.K.)*
Honduras*	*U.S. Virgin Islands (U.S.A.)*
Jamaica	Venezuela*

NOTE: Overseas/dependent territories are shown in italics, with their metropolitan countries in parentheses.
*Continental states bordering the Caribbean Sea.
† Recognized as a territory of France on February 22, 2007.

with effective protection and management of a Sea shared among so many individual states, political systems, economies, languages, and cultures.

1.2 Definition of the Caribbean Sea

The geographic focus of the assessment is the area known as the CLME and the countries and territories bordering this marine expanse (Fig 1.1), an area which will subsequently be referred to as the Wider Caribbean. However, it should be noted that a larger region, known as the Greater Caribbean, has been recognized in international agreements including the 1994 Convention, which set up the Association of Caribbean States (ACS). The scientific rationale behind the 'Greater Caribbean' definition is that the oceanography of the southern Caribbean is strongly influenced by the outflow of two of the world's largest river systems (the Amazon and the Orinoco), and that the Caribbean in turn has a great influence on the "downstream" Gulf of Mexico—so the Gulf and the Guianan region of the Atlantic Ocean are included.

From a geographical and political perspective, several overlapping groupings of countries in the region present a confusing framework for the governance of the Caribbean Sea:

- The Caribbean Community (CARICOM) grouping of Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, St. Kitts/Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Trinidad and Tobago;
- The Organization of Eastern Caribbean States (OECS) grouping of six eastern Caribbean Islands: Antigua and Barbuda, Dominica, Grenada, St. Kitts/Nevis, St. Lucia, and St. Vincent;
- The ACS grouping (also called the Greater Caribbean or Caribbean Basin), including all the island and mainland states in the CARSEA definition, plus El Salvador, Guyana, Suriname, and French Guiana.

1.3 Framework for the Caribbean Sea Ecosystem Assessment

The Caribbean Sea Ecosystem Assessment is an approved project of the Millennium Ecosystem Assessment. In addition to the global assessment carried out between 2001 and 2005, the MA supported a number of sub-global studies applying the same conceptual framework to ecosystems and human communities at various lower scales, ranging from small localities to major world regions. This is one of those sub-global assessments.

The four-year international work programme of the MA, launched by the then UN Secretary-General Kofi Annan in 2001, was designed to meet the needs of decision-makers for scientific information on the links between ecosystem services and human well-being. It was a response to the recognition that people depend on ecosystems not only for providing basic needs (*provisioning services*) such as food, fresh water, and timber, but also for essential *regulating services* such as purification of air, filtration of water pollutants, and protection from extreme events such as storms and tidal surges. *Supporting services*, including soil formation, pollination, and nutrient cycling, provide indirect benefits to people by creating the conditions

[5]Martinique is a department of France.

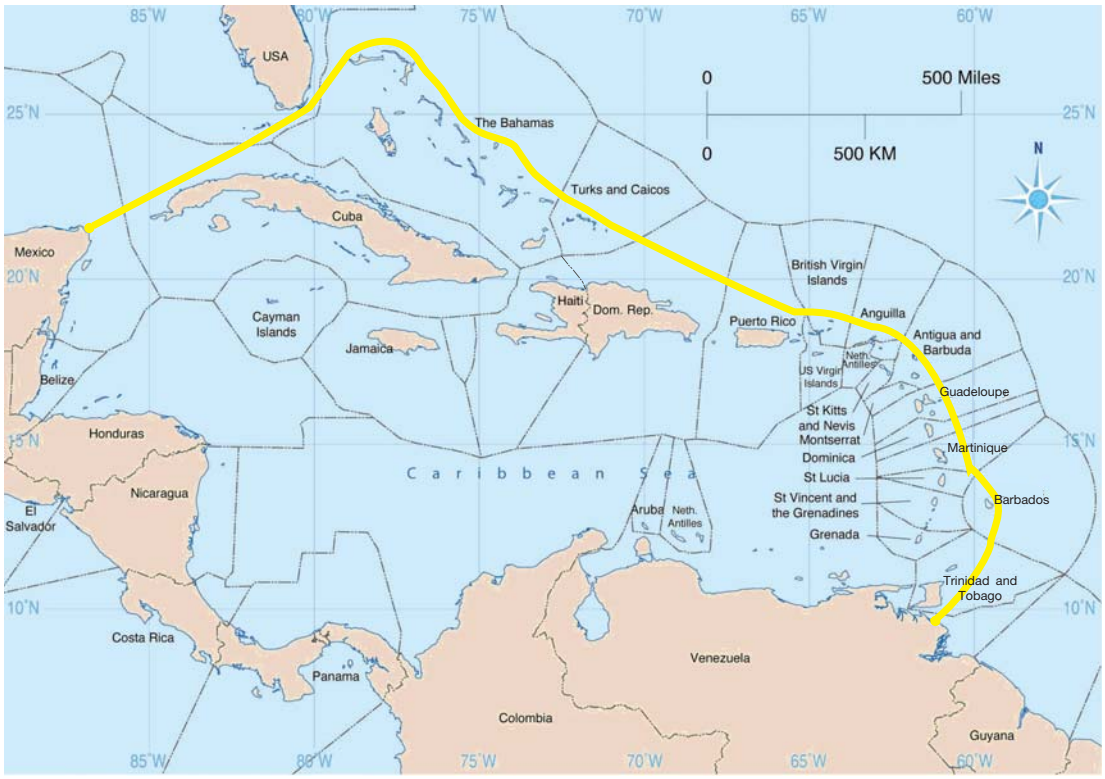


FIG. 1.1. The Caribbean Large Marine Ecosystem (yellow line) with hypothetical Exclusive Economic Zone (broken line) boundaries.[6]
SOURCE: The Nature Conservancy (TNC; pers. commun. 2005).

necessary for other services to function. In addition, ecosystems provide less tangible *cultural services* such as recreational, aesthetic, and spiritual values, which are nevertheless highly valued by human societies, and which can generate very significant financial returns, as in the case of tourism (Fig. 1.2).

According to the MA conceptual framework (MA 2003), human well-being includes the *basic material for a good life*, such as secure and adequate livelihoods, enough food, adequate shelter, clothing, and access to goods; *health*, including feeling well and having a healthy physical environment, such as clean air and access to clean water; *good social relations*, including social cohesion, mutual respect, and the ability to help others and provide for children; *security*, including secure access to natural and other resources, personal safety, and security from natural and human-made disasters; and *freedom of choice and action*, including the opportunity to achieve what an individual values doing and being.

Humans are thus highly dependent on the flow of ecosystem services (Fig. 1.3). However, the links have become less obvious to some urban dwellers who are buffered against environmental change by factors such as culture and technology, and therefore associate water with treatment plants, food with supermarkets, air with air conditioners, and recreation with television. The central focus of the MA is an examination of the effects of ecosystem changes on people in future decades, and the types of responses that may be adopted at local, national, regional, and global scales to improve ecosystem management, and so enhance human well-being.

The Caribbean Sea Ecosystem Assessment draws heavily upon the MA conceptual framework and methodology. The technical work of the assessment was conducted by three working groups[7]—on Condition and Trends, Scenarios, and Responses—and at three scales (described later).

[6]It should be emphasized that the lines on this map are indicative only, as some boundaries are disputed.

[7]Experts were selected during an initial workshop conducted by the MA on Scenarios for the Caribbean Region in April 2002, and further experts from the region added through invitations. Disciplines represented were environment and development, agriculture, engineering, law, economics, marine sciences, geo-informatics, politics, ecology, epidemiology, international relations, media/literature, information management and communication, and meteorology.

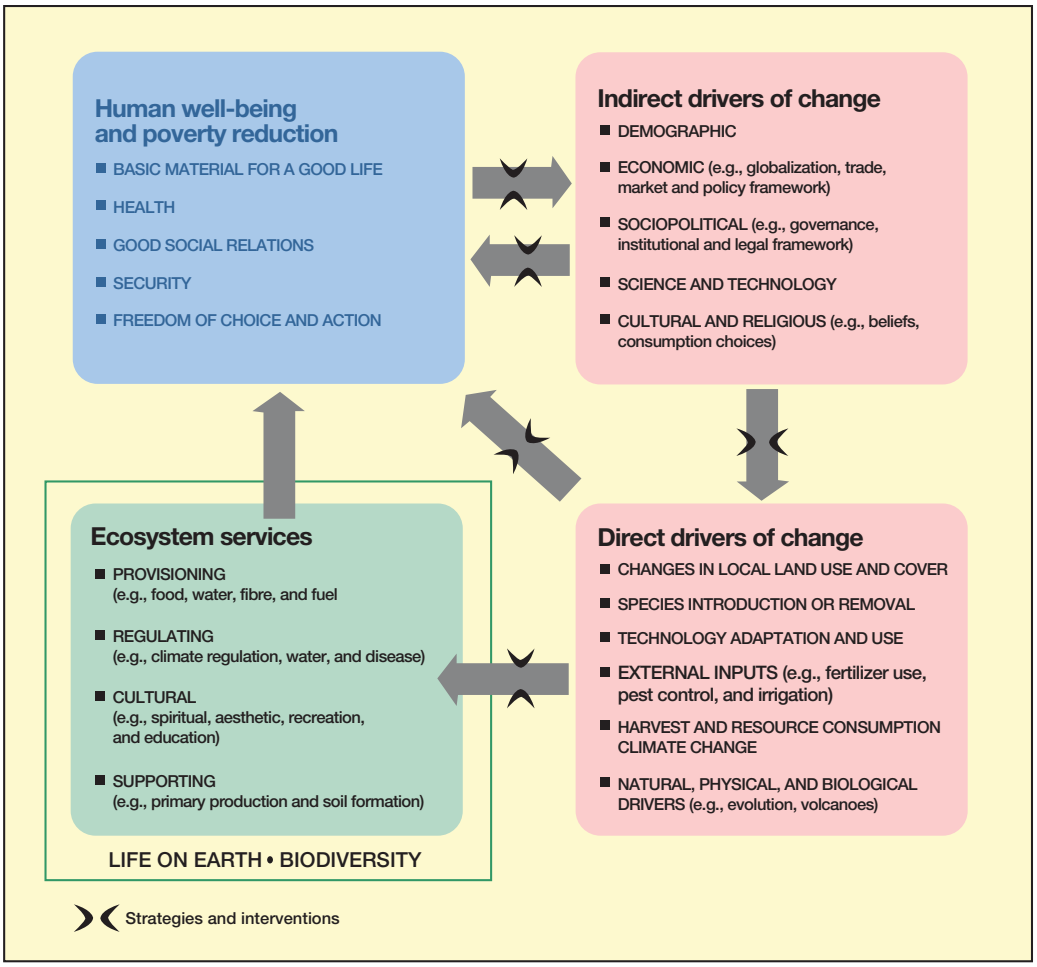


FIG. 1.2. Millennium Ecosystem Assessment conceptual framework diagram.
SOURCE: MA (2005a).

The main ecosystem services being examined in CARSEA are:[8]

- Provisioning: The fisheries production service
- Cultural: Tourism amenity value of the ecosystem, a product of aesthetic and recreational services
- Supporting: The biodiversity service through coral reefs and other coastal habitats.

The components of human well-being prioritized in this study are:

- *Material minimum for a good life*: livelihoods (jobs and income related to tourism and fisheries), food (fish protein as % total protein)
- *Security*: tropical cyclone property damage
- *Health*: the recreational benefits to local populations and tourists, provided by well-functioning coastal ecosystems.

The three scales for assessment are:

- Scale 1: Small island states of the Caribbean
- Scale 2: Coastal zones and Exclusive Economic Zones (EEZs) of countries surrounding the Caribbean Sea
- Scale 3: The Caribbean Sea marine environment.

[8]Important ecosystem services not covered in detail in the assessment are:
- Provisioning: The provision of desalinated/fresh water; oil and gas (it is arguable that this is a provisioning service of ecosystems, albeit from the distant past); ornamental resources; fibre; fuel-wood from mangroves; construction material; pharmaceuticals.
- Regulating services: Climate regulation; water purification; and waste treatment.
- Supporting services: The Sea as a medium of transport.

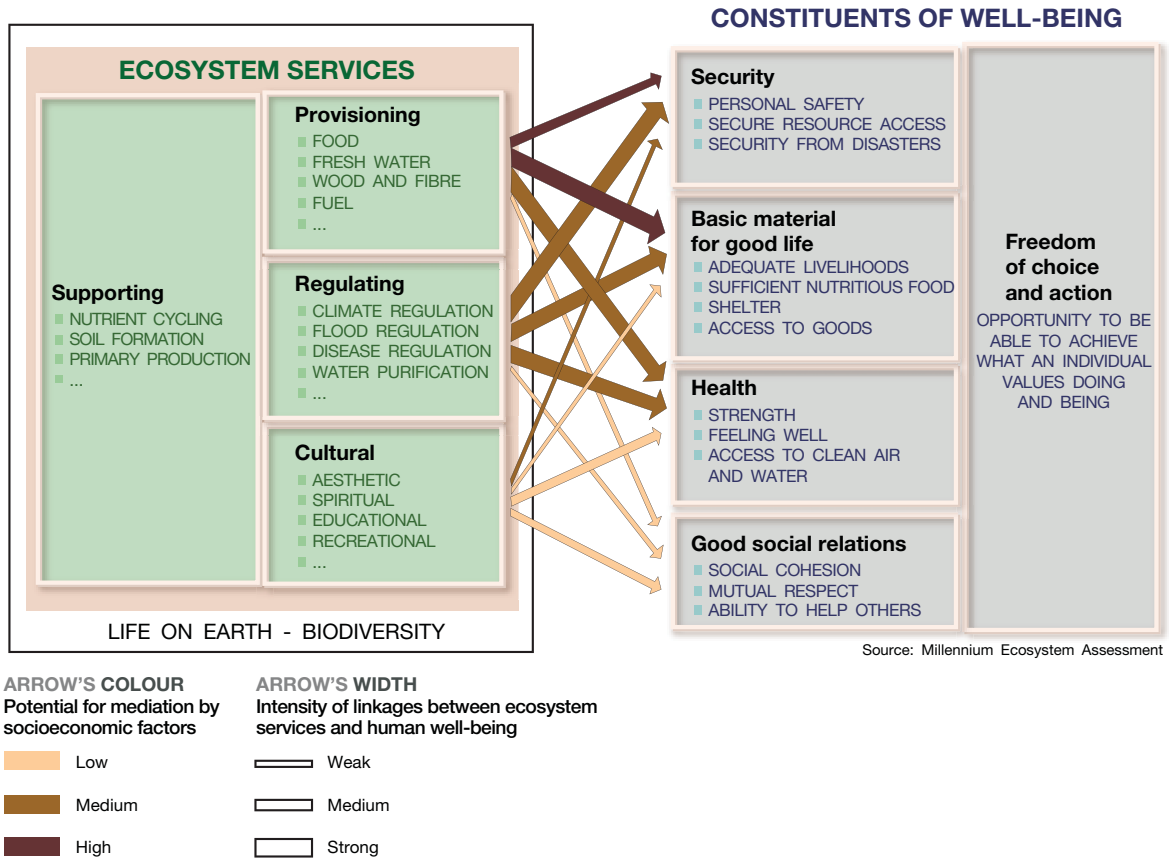


FIG. 1.3. Links between ecosystem services and human well-being.
SOURCE: MA (2005a).

The quality of assessment at these different scales varied greatly according to the availability of data. Little data were available on the Caribbean Sea as a whole—most information refers to individual countries and their EEZs, with little coverage of international waters. Another problem is that most of the continental Caribbean Sea countries also have coasts bordering on either the Pacific or the Atlantic, so that only some undetermined portion of an individual country's statistics will be associated with the Caribbean Sea. The most complete data were available for the islands of the Caribbean, because of their isolated or discrete nature. This inevitably influenced the assessment, with the result that it may generally seem to give more prominence to the insular Caribbean.

The project also analyses and presents response options according to three scales of intervention:

1. For Individual states
2. Collectively as Caribbean States
3. For non-Caribbean states involved.

This assessment builds on several recent studies of the Caribbean environment which have thoroughly documented threats from multiple sources, such as pollution from international marine shipping (including nuclear waste trans-shipment); waste from yachts and cruise liners; and large foreign commercial fishing vessels from nations not indigenous to the subregion (UNEP 2004a, 2004b, 2006).

2.0 THE CARIBBEAN SEA — PHYSICAL FORM AND DEFINING PROCESSES

2.1 Coastal Form and the Littoral

The form of the coastline around the Caribbean Sea is extremely varied, and determined by local geological history. Coasts adjacent to mountain ranges may have steep cliffs and deeply indented bays. Coasts in areas adjacent to major stable plates, in contrast, may be generally flat and consist of recent sediments. Where

there is plate collision or subduction, coastal form may also be variable, partly from volcanic activity and partly from the elevation of deposits of marine origin, including paleoreefs, ancient reefs, beach rock, and sandstones. The littoral (area close to the shoreline) is typically the most densely populated region of all Caribbean countries and has been much perturbed by human settlement.

2.2 The Shallow Sub-littoral

The characteristics of the shallow sub-littoral (the area below the low-tide mark) again vary with geological history. Adjacent to continental landmasses and larger islands there is generally a wide shallow sub-littoral or shelf. This may be seen in various places, such as off northern South America, off Nicaragua and Honduras, parts of Cuba, and the Bahamas. Many small countries of the Lesser Antilles, however, have narrow island shelves and are surrounded by deep water.

2.3 Bathymetry

The form of the Caribbean basin floor is highly folded, with many ridges and troughs. The most prominent ridge is that between Nicaragua and the Greater Antilles, along which the island of Jamaica emerges. On either side of this prominent feature are deep troughs that extend down to depths of about 5,000 metres. There are several smaller ridges and rises, notably the Cayman Ridge south of Cuba, the Beata Ridge south of Hispaniola, and the Aves Ridge running north from Venezuela. These ridges effectively separate the deep-water masses of the Caribbean Sea into three prominent basins.

There are two notable deep troughs in the Caribbean Sea, the Cayman Trough south of Cuba and the Puerto Rico Trench north of Puerto Rico and Hispaniola. A final prominent feature of the bathymetry (the shape of the ocean floor) of the Caribbean Sea is the Great Bahama Bank, with its extensive shallows and low-lying islands. There are also many other less prominent ridges and basins that convey a picture of highly irregular contours to the floor of the Sea, and a separation of the deep-water masses. The overall picture projected is of a Sea largely enclosed by the landmasses of South and Central America and the Greater Antilles, with comparatively narrow passages between the Lesser and Greater Antilles, connecting it with the Atlantic Ocean. Therefore the Caribbean Sea is a semi-enclosed sea which, according to Article 122 of the 1982 United Nations Convention on the Law of the Sea (UNCLOS), is defined as ‘a gulf, basin or sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the territorial seas and exclusive economic zones of two or more coastal States.’

2.4 Plate Tectonics, Seismic Activity, and Volcanism

The distinctive shape of the Caribbean Sea and the arc of islands surrounding it relate closely to the tectonics of the region—the position of the dynamic plates of the Earth´s crust and the boundaries between them. Figure 2.1 shows that all of the islands, with the exception of the Bahamas, lie close to the boundary of a formation known as the Caribbean Plate. It is moving eastward with respect to the adjacent North American and South American plates at a rate of approximately 20 mm/yr (Miller et al. 2005).

Seismic activity caused by the movement between the plates is generated along these boundaries. Along the Northern margin, including areas close to Jamaica and the Virgin Islands, moderate earthquakes of shallow depth are generated. Near the plate boundaries there is also activity caused by movement within the plates themselves: for example, in the Northern Caribbean earthquakes are caused by internal deformation in a slab of the North American Plate. Concentrations of these earthquakes occur at depths of up to 300 km (Fig. 2.2).

Seismic events in the Eastern Caribbean are principally associated with a subduction zone[9] at the junction of the Caribbean and the North American plates. The North American Plate dips from East to West beneath the Caribbean Plate along a north–south line just east of the main island arc. Earthquakes are also concentrated in the Leeward Islands due to movement within the Caribbean Plate and in the region north-west of Trinidad, where the plate boundary changes direction.

The pattern of earthquakes along the boundaries of the Caribbean Plate (Fig. 2.1) illustrates that except for the Bahamas, Cuba, and the Yucatan Peninsula of Mexico, the countries surrounding the Caribbean Sea are prone to significant earthquake hazards (Fig. 2.2). This is perhaps one of the three distinctive and defining features of the Caribbean region.

2.5 Climate and Circulation

Given its latitude, the Caribbean Sea and the adjacent littoral coastal landmasses have a wet tropical climate with

[9]A subduction zone is a region where two tectonic plates converge, with one sliding underneath the other towards the molten rock of the Earth’s mantle. It is typically associated with volcanic activity and earthquakes.

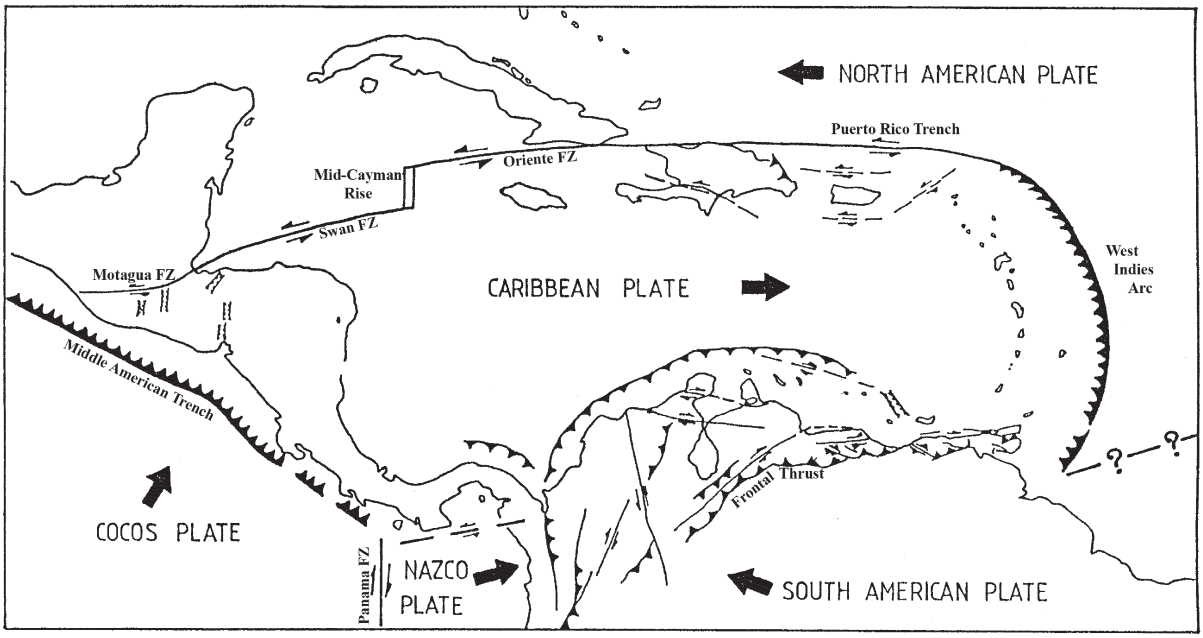


FIG. 2.1. Tectonic setting of the Caribbean.
SOURCE: Molnar and Sykes 1969.

distinctive wet and dry seasons, moderate temperature ranges, and persistent trade winds. The wet season is associated with the seasonal northward migration of the Inter-tropical Convergence Zone (ITCZ) and a continuous series of tropical waves that move westward, some developing into depressions, tropical storms, and hurricanes. While local climate may be varied by other factors such as topography or deforestation, the region as a whole experiences a distinctive hurricane season from June to November. The Caribbean region is also influenced periodically by the wider El Niño/Southern Oscillation (ENSO), a multi-year cycle involving variations in surface temperatures and salinity, due to the changes in rainfall patterns on the South American continent. Some of the hurricane activity is generated far out to the east in the Atlantic Ocean, but may also originate in the Caribbean Sea. This phenomenon is perhaps the second distinctive and defining feature of the Caribbean Sea.

The third defining feature of the Caribbean Sea is its general surface circulation pattern (Fig 2.3). The pattern is that of waters of the South Equatorial Current that flows from a major upwelling of the southern area of Africa flowing across the Atlantic and along north-eastern South America into the Caribbean Sea, through the island arc of the Lesser Antilles. In the Caribbean Sea, this stream of water is known as the Antillean Current that flows in a generally westward direction, exiting the Sea via the Yucatan Channel. There is also some inflow of northerly waters into the Caribbean Sea through the inter-island passages in the Greater Antilles, and persistent gyres (circular or spiral movements of water) in the Colombian and Yucatan basins. Water quality, particularly salinity and turbidity of the incoming stream, is much influenced seasonally by discharge from the Amazon and Orinoco rivers and those of the Guianas. The Sea is also affected by continental river discharge directly into it.

2.6 River Plume Dynamics

The ecology of the Caribbean is greatly affected by the massive quantities of fresh water and sediments entering the Sea from three great South American river systems: the Amazon, Orinoco, and Magdalena. Although a large part of the outflow of the Amazon is taken eastward across the Atlantic, a significant quantity flows northward around the coast of the continent into the Eastern Caribbean and, together with the waters of the Orinoco, this creates plumes of buoyant fresh water across wide stretches of the ecosystem (Müller Karger et al. 1988, 1989). In the Western Caribbean, the plume of the Magdalena River extends north and eastward under the influence of a current known as the Colombian gyre (Box 2.1).

The influx of sediments and nutrients originating from human activities in the Magdalena drainage basin has a

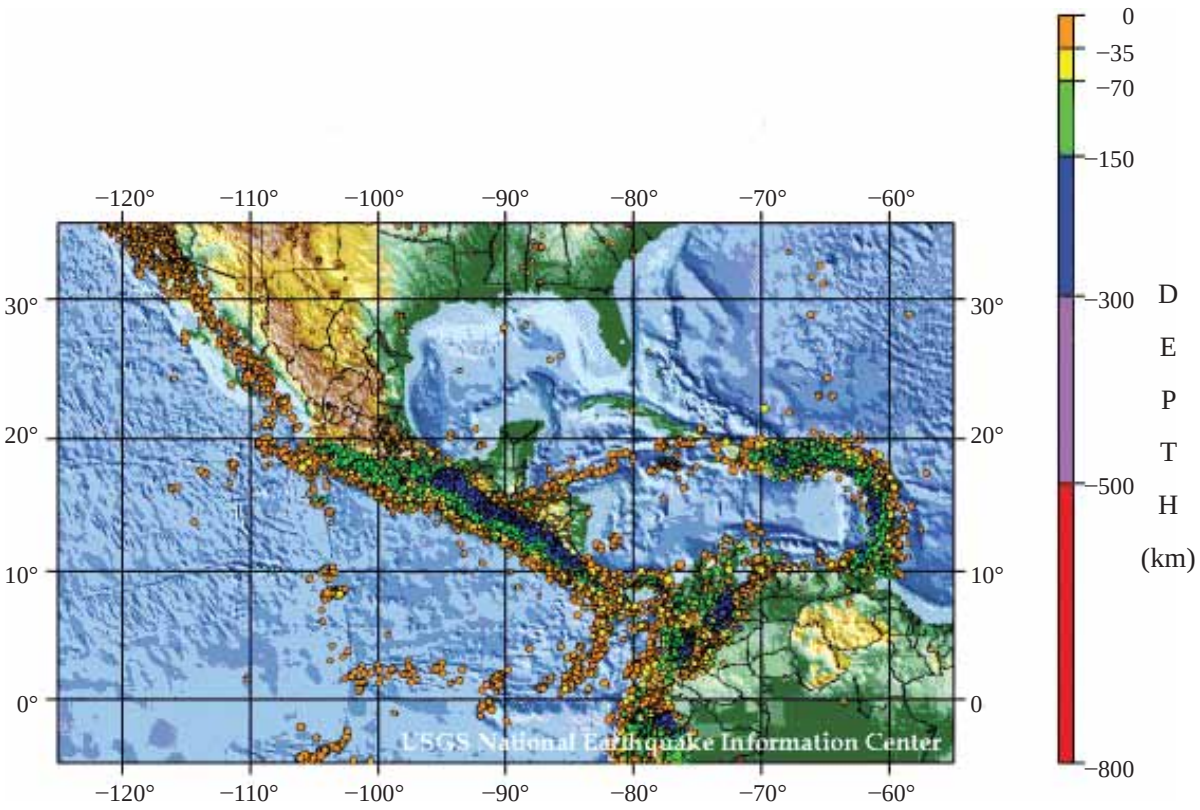


FIG. 2.2. Seismicity of Central America: 1990–2000.
SOURCE: United States Geological Survey 2007.

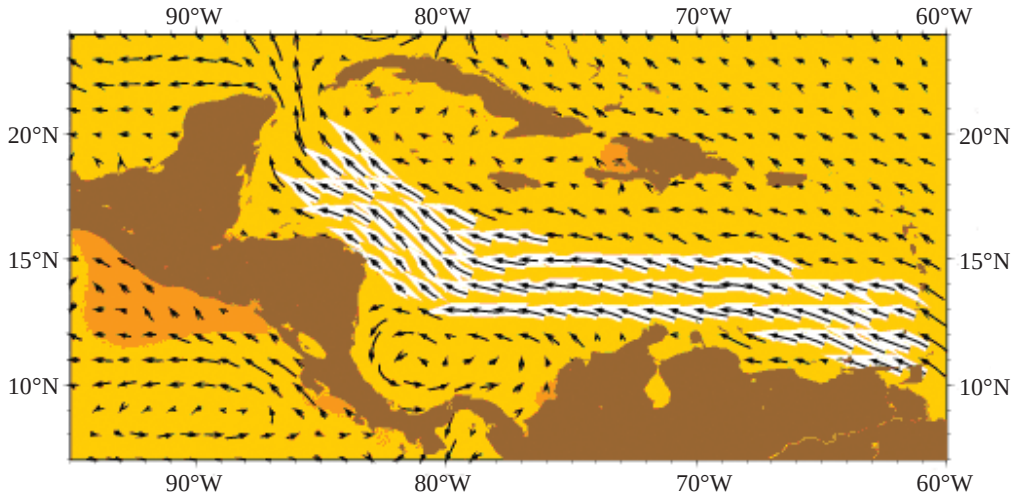


FIG. 2.3. Caribbean Sea circulation.
SOURCE: Gyory et al. 2006.

major influence on the dynamics of plankton and, hence, on the fisheries of the Caribbean. These river plumes extend to very shallow depths in the southern Caribbean (less than 10 m) but, under the influence of wind and current, slowly mix into the underlying saltier water. They can achieve depths of between 40 m and 60 m in the north-east Caribbean. Eddies crossing the sea further complicate the transport of fresh water, resulting in a complex mosaic of different levels of salinity on the surface.[10]

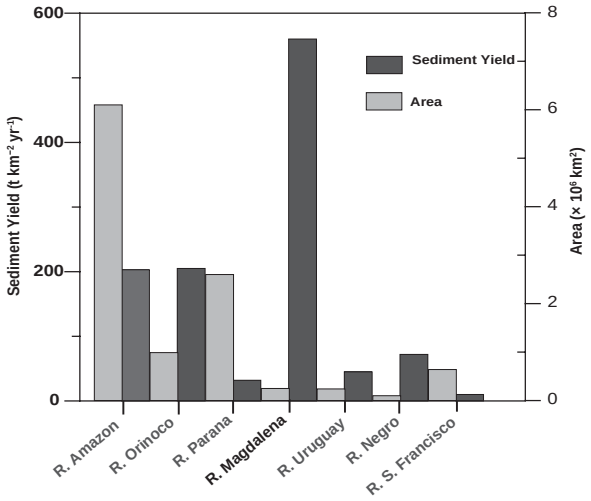
Recent studies have shown that the impact of these river plumes can be very great, even hundreds of kilometres from the deltas where they originate. Dissolved organic matter from the Orinoco, for example, has been found to stimulate the growth of plankton far out into the Caribbean, through a process known as photomineralization which releases nutrients into the marine environment (Corredor et al. 2003).

BOX 2.1: The Magdalena River and its Impacts on Coastal Ecosystems[11]

The Magdalena River is one of the most important rivers in the world in terms of its impact on the wider environment. For example:

- It discharges more sediment for each square kilometre of its catchment area than any of the other large rivers along the Caribbean and Atlantic coasts of South America (the rate is 560 t km^{-2} $year^{-1}$).
- The total amount of sediment transported into the Caribbean by the Magdalena is of the same magnitude as the three larger rivers of the continent, the Amazon, Orinoco, and Paraná (Plata), which all drain into the Atlantic.
- It has a large drainage basin (257,438 km^2) covering 24% of the territory of Colombia.

The Magdalena River extends for 1,612 km and drains the Western and Central Cordilleras of the Andes. The basin is characterized by high tectonic activity, landslides, steeply sloping tributary basins (71% of the catchment area corresponds to elevations above 1,000 m), and moderate precipitation, with an average rainfall of 2,500 mm per year.



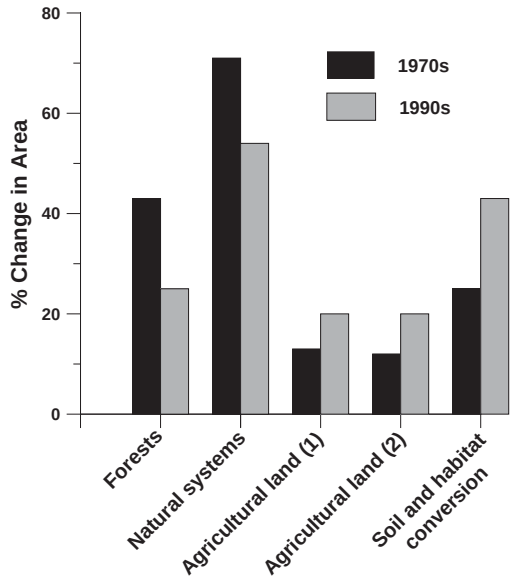
SOURCE: Restrepo and Kjerfve 2000b, 2002, 2004.

During the past 50 years, the Magdalena River has come under increasing environmental stress accompanying economic development in Colombia between the 1970s and 1990s, with major implications for the Caribbean coastal areas into which the river drains. Ongoing trends include (1) escalating population densities along the basin and at the river mouth. Eighty per cent of the Colombian population, including the cities of Bogotá, Medellín, Cali, and Barranquilla are located in the Magdalena watershed. This gives rise to a density of 120 inhabitants/km^2 for the basin as a whole, compared to just 0.24 inhabitants/km^2 in the Amazon basin; (2) accelerating upland erosion rates due to increasing deforestation, mining, and poor agricultural practices; and (3) increasing levels of water pollution, also linked to increased population, deforestation, and poor farming practices. The overall result has been a distortion of the natural dynamics of the river system, in turn leading to the loss of critical habitat, biodiversity, and altered patterns of the transport of sediments and other material.

[10]Dramatic satellite-derived imagery of these interactions can be viewed on the website of the US Naval Research Laboratory at http://www7320.nrlssc.navy.mil/IASNFS_WWW/

[11]The information in this box is largely sourced from Restrepo and Kjerfve 2000a, 2000b, 2002, 2004; Restrepo and Syvitski 2006; Restrepo et al. 2005.

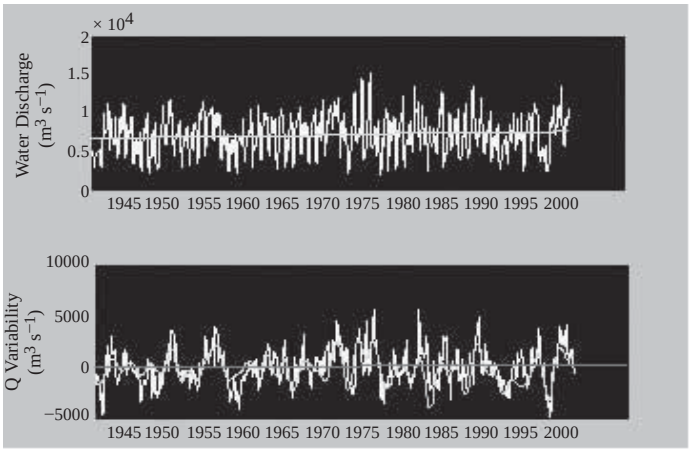
BOX 2.1: (*Continued*)



SOURCE: Restrepo and Syvitski 2006.

Land Use Change in The Magdalena River Basin

During the past 30 years, the Magdalena basin has been under increasing environmental stress. Recent land use analysis for the 1970–1990 year period indicates that forest cover was reduced from 71% to 54% within the river's watersheds. The only remaining rainforest area is located in the lower Magdalena valley, and most of the land on the lower and middle slopes is under cultivation. In addition, this period witnessed an increase in the proportion of soils and habitats converted to agricultural use, from 25% to 40% of the basin area.

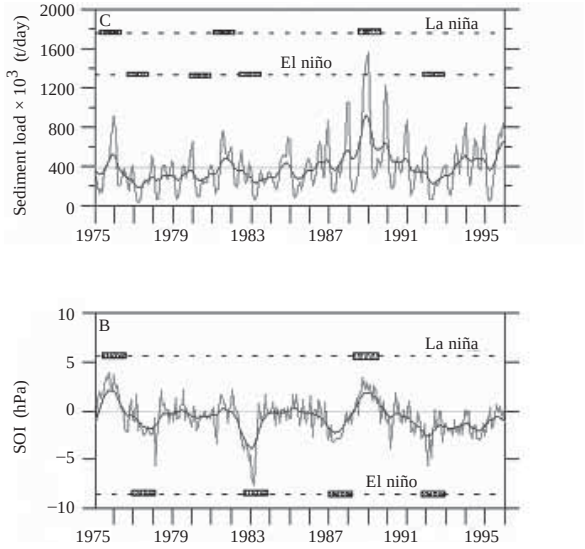


SOURCE: Restrepo et al. 2005.

Water Discharge into the Caribbean Sea

The Magdalena River discharges 228 km^3 of water annually, or on average 7,200 m^3 per second, into the western Caribbean, based on 70 years of daily data between 1942 and 2002.

Analysis has shown that 69% of the variation of the Magdalena streamflow is explained by the multi-annual cycle of the Southern Oscillation (the El Niño effect), with high discharge occurring during La Niña phase and low discharge during El Niño phase.



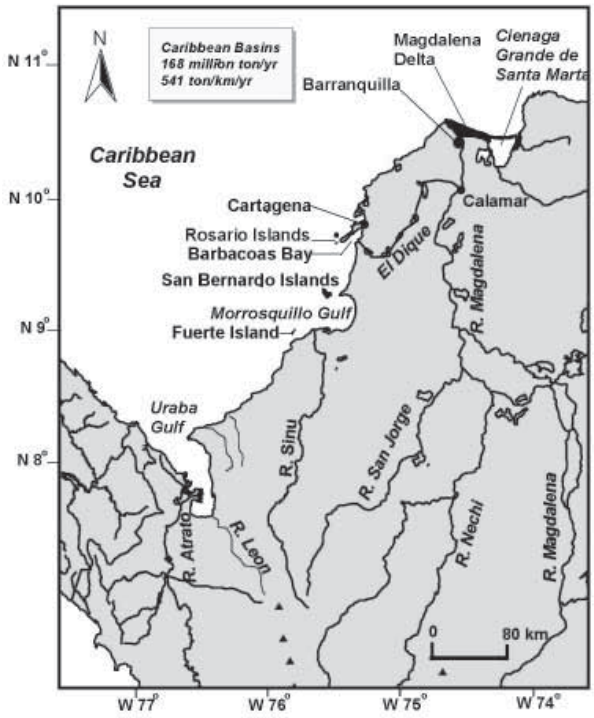
SOURCE: Restrepo and Kjerfve 2000b.

Sediment Load into the Caribbean Sea

The mean sediment load for the Magdalena is 144 million tonnes per year, corresponding to a sediment yield of 560 t km^{-2} yr^{-1} for the 257,438 km^2 basin. This corresponds to 86% of the total sediment load of all Colombian rivers draining into the Caribbean. The main tributary, the Cauca River, contributes 31% of the Magdalena total.

The sediment load also shows an inter-annual oscillation well correlated with the El Niño/Southern Oscillation (ENSO) cycle which explains 54% of the variation. The La Niña high flow in 1988–89 caused a marked increase in sediment load from the Magdalena, with one prominent peak of 1.6 m tonnes per day. Other flood events are clear but less pronounced, e.g., in 1975–76, 1981–82, and 1995. Low sediment loads occurred during El Niño events in 1977–78, 1982–83, and 1991–92. The mean daily sediment loads during El Niño and La Niña years are 256 tonnes per day and 511 tonnes per day, respectively.

BOX 2.1: (*Continued*)



Nutrient fluxes of phosphate (PO_4^{-3}) and nitrate (NO^{3-}) in non-pristine fluvial systems of the Caribbean basins of Colombia. Nutrient values are based on averages calculated from monthly samples covering three-year period 1998–2000

River	Water discharge ($km^3\ yr^{-1}$)	Total nitrate	Total phosphate PO_4^{-3} ($\times 10^3\ t\ yr^{-1}$)
Caribbean			
Magdalena	228	186	47
Dique	9.4	12	3.0
Sinu	11.8	1.5	0.07
Leon (Uraba Gulf)	2.1	2.5	0.7
Turbo (Uraba Gulf)	12	0.1	0.003
Atrato (Uraba Gulf)	81	58	2.4

SOURCE: Restrepo and Kjerfve 2004.

Sediment Load and its Impact on Coastal Ecosystems

Sediment load from the Magdalena River has had a strong impact on coastal ecosystems. Since 1954, the government of Colombia has dredged the El Dique Canal, a 114-km man-made channel from the Magdalena River at Calamar to Cartagena Bay. Because of increased sedimentation in the bay during the 1970s, new canals were constructed from El Dique to Barbacoas Bay, and since then, the suspended sediment load in Barbacoas has reached and impacted the El Rosario Islands, a 68-km^2 coral-reef ecosystem in the Caribbean Sea. Sediment load is responsible for most of the observed reef mortality, with dead coral-reef cover reaching 58 per cent. Also, the suspended sediment load from the Sinú River is probably responsible for impacts on the largest coral reef on the Colombian Caribbean coast, a system covering 135 km^2 between the San Bernardo and Fuerte Islands, north and south from the Morrosquillo Gulf. Live coral cover had, in some areas, decreased 25% between 1995 and 2000.

Human-induced Nutrient Fluxes and their Impact on Coastal Systems

Since the 1950s, the use of nitrogen (N) and phosphorous (P) in agricultural fertilizers, and in a range of products such as detergents, has resulted in a rapid increase in the flow of these elements through rivers, now exceeding pristine levels by a factor of 10 in some world rivers. This can drastically alter the ecology of aquatic systems, overstimulating the growth of algae and leading to oxygen depletion, toxic blooms, fish kills, and coral-reef degradation.

In Colombia, non-pristine fluvial systems like those draining the Caribbean basins have much more phosphate (PO_4^{-3}) and nitrate (NO^{3-}) loads when compared to pristine rivers (e.g., Pacific rivers). The Magdalena and Atrato rivers are the Colombian systems which contribute by far the highest P and N fluxes to the Caribbean Sea, with total phosphate and nitrate flows up to 186,000 t and 47,000 t per year, respectively. Many causes are responsible for these high nutrient loads, including massive sewage discharges in cities and towns, mainly in the Magdalena basin, and also the use of chemical fertilizers on banana plantations in the lower course of the Atrato River.

Urban, agricultural, mining, and industrial waste inputs from the Magdalena basin have aggravated the condition of the Ciénaga Grande lagoon and coastal ecosystems. Biodiversity has been reported to be considerably lower in the area affected by mangrove mortality, as well as in the coastal zone. A decline in fisheries catches by a factor of eight, from 63,700 t in 1978 to 7,850 t in 1998, is another indication of the environmental degradation caused by reduced water quality.

BOX 2.1: (*Concluded*)

Water Diversion and Mortality of Mangrove Ecosystems

Water diversion due to the construction of a highway in the Magdalena delta/lagoon complex, the Ciénaga Grande de Santa Marta, has resulted in hypersalinization of mangrove soils, and the consequent die-off of almost 270 km^2 of mangrove forests during the past 39 years. Between 1956 and 1995, 66% of the original mangrove forest died. Recent estimates indicate that for the whole Magdalena lagoon/delta complex and associated coastal zones, the mangrove area has been reduced from 62,000 ha in 1991 to 52,478 ha in 1996, a loss of almost 2,000 ha per year. In addition, fresh-water input from the Magdalena River to the lagoon was also diverted for irrigation purposes, and interrupted by dikes built along the delta distributaries to prevent flooding of farm lands. The changes in the hydrological regime have also caused water quality changes in the lagoons and canals, resulting in low dissolved oxygen concentration, fish kills, and eutrophication.

2.7 Major Coastal and Marine Habitats

2.7.1 Beaches

Beaches are deposits of sand between the high- and low-tide marks, transported to shore and moulded by waves. The sand can be calcareous (derived from the broken skeletons of corals, calcareous algae, molluscs, and echinoderms) or siliceous (derived from eroded rocks). Beaches are dynamic, the sand being constantly subjected to deposition (accretion) or loss (erosion). Storms, offshore reefs, sand shoals, currents, and onshore dunes play important roles in controlling deposition and erosion on a beach. The stability of a beach, whether eroding or accreting, depends on a balance, over time, between the supply of sand and the rate at which it is transported away.

Beach and dune sands serve as one of the world's major sources of construction aggregate. Noncalcareous sand is also used to produce minerals and ores for various industries, including electronics. However, beaches in the Caribbean are best known for their importance to tourism: the quality of the beach is cited by most tourists as the main feature of a successful holiday (Uyarra et al. 2005). They also provide areas of recreation and enjoyment for local people throughout the region and, therefore, have great cultural value in addition to their economic importance in attracting overseas visitors.

Beaches are important habitats for sea turtles, which nest in the zone above the high-tide mark. This can create a conflict between the use of a beach for recreation and its contribution to the biodiversity of the Wider Caribbean Sea ecosystem, but it can also provide income, community employment, and educational opportunities through well-managed eco-tourism.

A number of threats linked to human activity are causing beach erosion and polluting coastal waters, compromising the ability of Caribbean beaches to continue providing ecosystem services. Unregulated sand mining, for example, causes loss of sand and prevents the natural replenishment of other beaches as material is carried around the coast by tides and currents.

Another key threat is being brought about largely by the tourism industry itself, despite its reliance on beaches to attract visitors. Many poorly planned developments are simply too close to the edge of the sea. They frequently lack adequate waste-disposal facilities, which leads to contamination with sewage and other effluents, causing a health hazard and badly diminishing the aesthetic value of beaches. Failure to set buildings back 50 m or more from the shore also exposes them to storms and damages dunes which are part of the dynamic system stabilizing beaches. In addition, construction on beaches may alter patterns of water currents which, in turn, could increase erosion.

It has recently been estimated that 70% of beaches on the islands of the Caribbean are eroding at rates of between 0.25 m and 9 m per year (Cambers 1997). It is possible that the decline in Caribbean coral reefs (a source of much of the calcareous sand) has reduced both protection from wave action and the supply of sand, thereby increasing erosion. The cost of artificial replacement of sand, a process known as beach nourishment, can run into millions of U.S. dollars (U.S. $).

2.7.2 Seagrass Beds

Seagrasses are flowering plants that flourish in shallow, sheltered, marine environments, such as lagoons near mangroves or coral reefs, or just offshore from beaches. The Caribbean region has six species of seagrass, the most common of which is turtle grass (*Thalassia testudinum*).

The beds formed by seagrass perform a number of important roles in the Caribbean Sea ecosystem, including the stabilization of sediments, reducing the energy of waves as they approach the shore, and the provision of a nursery habitat for organisms that as adults live in other systems.

Seagrass communities serve as habitats for a wide range of organisms. They provide food for species such as parrot fish, surgeonfish, queen conch, sea urchins, and green turtles. The seagrass leaves carry epiphytic algae[12] and animals, which are grazed by invertebrates and fish. The seagrass blades enhance sedimentation and reduce erosion by slowing down waves and currents, while the roots and rhizomes[13] bind and stabilize the sediment surface.

Seagrass beds are very important in the marine food chain as a result of the high rate at which they convert carbon dioxide dissolved in the water into organic matter, through the process of photosynthesis (high net productivity). This rate, approximately 1 kg of carbon for each square metre in the course of a year ($1\ kg\ C\ m^{-2}\ year^{-1}$) is significant because about half of this material is exported as detritus, which contributes food to offshore ecosystems.

Seagrass habitats act as a nursery for the young of many commercial species of fish, crustaceans, and molluscs, while reef-based carnivores venture off into nearby seagrass beds in search of food. The wide variety of epiphytes which live in the seagrasses become the food of many bottom-dwelling fish species which feed off detritus.

Organisms in seagrass beds with calcium-based external skeletons (for example, molluscs, echinoderms, crustaceans, calcareous algae, and some protozoa) also help to form beach sand.

Threats to seagrass beds in the Caribbean include their removal from shallow water to "improve" bathing beaches; dredging to allow access to shipping or to lay cables, pipes, and other submarine structures; burying by sediment from nearby dredging and filling activities; and pollution from nutrients such as nitrogen which causes excessive growth of epiphytes. Nutrient pollution can also overstimulate the growth of the seagrass itself, leading to difficult decisions on whether to clear beds which expand into previously unsettled sandy areas.

In summary, seagrass colonies are undervalued for the contribution they make to key services of the Caribbean Sea ecosystem, including fisheries (directly) and tourism (indirectly) through the production of sand, protection from wave action, and nurturing of wildlife important for eco-tourism).

[12]An epiphyte is an organism which grows naturally on another but does not use it for nourishment.

[13]A rhizome is a plant stem which grows beneath the soil or sediment surface.

2.7.3 Coral Reefs

Coral reefs are among the most productive tropical marine ecosystems and have the highest biodiversity (MA 2005b). Corals are sessile (immobile) organisms whose bodies are in the form of a small polyp, usually less than 1 cm in diameter. Reef-building corals are colonial, occurring as sheets of many thousands of polyps over a calcium-carbonate skeleton. Corals are found in all of the oceans, but it is only in the tropics that they form reefs. This is done with the help of symbiotic single-celled algae contained in their tissues. The algae use sunlight to carry out photosynthesis and provide organic nourishment for the corals, and also help to deposit the skeleton. The accumulated skeletons of many generations of corals, cemented together with other carbonate sediments, form the reef.

The living corals, and the spurs and canyons within the reef, give the three-dimensional structure which provides habitats for so many species. The typical structure of a Caribbean fringing reef includes a lagoon tens to hundreds of metres wide, a shallow platform or reef flat, a defined reef crest, and a more or less steeply sloping fore-reef on which spurs may develop.

Seven per cent of the world's coral reefs are located in the Wider Caribbean (Burke and Maidens 2004). They include the Meso-American reef, the largest coral system in the Northern Hemisphere, stretching nearly a thousand kilometres from the northern tip of the Yucatan peninsula in Mexico, along the coasts of Belize and Guatemala, to the north-east shoreline of Honduras.

Coral reefs in the Caribbean Sea are prolific providers of ecosystem services, including food, protection from storms, recreational value and therefore tourism income, and medicinal products. It is estimated that the potential yields for fisheries from coral reefs amount to $10\ t\ km^{-2}\ year^{-1}$, which could provide up to 6% of global fisheries if properly managed (Burke and Maidens 2004). Commercially valuable species fished on coral reefs include snappers (Lutjanidae), groupers (Serranidae), and jacks (Carangidae), while less valuable species include parrot fish (Sparidae) and surgeon fish (Acanthuridae). Important shellfisheries include those for conch (a large marine gastropod mollusc) and lobster.

Harvesting of other reef resources includes live ornamental fish for the aquarium trade; collection of coral skeletons and shells of other creatures for jewellery and other ornaments; mining of reef rock, coral heads, and coral sand for construction; and bioprospecting for potential pharmaceuticals. Only a small fraction of the huge reef biodiversity has so far been tested for the presence of

products useful for medicine and industry, but already many have been found and exploited commercially.

Coral reefs are among the most beautiful and visually impressive habitats on earth, full of life and colour. The Caribbean tourism industry owes much to the opportunities they provide for diving and snorkelling. Reefs also contribute to the attraction of beach holidays through the calm water and blue-green colouring provided by their lagoons, the protection they offer against beach erosion, and the role of coral skeletons in forming the white sand of Caribbean beaches.

Shoreline protection is a very important service provided by coral reefs, and an assessment of their value should include the replacement cost of beaches and of buildings and developments close to shore—a service likely to become increasingly important according to models which predict both rising sea level and more destructive storm activity as a result of global warming.

Taken together, the annual value of services provided by Caribbean coral reefs has been estimated at between U.S. $3.1 billion and U.S. $4.6 billion, with degradation by 2015 potentially costing between U.S. $350 million and U.S. $870 million per year (see Table 2.1; Burke and Maidens 2004).

Caribbean coral reefs are already greatly degraded. They have lost some 80% of living coral over the last 20 years, an unprecedented rate of degradation, declining in some instances from more than 50% live cover to less than 10% (see Fig. 2.4; Gardener et al. 2003). The degradation has, in most cases, been due to a mixture of impacts, all of

TABLE 2.1 — Estimated value of ecosystem services from Caribbean coral reefs, and potential losses from their degradation.

Good/service	Estimated annual value in 2000 U.S. $	Estimated future annual losses due to coral-reef degradation
Fisheries	312 million	Fisheries productivity could decline an estimated 30–45% by 2015 with associated loss of annual net benefits valued at U.S. $11–140 million (in constant-dollar terms, standardized to 2000).
Tourism and recreation	2.1 billion	Growth of Caribbean dive tourism will continue, but the growth achieved by 2015 could be lowered by 2–5% as a result of coral-reef degradation, with the region-wide loss of annual net benefits valued at an estimated U.S. $100–300 million (in constant-dollar terms, standardized to 2000).
Shoreline protection	0.7–2.2 billion	Over 15,000 km of shoreline could experience a 10–20% reduction in shoreline protection by 2050 as a result of coral-reef degradation. The estimated value of lost annual net benefits is estimated at U.S. $140–420 million (in constant-dollar terms, standardized to 2000).
TOTAL	3.1–4.6 billion	U.S. $350–870 million

SOURCE: Burke and Maidens 2004.

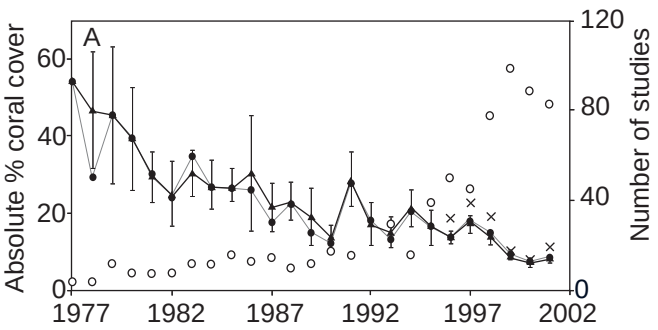


FIG. 2.4. Absolute per cent coral cover from 1977 to 2001 across the Caribbean Basin.[14]
SOURCE: Gardener et al. 2003.

which are still present. These include hurricane damage; disease; bleaching;[15] pollution, including sediment runoff from coastal developments and agriculture; overfishing; and direct damage from boat anchors, fish traps, grounded ships, dredging, collection, and dynamite.

All of these impacts probably have some human component. Global warming may have led to more frequent occurrence of severe hurricanes which results in mechanical damage to reefs and is also largely responsible for coral bleaching. The spread of coral diseases has probably been enabled by shipping and possibly through increased transport of disease organisms over long distance via dust through desertification.[16] Overfishing, especially of alga-grazing fish such as parrot fish, has allowed algae to overgrow corals. Jamaica, for example, has been cited as having some of the most overfished coral communities in the world.[17] Pollution, principally elevated nutrient levels from sewage and agricultural fertilizers, has further stimulated the growth of these algae. In fact, most Caribbean reefs have experienced a shift in ecological dominance from corals to algae. Recovery has been both rare and, when present, slow.

2.7.4 Mangroves

A mangrove is a tree or shrub adapted to colonize tropical, sheltered, coastal environments between the high-water and low-water marks. Mangroves reach their greatest development in estuaries, where they may form extensive forests. The term mangrove is also used to describe the complex community of animals, plants, and micro-organisms adapted to life in a saline and muddy environment. Tree-dwelling animals, including nesting and roosting seabirds, occupy the upper level of the mangrove plants, while marine animals occupy the bases. Sessile marine organisms such as barnacles, oysters, and sponges are dependent upon the hard surfaces provided by the mangrove roots, while mobile animals such as crabs, gastropod molluscs, shrimps, and fish occupy the mud around the stilt roots and the water in the tidal creeks. In the Caribbean region, only 4 common mangrove species are present, far fewer than in the Indo-Pacific region where some 44 species occur.

Mangroves are found along sheltered coastlines of almost all countries and territories surrounding the Caribbean Sea, and they fulfil important socioeconomic and environmental functions. These include the provision of a large variety of wood and non-wood forest products; coastal protection against the effects of wind, waves, and water currents; conservation of biological diversity—including a number of endangered mammals, reptiles, amphibians, and birds; protection of coral reefs, seagrass beds, and shipping lanes against siltation; and provision of habitat, spawning grounds, and nutrients for a variety of fish and shellfish, including many commercial species. Mangroves can provide income as eco-tourist attractions for viewing birds, manatees, crocodiles, and other fauna and flora.

High population pressure in coastal areas has, however, led to the conversion of many mangrove areas to other uses, including infrastructure, aquaculture, rice, and salt production. Numerous case studies describe mangrove losses over time, but information on the status and trends of mangrove area extent at the global level is scarce.

A comprehensive database on mangrove extent has been assembled by the UN Food and Agriculture Organisation (FAO 2002, 2003a). This contains a compilation of mangrove area estimates by country along with revised estimates for 1980, 1990, and 2000 for each country (Table 2.2). The results of the trend analyses indicate that the mangrove area around the Caribbean Sea has in general decreased by about 1% per year since 1980. Table 2.2 also shows that the region of Central America and the Caribbean has lost about 413,000 ha of mangroves since 1980, but that the rate of loss seems to have slowed from about 1.4% per annum between1980 and 1990 to 1.1% from 1990 to 2000. The highest rates of deforestation in the 1980s were found in Barbados, Jamaica, Dominica, and Honduras, while the same countries plus Dominican Republic, El Salvador, Haiti, and Honduras had the greatest rate in the 1990s.

[14]The trend line represents the decline in percentage live coral cover based on weighted means of several studies, the exact number of which are shown by open circles. The error bars indicate 95% confidence intervals.
[15]Coral bleaching is a phenomenon in which elevated sea temperatures cause stress to the symbiotic algae, which then leave the tissues of the coral polyp. Since the algae provide pigment to the corals, the reef loses its colour and rapidly declines in biodiversity. Caribbean corals typically bleach when the water temperature exceeds 30ºC.
[16]See Section 3.3.
[17]See Section 3.2.

TABLE 2.2 — Estimates for mangrove area in the Caribbean, 1980, 1990, 2000

Mangrove area estimates									
	Extent								
	Most recent, reliable, mangrove area estimate		Mangrove area 1980	Mangrove area 1990	Annual change 1980–1990		Mangrove area 2000	Annual change 1990–2000	
Country/ Area	ha	Ref. Year	ha	ha	ha	%	ha	ha	%
Anguilla	90	1991	90	90	n.s.	n.s.	90	n.s.	n.s.
Antigua and Barbuda	1,175	1991	1,570	1,200	−37	−2.7	900	−30	−2.8
Aruba	420	1986	420	420	n.s.	n.s.	420	n.s.	n.s.
Bahamas	141,957	1991	170,000	145,000	−2,500	−1.6	140,000	−500	−0.4
Barbados	14	1991	30	16	−1	−6.1	10	−1	−4.6
Belize	65,767	1995	75,000	68,800	−620	−0.9	62,700	−610	−0.9
Bermuda	16	1992	17	16	n.s.	−0.6	15	n.s.	−0.6
British Virgin Islands	587	2001	660	630	−3	−0.5	590	−4	−0.7
Cayman Islands	7,268	1991	7,300	7,300	n.s.	n.s.	7,200	−10	−0.1
Costa Rica	41,330	1992	41,000	41,000	n.s.	n.s.	41,000	n.s.	n.s.
Cuba	529,700	1992	530,500	529,800	−70	n.s.	529,000	−80	n.s.
Dominica	10	1991	40	13	−3	−10.6	9	n.s.	−3.6
Dominican Republic	21,215	1998	33,800	26,300	−750	−2.5	18,700	−760	−3.4
El Salvador	26,800	1994	47,200	35,600	−1,160	−2.8	24,000	−1,160	−3.9
Grenada	255	1992	295	262	−3	−1.2	230	−3.2	−1.3
Guadeloupe	2,325	1997	3,900	2,500	−140	−4.3	2,300	−20	−0.8
Guatemala	17,727	1998	19,800	17,800	−200	−1.1	15,800	−200	−1.2
Haiti	15,000	1990	17,800	15,000	−280	−1.7	10,000	−500	−4.0
Honduras	54,300	1995	156,400	103,300	−5,310	−4.1	50,000	−5,330	−7.0
Jamaica	9,731	1997	23,000	10,800	−1,220	−7.3	9,300	−150	−1.5
Martinique	1,840	1998	1,900	1,900	n.s.	n.s.	1,800	−10	−0.5
Montserrat	5	1991	5	5	n.s.	n.s.	5	n.s.	n.s.
Netherlands Antilles	1,138	1980	1,140	1,140	n.s.	n.s.	1,140	−0.8	−0.1
Nicaragua	282,000	1992	336,000	280,000	−5,600	−1.8	214,300	−6,570	−2.6
Panama	158,100	2000	230,000	166,000	−6,400	−3.2	158,000	−800	−0.5
Puerto Rico	6,410	2001	6,500	6,400	−10	−0.2	6,400	n.s.	n.s.
St. Kitts and Nevis	79	1991	84	80	n.s.	−0.5	75	−0.5	−0.6
St. Lucia	200	2002	200	200	n.s.	n.s.	200	n.s.	n.s.

TABLE 2.2 — (*Concluded*)

Country/ Area	Mangrove area estimates: Extent — Most recent, reliable, mangrove area estimate (ha)	Ref. Year	Mangrove area 1980 (ha)	Mangrove area 1990 (ha)	Annual change 1980–1990 (ha)	Annual change 1980–1990 (%)	Mangrove area 2000 (ha)	Annual change 1990–2000 (ha)	Annual change 1990–2000 (%)
St. Vincent and Grenadines	51	1991	60	52	−1	−1.4	45	−0.7	−1.4
Trinidad and Tobago	7,150	1991	9,000	7,200	−180	−2.2	6,600	−60	−0.9
Turks and Caicos Islands	23,600	1991	23,600	23,600	n.s.	n.s.	23,600	n.s.	n.s.
United States Virgin Islands	978	1991	978	978	n.s.	n.s.	978	n.s.	n.s.
Central America and the Caribbean	1,417,238	1994	1,738,289	1,493,402	−244,887	−1.4	1,325,407	−167,995	−1.1
Colombia	379,954	1996	440,000	396,600	−4,340	−1.0	354,500	−4,210	−1.1
Venezuela	250,000	1986	260,000	240,000	−2,000	−0.8	230,000	−1,000	−0.4
South America	629,954	1992	700,000	636,600	−63,400	−0.9	584,500	−52,100	−0.8

NOTES TO THE TABLE: According to FAO, the 1980, 1990, and 2000 figures have been determined as follows:
1. When sufficient quantitative information permitted a reliable trend analysis, 1980, 1990, and 2000 figures were based on the results of a regression analysis (Central America: Antigua and Barbuda, Belize, British Virgin Islands, Cuba, Dominican Republic, El Salvador, Grenada, Guadeloupe, Guatemala, Honduras, Martinique, Panama, Puerto Rico; South America: Colombia, Venezuela).
2. Where recent information was unavailable the extrapolation to year 2000 was based on the overall forest change rate 1990–2000 as reported in the Global Forest Resources Assessment (FRA) 2000 (FAO 2001; Central America: Cayman Islands, Montserrat, Netherlands Antilles, U.S. Virgin Islands), or on expert estimation (Central America and Caribbean: Anguilla, Aruba, Bahamas, Barbados, Costa Rica, Dominica, Haiti, St. Lucia, Turks and Caicos islands).
3. Where insufficient information was available, the area estimations for 1980 and 1990 were based on the overall forest change rates as reported in the Global FRA 2000 (FAO 2001; Central America and Caribbean: Nicaragua, St. Kitts and Nevis, St. Vincent and the Grenadines, Trinidad and Tobago), and in the FRA 1990 (FAO 1995;Caribbean: Bahamas).

SOURCE: Adapted from FAO 2002, 2003a.

2.7.5 Interdependence of Caribbean Habitats

It is important to note that, besides the large diversity of species that are resident in mangrove and seagrass communities, there is a continuous flow of biomass between these habitats and coral reefs in all directions. It is therefore necessary to consider all three habitats as one large interdependent marine ecosystem with shared biodiversity.

In addition, mangroves and seagrass communities are permanent recipients of planktonic larvae from the open sea (Eggleston 1995) and, in return, nurture crustaceans whose larvae provide food for ocean-going fish and mammals.

This interdependent nature of the marine ecosystem is a vital consideration in the management of the Caribbean Sea, as degradation of one type of habitat can have far-reaching impacts on the services provided to human communities by another. For example, the clearing of seagrass beds for cosmetic reasons could affect income from fisheries and, in the long run, speed up erosion of nearby beaches, which might reduce the appeal of a particular tourist resort and therefore damage local livelihoods.

3.0 DRIVERS OF CHANGE IMPACTING THE CARIBBEAN SEA

3.1 Overview

In common with the conceptual framework of the MA, a driver is defined here as any natural or human-induced factor that directly or indirectly causes a change in the state or condition of an ecosystem, and its ability to provide ecosystem services (MA 2003). Drivers can be either direct or indirect, exogenous (external) or endogenous (local). Table 3.1 summarizes the major drivers affecting the Caribbean Sea in each of these categories, as identified by this assessment and by recent scientific reviews of the Caribbean land and marine environment (UNEP 2004a, 2004b, 2006).

3.2 Interactions between Drivers

The loss of ecosystem services is frequently the result of the combination of two or more drivers, each of which in itself would not be sufficient to affect the long-term ability of human populations to derive benefit from the resources of the marine environment. This emphasizes the need for a broad overview of the functioning of the Caribbean Sea ecosystem, rather than focussing narrowly on specific sectors and activities. While it will not be possible to remove all drivers contributing stress on the natural environment, tackling individual drivers can add resilience to the ecosystem, making it more able to withstand other pressures which may be more difficult or impossible to predict and control.

A prime example of this can be found in the Caribbean, by comparing the fortunes of the diving industry in Jamaica and in the island of Bonaire in the Netherlands Antilles (Rodriguez et al. 2005). Between the 1950s and 1970s, Jamaica was the prime dive location of the region, and hard corals covered as much as 90% of the substrate.[18] By the late 1960s, chronic overfishing had reduced fish biomass by some 80% compared to the previous decade. In the early 1980s, two extreme events hit Jamaican coral reefs, causing their collapse. In 1980, hurricane Allen broke up the large elkhorn and staghorn coral into pieces. Then in 1983, an unidentified disease spread throughout the Caribbean and killed 99% of the long-spined sea urchin *Diadema antillarum*, which feeds on algae (Lessios et al. 1984) With the loss of both the sea urchins and reef-grazing fish, fleshy algae came to dominate Jamaican reefs in just two years, causing a decline in the lucrative dive tourism industry.

[18]The substrate is the surface on which an organism grows or is attached.

In contrast, Bonaire had taken steps to prevent overfishing of its reefs, including a ban on spear-fishing in 1971. As a consequence, the coral system was able to withstand the die-off of the sea urchins, as abundant grazing fish were available to maintain the equilibrium of the system. There was no reported overgrowth of algae, and the diving industry continued to thrive and grow—7 dive sites in Bonaire are now rated among the top 10 in the world for richness of fish species, with over 300 varieties. Income from dive permits within the Bonaire Marine Park now provides some U.S. $170,000 a year to support protected area management, and economic activity linked to diving is valued at more than U.S. $23 million per year.

Thus the unforeseen driver of the sea urchin disease had very different impacts on the recreational services of coral reefs in the two locations, because of different approaches to deal with overfishing. Other important interactions between drivers observed in the Caribbean Sea include:

- Population growth, the influx of tourists, and migration of populations to coastal areas lead to (a) changes in coastal land and sea space use at the expense of habitats important to the overall ecosystem; (b) pollution, especially from sewage; (c) increased demand for food (including fish) and increased sensitivity of human and natural systems to damage from hurricanes.
- The use of more advanced fish harvest technology, together with open access to the Caribbean Sea by international fishing fleets, leads to over-harvesting of stocks which cannot be controlled because of the lack of a regional governance framework for fisheries.
- Pollution and climate change make coral reefs more susceptible to the impact of alien species introduced via Sahara dust (see Section 3.3), ship ballast water, river discharge, and aquaculture.

3.3 External Drivers — the Example of Sahara Dust

As shown in Table 3.1, a significant number of the drivers affecting the ecosystem of the Caribbean Sea have their origins outside the region. They can arise from activities deep inside the South American continent (see Box 2.1), or world-wide decisions on energy use through the important driver of climate change and its potential to increase the destructive force of hurricanes (see Section 4.2.3).

One of the most unusual external drivers is the impact of the dust which is blown westwards by prevailing winds from the Sahara region of Africa (Fig. 3.1). At certain periods of the year, mainly from April to October, Sahara

TABLE 3.1 — Summary of assessment of drivers affecting the Caribbean Sea

Driver	Rank (1 = most important)	Major findings or other comments	Scale and speed of impact
Exogenous (external), direct			
1. Climate variability and change:			
(i) Tropical cyclones	2	The frequency and intensity of tropical cyclones in the insular Caribbean vary in cycles correlated with sea-surface temperature. Since 1998 the region has seen a trend of increasing frequency of tropical cyclones. Deaths and damage to property and ecosystems have increased significantly, due to the interaction with the drivers of population growth and urbanization on the coast.	Continental Slow
(ii) Sea-surface temperature	2	Elevated sea-surface temperature episodes cause increasingly frequent episodes of coral-reef bleaching.	Global Slow
2. Species introductions and pollution:			
(i) Sahara dust	3	The occurrence of coral-reef diseases may be partially due to pathogenic bacteria associated with an increasing intensity of Sahara dust over the last two decades. This driver interacts with coastal pollution and overfishing.	Global Slow
(ii) Amazon, Orinoco, & Magdalena river discharge (see Box 2.1)	4	Deforestation and pollution in the watersheds of major rivers discharging to the Caribbean may be the cause of occasional fish kills in the Lesser Antilles and Central America, through a combination of fresh water, sediment, excess nutrients, and land-based pathogenic bacteria.	Regional Fast
(iii) Ship-borne alien species	4	Ballast water from ships may occasionally cause introductions of species that change local coastal ecology, e.g., the Indo-Pacific green mussel *Perna viridis*. This driver interacts with international shipping.	National Slow
Exogenous, indirect			
3. Economic: Trade			
(i) International shipping	3	Under UNCLOS, extra-regional vessels have a "right of innocent passage" through the Caribbean. This applies to fishing vessels on the high seas, cruise ships, and even ships carrying hazardous waste (including nuclear waste). This contributes to the direct drivers of overfishing and pollution.	Regional Slow
Endogenous (local), direct			
4. Changes in coastal land and sea use:			
(i) Habitat destruction (ii) Urban sprawl	1	Coral reefs, mangrove swamps, and seagrass beds are declining in extent due to development-related activities which target flat land on the coast, or land reclaimed from the sea, for example, for hotels, golf courses, ports, housing, and industry.	National Fast
5. Pollution			
(i) Land-based	3	Untreated sewage from land-based sources is the most pervasive pollutant in the coastal environment.	National Fast

TABLE 3.1 — (*Concluded*)

Driver	Rank (1 = most important)	Major findings or other comments	Scale and speed of impact
Endogenous (local), direct			
5. Pollution (ii) Marine	5	Petroleum exploitation and transport is the cause of chronic but decreasing oil pollution, and sewage discharges from cruise ships add a significant extra pressure on the marine environment of the Caribbean.	National/ Regional Slow
6. Technology adaptation and use: (i) Fish harvest	2	Efficiency of fish capture through the increasingly widespread use of gillnetting, purse-seining, long-lining, and trawling may be the cause of a recent decrease in fish catches, and a change in the trophic structure of the ecosystem (i.e., the dominance of species lower down the food chain due to the over-harvesting of higher predators).	Regional Slow
7. Species introductions: (i) Aquaculture	5	Species introduced for coastal aquaculture or mariculture are becoming naturalized.	Local Slow
Endogenous, indirect			
8. Demographic: (i) Urbanization on the coast	1	One hundred per cent of people on the islands and 61–100% in Central America live within 100 km of the coast. This is the major driver, which interacts with most of the others.	Regional Slow
9. Economic: Trade	2	Capital investment in Caribbean tourism is the highest in the world relative to its size, with a proportional demand for coastal infrastructure at the expense of valued ecosystems.	Regional Slow
10. Sociopolitical: (i) Regional co-ordination and governance	3	The Caribbean Sea has a large number of individual country jurisdictions, which are frequently in conflict with each other and with international interests. The consequent lack of co-ordination indirectly influences many other drivers such as overfishing and the impacts of unsustainable tourism.	Regional Slow

dust becomes visible in the Caribbean in the form of hazy conditions. The dust clouds have been shown to worsen air quality by increasing the concentration of particulates, and in one study admissions to hospital of children in Trinidad suffering from asthma were found to increase on the day after dust cover (Gyan et al. 2005).

In addition, disease organisms carried by Sahara dust may be responsible for significant impacts on some parts of the Caribbean ecosystem. Recent microbiological studies have identified viable bacteria and fungi in the atmosphere during dust events in the Eastern Caribbean and the mid-Atlantic (Weir et al. 2004; Griffin and Kellogg 2004). To date, more than 150 species of viable pathogens have been identified from air samples collected during Saharan dust events in the U.S. Virgin Islands (Garrison et al. 2003).

The mechanisms by which Saharan dust may affect Caribbean reefs include deposition of pathogenic micro-organisms; deposition of chemical contaminants that affect the immune systems of coral-reef organisms; and deposition of essential nutrients that trigger the disease-

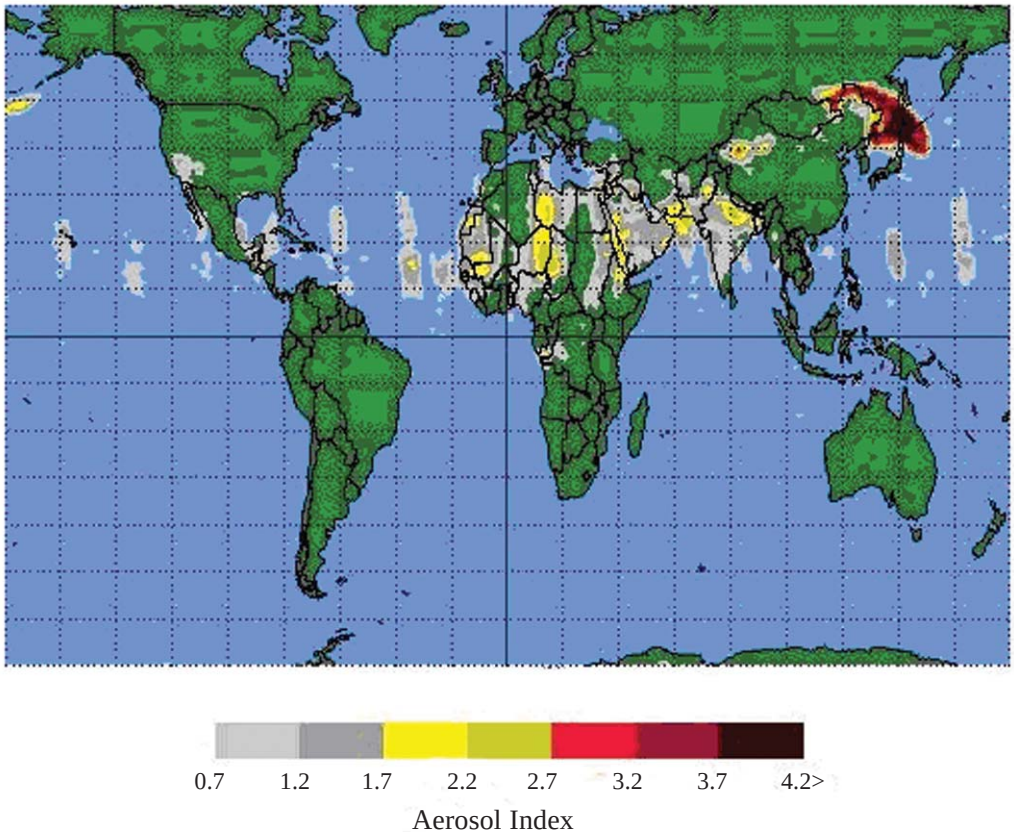


FIG. 3.1. Transatlantic flux of Saharan dust as recorded by TOMS satellite.
SOURCE: http//toms.gsfc.nasa.gov/aerosols/today_aero_v8.html

causing capability of microbes present on the reef, or that shift the structure of the microbe or sea-bed communities of the reef, thereby affecting the ecology.

There is mounting evidence to suggest that some of the declines occurring on Caribbean coral reefs today may be linked to African dust. The 1983 die-off of the long-spined sea urchin (Section 3.2) and the beginning of the Plague II outbreak in 1997 followed within months of peak dust events in the region. The strongest evidence thus far is that *Aspergillus sydowii*, a known fungal disease affecting sea fans, has been identified in its active pathogenic form, in air samples collected during Saharan dust events in the U.S. Virgin Islands, but not from clear atmospheric conditions (Garrison et al. 2003). *Aspergillus sydowii* is associated with soils, does not reproduce in seawater, has a wide geographical distribution, and occurs on reefs far from terrestrial sources of soil. Saharan dust is eroded soil and must thus be seen as a possible source of the disease.

Although dust has been making this journey for thousands of years, recent changes in climate since the mid-1960s, particularly decreased rainfall and desertification in northern Africa, have resulted in increased amounts of dust crossing the Atlantic.

4.0 ASSESSMENT OF MAIN CARIBBEAN SEA SERVICES: LINKS TO HUMAN WELL-BEING AND CONDITION AND TRENDS

4.1 Fisheries[19]

4.1.1 Importance of Fisheries

In the terminology of the MA the living marine resources of the Caribbean Sea constitute the most important 'provisioning' service of the ecosystem. Fisheries have always been a source of livelihoods and sustenance for the people of the region, contributing towards food security, poverty alleviation, employment, foreign-exchange earnings, and the development of rural and coastal communities, recreation, and tourism.

The fisheries of the Caribbean Sea are, with few exceptions, multi-species, small-scale fisheries conducted by low-capital, labour-intensive operators. The main

[19]A detailed description of the fisheries of the Caribbean and issues relating to their management is available in Annex 1.

exceptions are the industrial shrimp and tuna fisheries on the northern coast of South America and on the continental shelf adjacent to the Central American countries. The fishing sector is dominated by small, artisanal boats constructed of fibreglass and wood. These may be powered by outboard engines, oars, or sails, or a combination of all three. There are approximately 25,000 artisanal boats, 5,000 medium-sized boats, and 1,500 industrial vessels in the region.[20] Hook and lines, gillnets, and traps are the main types of gear used. In addition, trawls are common in the shrimp fisheries of South and Central America. Diving using compressed air is common in the lobster and conch fisheries. The main fisheries targeted in the region are based on the following resources: coral reefs and reef-associated fish; deep-water snappers and groupers; large pelagic fish;[21] small coastal pelagic fish; flyingfish; groundfish; shrimp; lobster and conch.

The fish resources of the Wider Caribbean region are extremely diverse. It has been estimated that there are some 680 species of bony fish and about 49 species of sharks targeted by fisheries in the region (Cervigón 1993). The invertebrates including shrimp, lobsters, and molluscs (conch, octopus, and squid) must be added to these figures to determine the total number of species that are of interest to fisheries.

This diversity presents a major challenge to the effective management of fish stocks in the Caribbean. There is little information on the status of most of the commercially important resources, and even less on the hundreds of species of lesser importance to the region's fisheries. For example, of the 197 stocks falling under the jurisdiction of the Caribbean Fisheries Management Council (CFMC), covering the U.S. Virgin Islands and Puerto Rico, the status of 175 (88%) was unknown or undefined.

Since the 1980s, aquaculture has been making an increasingly significant contribution to the economies of the region. The main species farmed are tilapia and penaeid shrimp (Haughton and Jacobs 1998).

4.1.1.1 Per Capita Consumption of Fish

Fisheries play a very important role in providing nutrition and food security within the Caribbean region. Fish is a vital source of animal protein and minerals in the diet of Caribbean people, particularly the poor and vulnerable members of society. Per capita consumption of fish in the region is approximately 15 kg per year. It is more variable in Central and South America, where the average is approximately 10 kg, and highest in the island states where the average per capita consumption is 19 kg, well above the world-wide average (FAO Database).[22] Consumption in several of the Small Island Developing States (SIDS) is higher than local production and has to be satisfied by high levels of imports. The high diversity of species of different shapes and sizes, the variation in taste and texture, and broad range in the commercial value of fish mean that fish is generally available at affordable prices to both rich and poor throughout the year.

4.1.1.2 Imports and Exports

Fisheries make a significant positive contribution to the balance of trade of the Caribbean region, even though the quantity of imports by weight considerably exceeds that of exports. According to statistics from the UN FAO, approximately 360,000 tonnes of fish and fishery products, worth some U.S. $410 million, were imported in 2000, while exports amounted to around 200,000 tonnes, worth U.S. $1.2 billion.

This apparent anomaly is due to the fact that exports are dominated by high-value products such as shrimp, spiny lobster, tuna, snappers and groupers, and queen conch, which command premium prices on the international market. The U.S.A. is the major destination of most exports from the Caribbean, which have been growing steadily in value.

Imports are very high in the island states, where they account for most fish supplied for human consumption. Haiti, for example, imports 70% of its fish, Jamaica 78%, and Martinique 80 per cent. The composition of imports in the small island states is dominated by dried, salted, and smoked fish. Fresh, chilled, and frozen products are also imported, mainly by the countries with a tourism industry.

4.1.1.3 Employment

Perhaps one of the most important roles of fisheries is the employment which the sector provides for hundreds of thousands of people, in a region where high levels of unemployment and under-employment continue to be a major concern. In a 1998 survey of 17 Caribbean countries, approximately 65% of respondents reported that they were either "concerned" or "very concerned" about losing their job in the next 12 months (Constance 1998).

[20]Fishery Information, Data, and Statistics Unit (FIDI), FAO 1998.

[21]Pelagic fish are those species spending most of their lives in the upper-water column, i.e., relatively close to the surface, as opposed to those finding sustenance close to the seabed (demersal).

[22]http://www.fao.org/docrep/T8365E/t8365e04.htm#1.3%20annual%20consumption%20of%20fish%20and%20shellfish

The fisheries sector in the CARSEA region provides stable full-time and part-time direct employment (as fishers) for more than 200,000 people, and jobs for an estimated additional 100,000 in processing and marketing. Indirect employment is also provided by boat-building, net-making, and other support industries. People engaged in fishing often have low levels of formal education, limited access to capital, and limited occupational and geographic mobility. It is estimated that each person employed in the fisheries sector has five dependents, suggesting that well in excess of 1.5 million people in the Caribbean rely on fisheries for their livelihood.

4.1.1.4 Recreational Fisheries and Non-consumptive Uses

Within the Caribbean region, fisheries are important not only as a source of food and employment for commercial and subsistence fishers, but also for a growing number of people involved in recreational fishing, defined as fishing conducted for the purpose of pleasure and relaxation rather than for commercial gain or subsistence by the fisherman. Popular sport-fishing magazines, such as *Marlin*, *Salt Water Sportsman*, and *Sport Fishing*, consistently rate the Caribbean as a prime destination for international anglers targeting billfish, such as marlins and sailfish, and for several other species of game fish. Dozens of international, regional, and national fishing tournaments are held each year throughout the region.

Despite its popularity, there is a lack of data and information on the recreational fishing industry of the Caribbean. Research is needed to understand better the scope and economic importance of the activity, as well as its impact on marine resources and management requirements. Statistics from the U.S. suggest the pastime generates very significant revenues and employment: the National Marine Fisheries Service estimated in 1996 that direct expenditure from sport fishing amounted to more than U.S. $7 billion per year, providing more than one million U.S. jobs. In most Caribbean countries, sport fishing is promoted by tourism interests and is neither monitored nor regulated by the national fisheries administrations.

There is therefore a strong link between the management of Caribbean fisheries and the value and impacts of tourism in the region, which are discussed in more detail later in this report. This link is also evident in the economic value of the diving industry, which depends on abundant and varied populations of coral-reef species of fish and other marine life.

4.1.2 Driving Forces Impacting Caribbean Sea Fisheries

The Caribbean Sea Ecosystem Assessment has identified the following drivers affecting the fisheries of the Caribbean:

4.1.2.1 Direct Drivers

- Environmental degradation and pollution of the world's seas and oceans, for example, the dumping of toxic waste at sea, and the destruction of mangroves and other critical coastal habitats which are spawning and nursery grounds.
- Irresponsible fishing practices, for example, the use of some types of trawls, dynamite, certain high-technology fishing techniques, and the capture of non-target species by nonselective gear.
- Global warming and sea-level rise are emerging as important factors affecting fisheries globally and in the Caribbean, although the precise relationships and impacts are still to be fully defined and quantified.

4.1.2.2 Indirect Drivers

- Inadequate policy framework and institutional capacity to manage fisheries in many countries as well as at the regional level for the management of shared stocks.
- Inadequate legal and regulatory framework, and capacity for enforcement.
- Lack of knowledge of the fish stocks; the fisheries; the social and economic conditions of the fishers; and the environmental and ecological processes which control abundance and distribution of the resources.
- Growing demand for fish and fishery products, resulting from population growth, increasing purchasing power, and improved awareness of the nutritional value of fish, has resulted in excessive pressure on the resource.
- Excessive investment in fishing capacity leading to overcapitalization, compounded by the open-access nature of most fisheries—there are just too many fishers, boats, and fishing gear.
- Growing desire for improvement in the standard of living coupled with high levels of unemployment and poverty in many developing states force large numbers of persons to enter and remain in fisheries.

4.1.3 Condition and Trends in Fisheries Resources

4.1.3.1 Overview

Within the Caribbean Sea, many species of fish are under stress from over-exploitation and/or habitat degradation, and are therefore not making an optimum contribution to socioeconomic development of the region. All the major commercially important species and species groups targeted by specific fisheries are reported to be either fully developed or over-exploited. These include conch, which has been placed on the Convention on International Trade in Endangered Species (CITES) list of threatened species (www.cites.org); lobsters and shrimp; groundfish; shallow shelf reef fish; deep-slope fish and some of the large oceanic pelagic species which are managed by the International Commission for Conservation of Atlantic Tunas (ICCAT; CFMC and CFRAMP 2000). It is likely that the status of Caribbean fisheries is similar to that of fisheries globally: the FAO observed in 1993 that over 70% of world fish stocks were either over-exploited, fully exploited, or were in a state of rebuilding after being overfished.

4.1.3.2 Trends in Finfish and Invertebrate Landings in the Caribbean Region (1950–2004)

Accurate data on trends for fish catches specific to the Caribbean Sea have been difficult to obtain because regional FAO statistics are generally combined with parts of the Atlantic Ocean. Recently, however, new analysis of these data has helped to build up a coherent picture of the state of fisheries in the CARSEA region.

Annual landings of finfish and invertebrates are provided in Figure 4.1. They are based on data from the Sea Around Us Project (SAUP) of the University of British Columbia (UBC) Fisheries Center (http://www.seaaroundus.org). The figures were reconstructed or reallocated from the larger Western Central Atlantic Region in the Fisheries database of the FAO (FAO FISHSTAT), to include only catches from the CLME, the focus of the CARSEA Project. Individual country data were re-examined jointly by UBC and national sources such as fisheries departments and research institutions in some countries including Venezuela, Cuba, Belize, St. Lucia, St. Vincent and the Grenadines, Barbados, and Trinidad and Tobago (Zeller et al. 2003).

According to this analysis, fish catches in the Caribbean generally increased from 84,411 tonnes in 1950 to 482,848 tonnes in 1998, before declining to 401,561 tonnes by 2004 (Fig. 4.1). The data suggest that the increased use of more efficient fishing gear including purse seines,[23] relative to other gear such as bottom trawls, may have contributed to the larger catches. The bulk of the catch is dominated by the artisanal sardine fishery (mainly "round sardinella") based in Venezuela. In terms of landed value, sardines, catfish, shrimp, and lobster are the leading products, worth about U.S. $600 million in 2004.

4.1.3.3 Trends in Landings of Inshore and Offshore Fisheries (1980–1999): Case Study — Windward Islands

Data on the quantity of fish landed in any particular year provide only limited information about the status of stocks in a given sea area. Trends in landings of individual countries or islands reflect differences in the level of development of the fishing industry, initiatives to manage stocks through rules on the gear used and/or species targeted, and the overall effort applied to catching fish in a specific area. These factors can lead to marked differences between the pattern of fish landings observed in particular areas and across the Caribbean Sea as a whole.

A more informative measure of the condition of the fishery ecosystem service can be obtained by comparing the size of the catch with the effort exerted by fishing fleets or Catch Per Unit of Effort (CPUE). A recent calculation of catch-and-effort trends in four of the Windward Islands provides a useful case study for this assessment (Mohammed 2003).

The data for the study were reconstructed from published material, "grey literature,"[24] historical documents, and recently computerized databases of the fisheries departments of the respective countries: Grenada, St. Lucia, St. Vincent and the Grenadines, and Barbados. This produced improved information on the catches of particular species, compared with current data in the FAO database for the respective island nations. Fishing effort was represented as the product of the number of boats, the average engine horsepower, and the average number of fishing days per year. The percentage change in these parameters between 1980 (Table 4.1) and 1999 was used to quantify the impacts of fishing on the available resources, for both offshore and coastal waters (Table 4.2).

Although the results are preliminary, some stark changes are evident during this 20-year period. Reconstructed catches declined by 12% in the inshore fisheries of Grenada

[23]A purse seine is a net which can be closed at the bottom using a line to draw together metal rings, forming the shape of a bag and trapping the fish.

[24]Grey Literature refers to publications issued by government, academia, business, and industry, in both print and electronic formats, but not controlled by commercial publishing interests and where publishing is not the primary business activity of the organization.

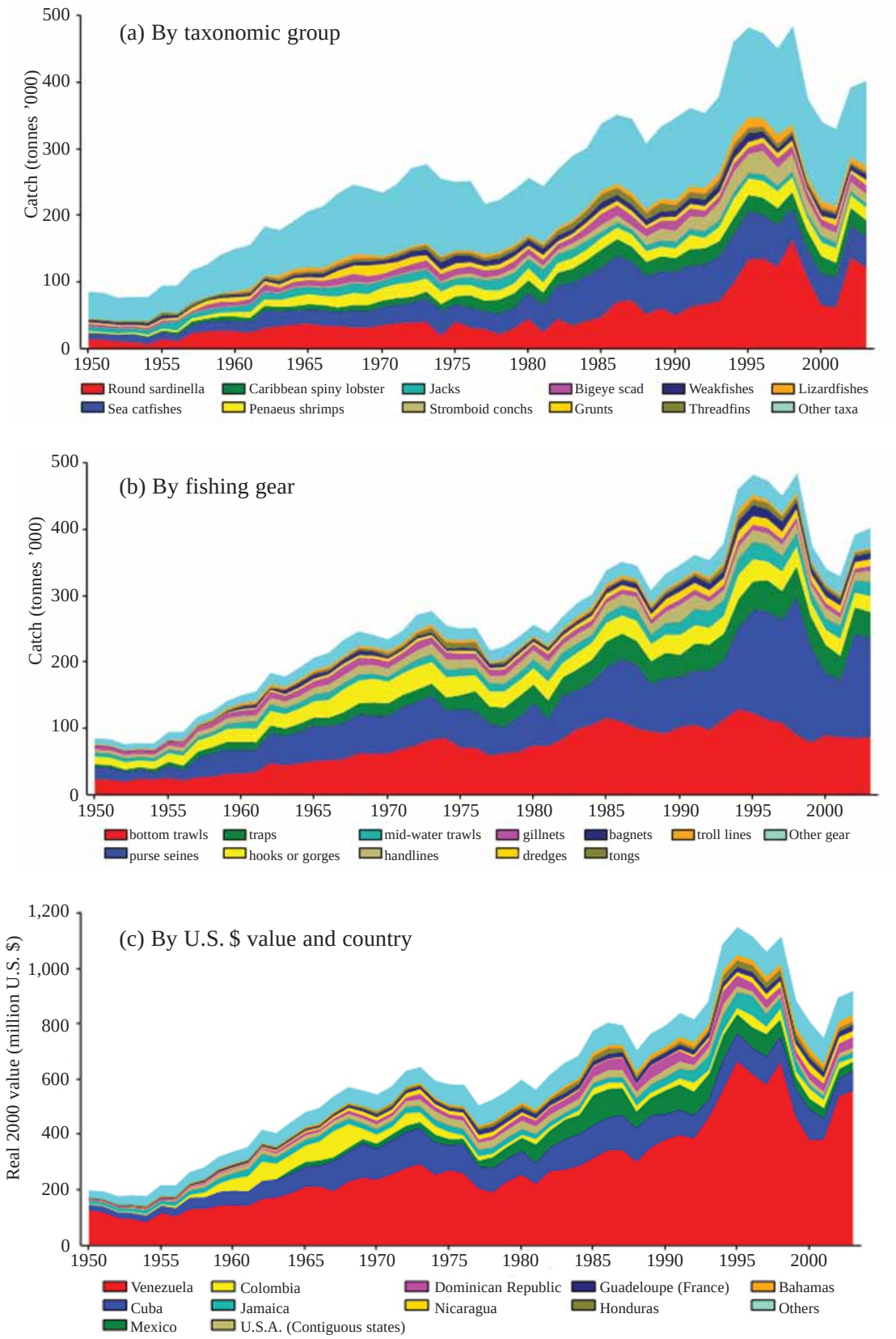


FIG. 4.1. Fish landings in the Caribbean Sea.
SOURCE: University of British Columbia (UBC) Fisheries Centre. Sea Around Us Project 2006.

TABLE 4.1 — Reconstructed catch, effort, and catch per unit effort of four countries in the south-eastern Caribbean, 1980

Fishery statistic	Grenada & Grenadines	St. Lucia	St. Vincent & Grenadines	Barbados
Inshore				
Catch (tonnes)	660	275	397	558
Effort (10^3 Hp-days)	302	527	1357	1018
CPUE (tonnes per 10^3 Hp-days)	2.08	0.38	0.27	0.51
Offshore				
Catch (tonnes)	745	549	204	3211
Effort (10^3 Hp-days)	815	1254	6445	2255
CPUE (tonnes per 10^3 Hp-days)	0.84	0.47	0.29	1.34

TABLE 4.2 — Percentage change in catch, effort, catch per unit area, and catch per unit effort of four countries in the south-eastern Caribbean, 1980–1999

Fishery statistic	Grenada & Grenadines	St. Lucia	St. Vincent & Grenadines	Barbados
Inshore				
Catch (tonnes)	−12	+36	+64	+16
Effort (10^3 Hp-days)	+42	+133	+4	+134
CPUE (tonnes per 10^3 Hp-days)	−38	−24	+58	−71
Offshore				
Catch (tonnes)	+129	+143	-29	+36
Effort (10^3 Hp-days)	+598	+513	+170	+339
CPUE (tonnes per 10^3 Hp-days)	−67	−65	−52	−69

and its associated islands. This was despite a 42% increase in fishing effort. While inshore catches in the fisheries of St. Lucia and Barbados increased by 36% and 16%, respectively, the corresponding CPUE declined by 24% and 71 per cent. Of the four island states examined, only St. Vincent and the Grenadines experienced an increase in CPUE for inshore waters (58%). This increase might be explained by two factors: changes in the areas favoured by fishing boats, such as would occur with the targeting of previously unexploited stocks in deeper waters; and improved data collection systems in the Grenadines, where most catches are taken from the shelf and slope areas. However, these reasons remain to be verified.

Many governments in the Eastern Caribbean, faced with the over-exploited state of inshore fisheries and the increasing need for food security, have promoted development of the offshore fishery, targeting large pelagic species such as tuna, through the provision of loans and other incentives. The data assembled for this study suggest that the increases in offshore catches between 1980 and 1999 (36% to 143%) were far outweighed by the corresponding increases in fishing effort to produce such catches (339% to 598%). The CPUE declined substantially in the offshore fisheries of each of the four countries (by a range of between 52% and 69%).

The data in this study suggest, therefore, that fish catches by the fleets of the Windward Islands failed to keep pace with a dramatic expansion of fishing effort in the last two decades of the 20th century, especially in offshore waters. This is consistent with international studies suggesting that oceanic pelagic stocks are either fully exploited or over-exploited.

A declining CPUE also affects the economic viability of a fishery—since a smaller quantity of fish is produced from the same investment of fuel, labour, etc. However, government financial incentives and increases in export prices may act to preserve or increase the economic gains from the fishery, despite obvious declines in stock abundance evident from declining catch per unit of effort. The economic impacts of increasing offshore activity have not been investigated.

Offshore resources are shared regionally, in the case of large coastal pelagic fish, or with other fishing nations including developed countries, in the case of large oceanic pelagics. Although each country is charged with the responsibility for management of the resources within its EEZ, this study highlights the need for regional and international collaboration and governance to preserve the long-term viability of shared Caribbean fish stocks and the human livelihoods associated with them.

4.1.3.4 Fishing Down the Food Web: Evidence of Declining Trophic Levels in the Caribbean

Another indicator of unsustainable fishing patterns has been an observed change in the structure of the marine food web, as reflected in the composition of fish catches over time. A landmark 1998 study by the fisheries scientist Daniel Pauly and colleagues demonstrated a gradual transition in global landings from long-lived, fish-eating species higher up the food chain (higher-trophic level), towards short-lived, plankton-eating fish and invertebrates lower down the food chain (lower-trophic level; Pauly et al. 1998). The phenomenon, known as "fishing down the food web," tends to lead first to increasing catches, then to an ecosystem transition associated with stagnating or declining catches. The SAUP has recently carried out the same analysis for the CLME, and the results indicate a decline in mean trophic level of fish in the catch (shown in Fig. 4.2a), from about 3.64 in 1950 to about 3.4 by 2004.

Changes are also evident at the local level. Analysis of data from the four Windward Island states mentioned in the previous section suggests a general shift of catch composition towards the bottom of the food web between 1980 and 2001 (Fig. 4.3; Mohammed et al. 2002). This decline in mean trophic level was most pronounced for the fisheries of Grenada and Barbados (0.17 and 0.22 per decade, respectively), and greater than the global average of 0.1 per decade estimated by Pauly et al. (1998).

Fishing at lower trophic levels may, however, be a deliberate fishing strategy to harvest the increase in biological production associated with "fishing down the food web." As a result, a decline in mean trophic level alone is insufficient to confirm the negative impacts of fishing on the ecosystem. Pauly et al. (2000) introduced the Fishing-In-Balance Index (FIB) to identify cases where the expected increase in biomass at lower trophic levels no longer holds true. The FIB declines if the observed catches are not consistent with expectations at the associated trophic level (Pauly et al. 2000).

Such an analysis indicates that the FIB index has steadily increased for the Caribbean Sea since the late 1950s (Fig. 4.2b), which may be the result of the expansion of fishing effort to deeper and more remote waters. Mixed trends for the FIB are evident in the four Windward Island states (Fig 4.3).

Taking these data together, the inescapable conclusion is that the phenomenon of fishing down the food web by selective removal of top predators is well advanced in the Caribbean Sea and has already had a significant impact on the inshore fisheries of some countries, including Grenada and Barbados. This strengthens the case for managing the industry in an integrated manner to safeguard the entire ecosystem, including the establishment of new marine protected areas.

4.2 Tourism and Recreation

4.2.1 Locational Advantage

The natural setting of the Caribbean, a product of the marine, island, and coastal ecosystems of the region, constitutes an asset of immense value due to the positive associations it invokes around the world. People from a wide range of nationalities and social backgrounds are prepared to travel thousands of miles, and commit a significant portion of their income, to spend just a few days on vacation there.

The attraction of the insular Caribbean is linked to a romantic perception of islands as "warm and sensuous" destinations, offering "stressed out visitors the much needed opportunity to relax, escape, recharge their batteries, and generally appreciate a way of life that has been lost in the too-busy commercial environment of the globalizing, post-industrial Western world" (Royle 2001; Harrison 2001).

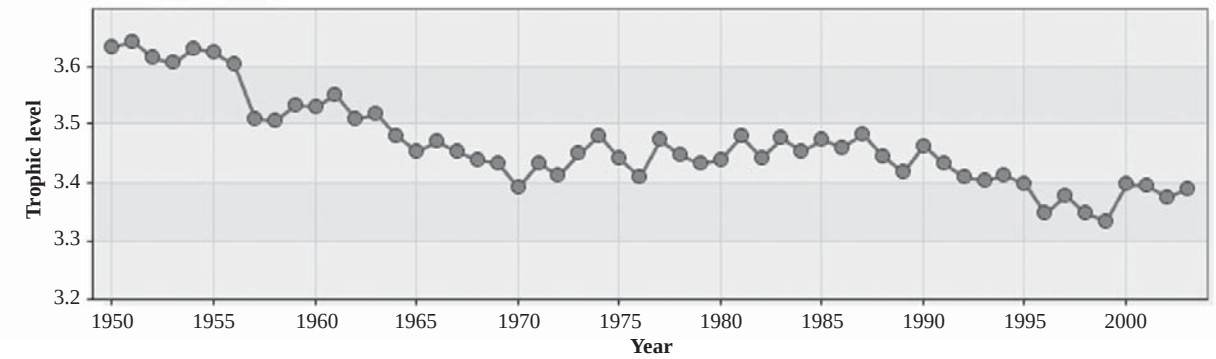


FIG. 4.2a. Mean trophic level for the Caribbean Sea.

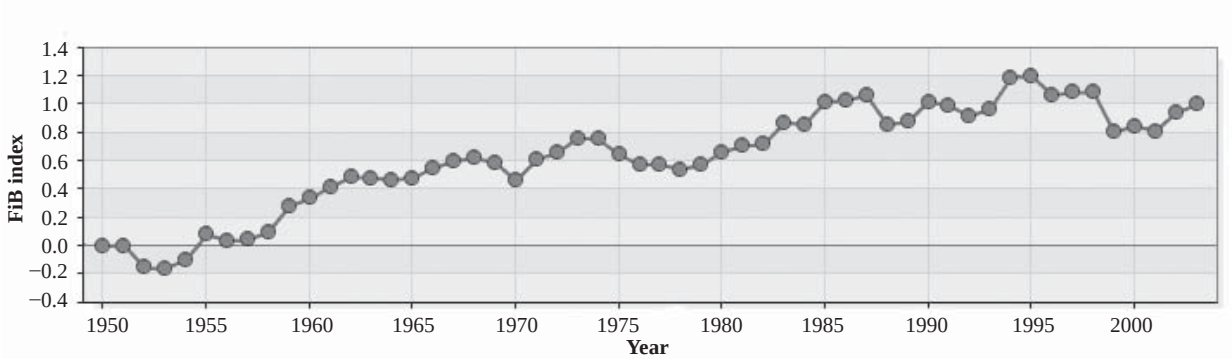


FIG. 4.2b. FIB index for the Caribbean Sea.
SOURCE: UBC Fisheries Centre. Sea Around Us Project 2006.
(http://www.seaaroundus.org/TrophicLevel/LMETrophicIndex.aspx?LME=12&FAO=0&country=Caribbean%20Sea)

Caribbean tourism conjures up images of sun-drenched, palm-fringed, white sandy beaches that epitomize the ideal symbol of paradise, rest, and relaxation.

4.2.2 Links between Tourism and Human Well-being

Recreation and tourism-related jobs and income are linked to the amenity value or cultural service provided by the Caribbean Sea ecosystem. As the fastest-growing economic activity in the region and, indeed, in many individual countries, the tourism sector contributes much by way of employment, foreign-exchange earnings, and, in some countries, important economic linkages with other sectors such as agriculture and construction. Tourism also has the potential to be the main engine of sustainable economic growth and development in many Caribbean islands.

To quantify the economic contribution made by tourism, new data and forecasts have been provided to CARSEA by Oxford Economic Forecasting (OEF). As shown in Tables 4.3 and 4.4, this analysis confirms the conclusion of the World Travel and Tourism Council (WTTC) in 2004 that relative to its size, the insular Caribbean is the most tourism-driven region in the world. In terms of jobs and export income, the contribution of tourism is nearly double that of the global average, and it accounts for more than a fifth of all capital investment in the region.

According to data from the Caribbean Tourism Organisation (CTO 2002) almost 25 million tourists travelled to destinations in the CARSEA region during the year 2000. The most popular destinations were Puerto Rico (3.3 million), Dominican Republic (3.0 million), Cancun (2.3 million), Cuba (1.8 million), Bahamas (1.6 million), and Jamaica (1.3 million). The total number of cruise-ship passenger arrivals in the Caribbean Sea was 14.6 million, with the most frequent ports of call being in the Bahamas (2.5 million), U.S. Virgin Islands (1.8 million), Cozumel (1.5 million), Puerto Rico (1.3 million), and Cayman Islands (1.0 million).

The number of rooms providing tourist accommodation in the CARSEA region (including Cancun, Cozumel, Venezuela, and Belize) increased from 122,000 in 1990 to almost 283,000 in 2000—an increase of more than 132% over the 10-year period. In 2000, the Dominican Republic

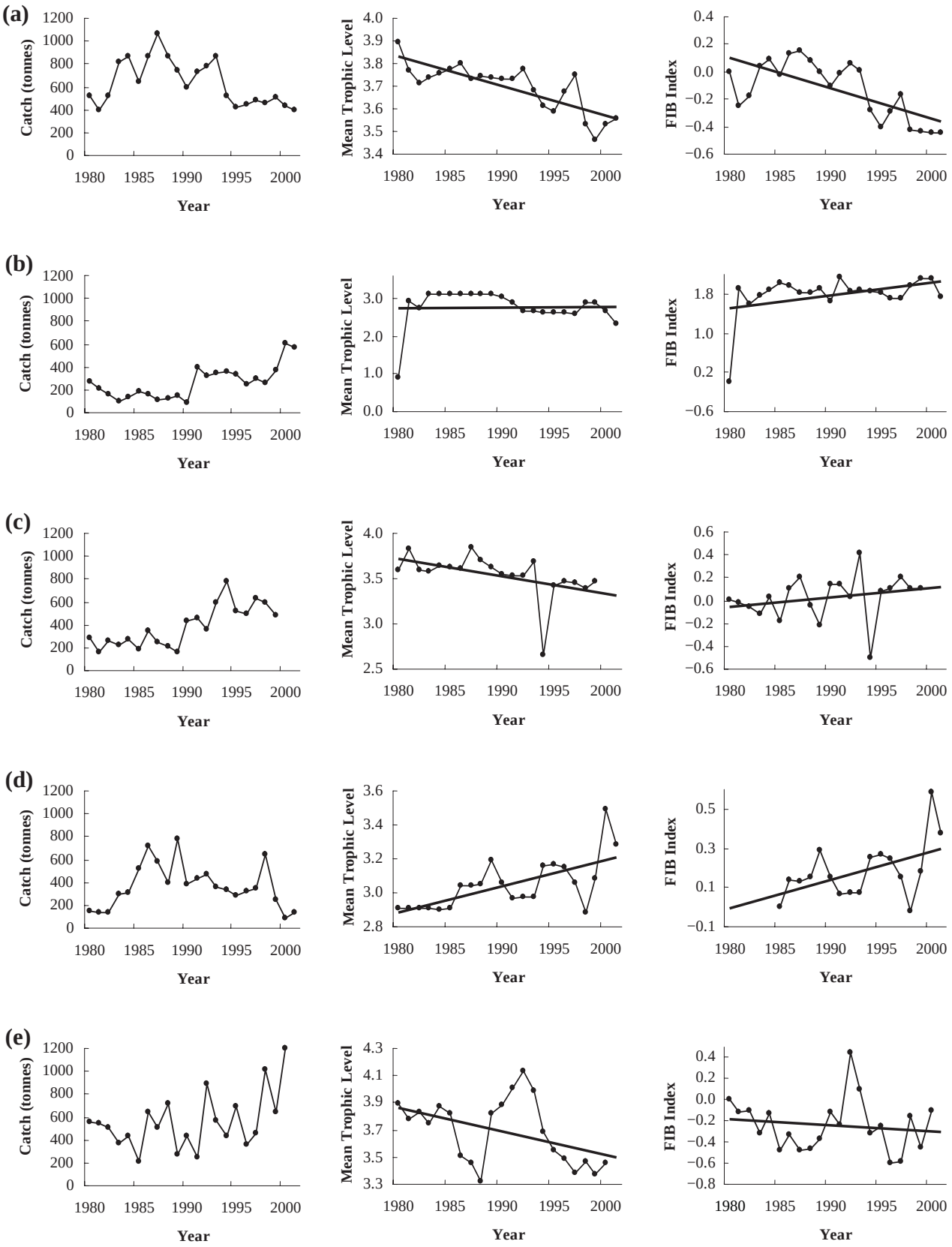


FIG. 4.3. Trends in annual catches and associated mean trophic level, and mean FIB index for islands of the south-eastern Caribbean: (*a*) Grenada; (*b*) St. Lucia; (*c*) St. Vincent; (*d*) Grenada and St Vincent Grenadines combined; and (*e*) Barbados.

TABLE 4.3 — Contribution of tourism to the economy of the insular Caribbean, relative to the global average, 2004 forecast

Tourism-related activities	Number/U.S. $ value for insular Caribbean	Percentage (%) of total, insular Caribbean	Global average, %
Jobs (direct and indirect)	2,416,500	15.5	8
Contribution to GDP	$28.4 billion	13	10
Exported services and merchandise	$19.0 billion	16.1	9
Capital investment	$7.4 billion	21.7	9

SOURCE: CARSEA/OEF.

TABLE 4.4 — Selected travel and tourism country rankings[1] forecasts for the Caribbean within the World Countries List 2004 and 2014

	2004	2014
Caribbean[2]	Relative size	Relative size
Personal & travel tourism	8	10
Government expenditures	1	1
Capital investment	1	1
Visitor exports	3	3
Economy GDP	1	1
Economy employment	1	1

[1]Total 13 regions (161 countries). Best is number 1, worst is number 13.
[2]Includes 23 insular Caribbean countries/territories. Adapted from World Tourism and Travel Council http://www.wttc.org/ (sub-menu: TSA Accounts, World Reports, Caribbean) accessed Aug. 17, 2004.

recorded the largest number of rooms (51,916), followed by Venezuela (33,149), Cancun/Mexico (25,434), and Jamaica (23,640).

The 2000 CTO data show the overwhelming statistical importance of U.S. visitors (50% of the total) and Europeans (25%). Some 6.5% of visitors are from Canada, 7% from the Caribbean, and 12% are classified as "Other." The dominance of U.S. tourists is consistent with the fact that tourist numbers are highest in destinations closest to the United States of America.

Cruise-ship arrivals represent the fastest-growing segment of the industry and will soon rival the hotel sector in bed/berth capacity (McElroy 2004). In their shore visits, cruise passengers provide a major source of direct income for small entrepreneurs such as taxi drivers and handicraft vendors, as well as the informal sector. This contribution to the development of entrepreneurial activity can be as important as that of the stay-over sector, whose link to the local economy is often limited by the enclave nature of the accommodation.

4.2.3 Driving Forces Impacting Caribbean Tourism

4.2.3.1 Climate Variability and Change

In its Third and Fourth Assessment Reports, the Inter-Governmental Panel on Climate Change (IPCC) cautioned that because many small islands are so heavily dependent on the tourism sector for their economic survival, adverse impacts on the industry, from climate change or other causes, would be of great concern to these countries (IPCC 2001; Mimura et al. 2007).

Since the tourism infrastructure of the Caribbean region is mostly located on the coast, an increase in the frequency and intensity of hurricanes represents a major threat to this essential service of the Caribbean Sea ecosystem. This is demonstrated by calculations of the losses to tourism income caused by recent storms.

In 1995, hurricanes Luis and Marilyn caused severe damage to hotel and other tourism properties in Antigua and Barbuda, leading to a 17% decrease in the number of tourist arrivals and adversely affecting employment

and foreign exchange.[25] Similar experiences occurred in 1998 and 1999 with the passage of hurricanes Jose, Georges, and Lenny.[26] The cost associated with damage from Hurricane Gilbert in 1988 was in the region of J $25 million.[27] Hurricanes Georges and Mitch in 1998 affected Jamaica's tourism sector.[28] Hurricane Lenny in 1999 caused approximately U.S. $250,000 damage to tourism infrastructure in Dominica, mainly along the western coast.[29] Tourism arrivals in St. Kitts by air and sea were negatively affected by the passage of hurricanes Luis and Marilyn (1995), Georges (1998), and Jose (1999).[30]

The precise relationship between human-induced climate change and the frequency and intensity of tropical cyclones remains a matter for scientific debate. Figure 4.4 shows, however, that the Caribbean has recently been experiencing a phase of more frequent storms relative to the past 100 years. Current research also suggests that the coming decades are likely to witness an increase in the destructive power of hurricanes, associated with higher sea-surface temperatures.

Emmanuel (2005) defined an index for the potential destructiveness of hurricanes based on total release of power over the lifetime of the cyclone. This index is a better indication of tropical cyclone threat than storm frequency or intensity alone. Using this index, he found there had been a marked increase in both the frequency and severity of tropical cyclones since the mid-1970s, with a near doubling of power dissipation over the period of record. This trend is due to both longer storm lifetimes and greater storm intensities. The research also found a close correlation between net hurricane power and sea-surface temperature and suggested that future warming may lead to an upward trend in tropical cyclone destructive potential, and a substantial increase in hurricane-related losses in the 21st century.

[25]Government of Antigua and Barbuda. 2001. Antigua and Barbuda's Initial Communication on Climate Change. pp. 35. Available from http://unfcc.int/national_reports/non-annex_i_natcom/items/2979.php

[26]Government of Antigua and Barbuda. 2001. Antigua and Barbuda's Initial Communication on Climate Change. pp. 36–37. Available from http://unfcc.int/national_reports/non-annex_i_natcom/items/2979.php

[27]Government of Jamaica. 2000. Jamaica's Initial Communication on Climate Change. p. 72. Available from http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

[28]Government of Jamaica. 2000. Jamaica's Initial Communication on Climate Change. p. 12. Available from http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

[29]Commonwealth of Dominica. 2001. Commonwealth of Dominica's Initial Communication on Climate Change. p. 51. Available from http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

[30]Government of St. Kitts – Nevis. 2001. St. Kitts – Nevis Initial Communication on Climate Change. p. 38. Available from http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

4.2.4 Consequences of Trends in Tourism for the Caribbean Sea

As well as being highly dependent on the services provided by the Caribbean Sea ecosystem, the tourism industry has an important influence on its condition. Most tourism facilities in the Caribbean, for example, are located within 800 metres of the high-water mark and can disturb sensitive ecological processes provided by habitats such as reefs and mangroves (see Section 2; Crompton 1999).

The true impact of tourism on the environment can only be addressed if one takes into account its use of resources such as fresh water, land and energy, as well as the wastes and pollution generated by the tourism industry. Tourism is a major consumer of water, with many resorts showing water consumption 5 or 10 times higher than other residential areas (UNEP 1999; SEDU 2002). Of equal importance is the widespread transformation of coastal environments by the filling-in of wetlands as well as beach and coral-reef loss, for hotel and marina construction.

The growth of the cruise-ship sector presents challenges for the sustainability of Caribbean tourism for two principal reasons. The first relates to the concentration of the industry in the hands of a few companies based outside the region. Three operators, CARNIVAL, Norwegian Cruise Lines (NCL), and Royal Caribbean International accounted for nearly 90% of cruise capacity in 2004 (Wood 2004).

Secondly, from the environmental perspective, one of the major implications of this growth is the potential for increased pollution of the Caribbean Sea from effluent such as sewage and lubricants. It has been estimated that cruise ships contribute around 77% of all marine pollution worldwide. On a single voyage, a large cruise ship produces on average 210,000 gallons of sewage, 1,000,000 gallons of waste water, 125 gallons of toxic chemicals and hazardous waste, 8 tonnes of garbage, and 25,000 gallons of oil bilge water.

While relatively little data exist on cruise-ship pollution in the Caribbean Sea, particular cases of environmental damage have been recorded. They include the destruction of 300 acres of coral reef by cruise-ship anchors around George Town, Cayman Islands, and severe damage to 80% of a reef in a marine park off Cancun, Mexico, when a cruise ship ran aground.

Caribbean national and regional authorities have only limited capacity to prevent such damage to the ecosystem, as the "flag of convenience" regime enshrined in UNCLOS and other international agreements effectively insulates cruise ships from territorially based state and regional regulation.

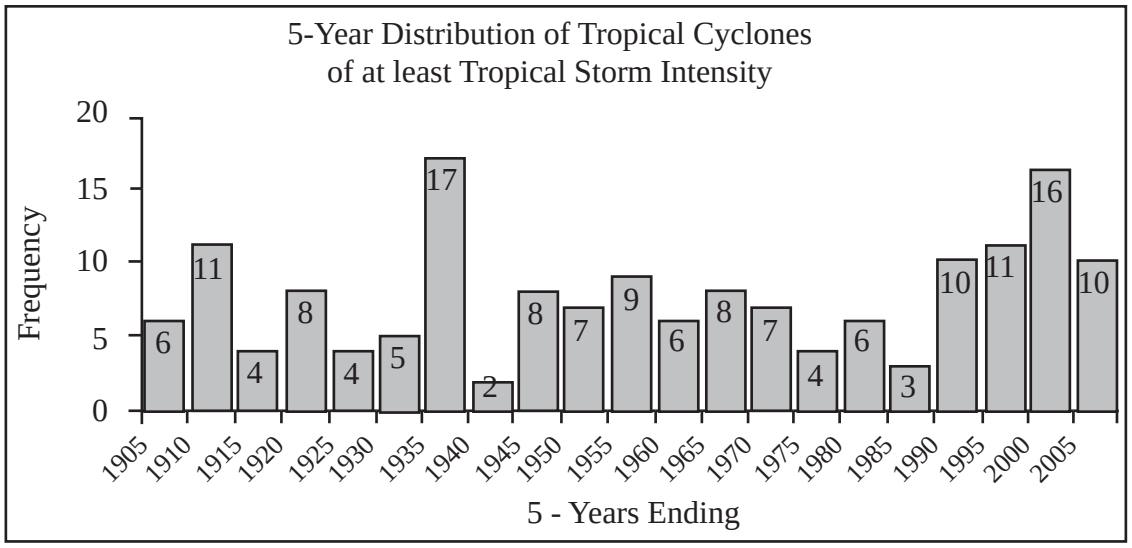


FIG. 4.4. Tropical cyclone information for the Eastern Caribbean.
SOURCE: Caribbean Meterological Institute/CARSEA.

5.0 SCENARIOS

5.1 Developing the Caribbean Sea Scenarios

In keeping with the MA, CARSEA has developed four scenarios to help policy-makers and stakeholders assess the likely consequences for the ecosystem and its services of different approaches to economic and environmental management. They are intended to generate a range of plausible stories of the future which contain potential surprises, and cover a range of alternative futures. Scenarios are not predictions of what the future will be but rather what the future could be. They are a tool to stimulate thinking about the dynamics of the relationship between choices and alternative futures, given what is known about the interactions between the different driving forces affecting ecosystem services.

The scenarios were drawn up by a multi-disciplinary team of experts from South America, Central America, the Caribbean islands, the MA Global Scenarios Group, and the United Nations Environment Programme´s Global Environmental Outlook for Latin America and the Caribbean (UNEP GEO LAC). The procedure for choosing the parameters of each scenario and developing the storylines is summarized in Box 5.1, and a detailed description of the process is available in Annex 2a.

5.2 Scenarios for the Caribbean Sea

The scenarios selected for CARSEA were designed to model plausible outcomes for the region in the period to 2050, according to four overarching trends which might conceivably come to dominate the next few decades in the Caribbean, and which have contrasting implications for the ecosystem and its peoples. In each case, a specific focus was selected, relating to a major strategy decision affecting the region, which helped to tease out some of the key outcomes for ecosystem services and human well-being.

Thus the **Neo-plantation Economy** scenario explores the consequences of the Caribbean economy continuing to be dominated by outside interests, with little regional co-operation or priority given to ecosystem management. The focus of this scenario is an emphasis on mass tourism; **Growing Asymmetries** looks at a future in which there is also limited co-operation between Caribbean states, but the focus here is a free trade area covering all of the Americas; **Quality over Quantity** models a future in which Caribbean countries give priority to the long-term sustainability of their economies, although with an emphasis on competing in the global market-place. The focus in this scenario is a decision to move towards more specialized, “niche” tourism; finally, **Diversify Together** looks at a future in which the Caribbean seeks to reduce its collective dependence on overseas interests and takes as its focus a trend towards much greater regional co-operation.

Detailed analysis of the implications of each of these scenarios for the key services of fisheries and tourism in the Caribbean are set out in annexes 2b and 2c. The broad “storylines,” including some of the key risks and benefits, follow in the next section.

BOX 5.1: Approach Used to Develop Storylines for the Caribbean Sea (CARSEA)

Part I: Stakeholder involvement (conducted separately in small breakout groups)

1. Assess the current knowledge and current state of the system

   List key historical eras, key actors, external forces affecting the region, and ecosystem services.

2. Identify a focal issue or issues

   List hopes and fears for the future to determine focal questions that might drive scenario development.

3. Identify alternative trajectories and branch points

   Identify key sources and threats to the resilience of the region (ability to adapt to coming surprises). We developed focal questions for Caribbean marine ecosystems based on: What is the biggest concern for the region in the future? What are the factors that do or can make this region more able to cope with whatever the future brings?

4. Build scenarios

   Ask breakout groups to come up with a set of storylines, based on the focal questions and considering the major eras and vulnerabilities of the region. They were asked to do this in 1 hour to create a sense of urgency. Each group was then asked to present their set of scenarios to the entire group in a Plenary.

Part II: Refine and test the scenarios (conducted by a single small focus group)

5. Assess the scenarios

   Are there certain themes emerging? Can we come up with a set of 4 or so that seem to make sense together? What are the critical contrasts among the scenarios? What are the recurring themes? Are the trends/events plausible? What trends/events are useful for illustrating key themes or concepts?

   Does the set address the focal questions?

6. Shocks and surprises

   Come up with a list of shocks and surprises that might happen and ask how the world would respond under each of the scenarios.

7. Use this analysis to *refine* a final set of scenarios.

   (a) Storyline construction

   Using matrices and graphical illustrations, list (i) major historical eras, (ii) current trends, (iii) major actors at different scales, (iv) external forces, and (v) ecosystem services. We crossed some of these key drivers with ecosystem services and resources and worked on developing scenarios around these axes. However, we found the use of axes in a single diagram too limiting to capture the complexity of the issues we wished to explore. We discussed the major drivers in the region and constructed the stories around them packaged as clusters of issues. In the final analysis we choose from the large set of possible scenarios, those that addressed the focal questions whether they fell neatly into the quadrants or not. We also discussed the key tipping points that might change the direction of any storyline. These tipping points included a regional governance framework, fisheries collapse, etc.

   (b) How were assumptions made explicit?

   Assumptions were made explicit by constructing a matrix of anticipated changes in key human well-being and ecosystem services variables versus the different scenario logics. This allowed key contrasts between scenarios to be made explicit.

   (c) Model use in the scenarios

   Tourism in the Caribbean was modelled for CARSEA to the year 2050 by OEF using the Tourism Satellite Accounting (TSA) template.

   (d) Scenarios connections with or reinforce other parts of the assessment analysis

   Scenarios have been used to explore uncertainties that are difficult to deal with in the conditions and trends or responses analyses.

   (e) Interaction with the global scenarios

   Use the global scenarios as boundary conditions for the regional scenarios by exploring how the regional or local scenarios would play-out in the context of the global scenarios.

5.2.1 The Neo-plantation Economy

5.2.1.1 Logic

The Neo-plantation Economy is driven by a demand for ecosystem services that are mostly enjoyed by people from outside the region. In this scenario, the Caribbean remains primarily a zone of production and extraction, as it has been for much of the past 500 years. External ownership of key industries is a continuation of historical trends. Relatively few economic benefits are captured locally. Government policies are geared towards trade and foreign aid, and not to alleviating the shortages of the appropriate human and social capital that would be required for the region to become more independent. There is little or no regional integration. In this storyline, apparently positive trends in increasing tourism-related job creation emerge around 2015, but carry the seeds of their own downfall around 2035, with the decline of coastal ecosystems such as coral reefs and mangrove swamps, leading to a local recession and the need for a substantial reorganization and restructuring of the regional economy.

5.2.1.2 Storyline

The Neo-plantation Economy emerges naturally from the trends of the 1990s. Although individual countries attempt to move away from the plantation model in the early 2000s, they are unable to create and maintain the level of internal economic development that would be required for them to break free from external control. Instead, the heavy reliance of many states on international tourism companies and the lack of solid secondary-processing industries result in an increasing reliance on external businesses. As these businesses invest more heavily in the region, they obtain increasingly greater political power and are able to lobby successfully for the creation and maintenance of laws and regulations that support their activities.

By 2015, the dominance of external businesses in regional economics is even more obvious than in 2000. In the agricultural sector, plantation-type crops are grown for sale abroad. The crops that are grown, and their prices, are dictated by global markets. The processing and value-adding for crops such as coffee and fruit is mostly done abroad, and high-value end-products are imported back into the region at great expense. The best cocoa in the world is exported at low prices from Trinidad, while the country continues to import expensive chocolates from Europe. Some agricultural degradation occurs, primarily through erosion following the cultivation of steeper hillsides, and more areas are used for subsistence farming as inequity increases; but the total area under cultivation does not vastly expand.

The tourism industry continues to grow over the period 2000–2015. Hotel chains, which occupy prime land, are largely foreign-owned. They are able to undercut local hotels and bed-and-breakfast businesses, offering cheaper rates and better package deals with support from their parent companies in the U.S.A. and Europe. Many Caribbean countries offer international hotels a range of financial incentives, including tax breaks, lower docking charges for cruise ships, and cheap real-estate deals. Competition between Caribbean nations works in the favour of the external chains. Although these hotels provide many low-paying service jobs, the profits largely remain in their home countries.

During 2000–2015 there is also an increase in industry within the region. Venezuela and Trinidad and Tobago continue to export petroleum, and multinational companies start to mine a range of minerals in different places. Although these operations contribute to national Gross Domestic Product (GDP), they mostly fail to translate into increased local wealth because much of the higher-paid expertise comes from outside the Caribbean and the profits are largely returned to the companies.

By 2015, the Caribbean tourism industry is booming. Large numbers of tourists are attracted to the area by cheap deals and the promise of sun, sand, and sea. More and more international companies enter the region, building extensive coastal resorts and modifying the coastline. This carries an increasingly heavy environmental cost, and by 2030, many negative impacts start to become evident. Coral reefs are damaged by the activities of too many divers; sand-deposition patterns on beaches are altered by the construction of piers and docks; and in some areas, water quality declines as waste management facilities fail to cope adequately with higher demands. Pollution from industries and coastal development adds to the problem. Turtle populations plummet as a consequence of additional lighting near beaches. Increased trade and traffic in the area increases the problem of invasive species, reducing the local diversity of endemic wildlife. Fish and exotic plants are exported for the pet trade, placing pressure on fragile populations.

During this period, most Caribbean governments feel themselves to be too vulnerable to external market forces to be confident about saying no to foreign

investment. Although many foreign companies seek to mine resources and have little concern for sustainability, others either have higher environmental awareness or are responsive to the demands of markets in external regions. Protection of natural resources thus happens primarily through restrictions imposed by outsiders. For example, some of the larger tourist companies purchase extensive stretches of coastline that they protect from development to maintain vistas (and the illusion of walking on an uninhabited island) for their clients. Conflicts arise between tourism companies and those that seek to exploit mineral and forest resources; without a consistent regional policy, these struggles tend to be won by the most lucrative venture, resulting in a patchwork of semi-natural and highly degraded areas throughout the region.

The neo-plantation economy has varying effects on fisheries. Many poor people resort to fishing when they are unable to obtain food by other means. Near-shore fishers, who are mainly artisanal, find fewer and fewer fish. Offshore fishers are largely outsiders. As artisanal fishers venture further out to offshore fisheries to find fish, they come into conflict with offshore fishers. The outsider fishers have better technology and equipment and out-compete the artisanal fishers. Tourism company owners are worried about the depletion of fish because they know that many tourists come to see fish and artisanal fishers, and they push countries to take action. Some countries make near-shore fisheries off-limits, which is good for the fish population but hard on the artisanal fishers. By 2030, there is high conflict both within the Caribbean and between Caribbean nations and external countries over management of fisheries.

Under this scenario, although net GDP increases in most countries, a greater percentage of the population find themselves below the poverty line by 2030. This is indicative of a widening gap between rich and poor. Increases in poverty reduce options for many people. Those without regular jobs do whatever is necessary to get the next meal, including making poor long-term decisions about use of ecosystem services. Illegal industries flourish, such as the export of rare animals to the U.S.A. for sale to pet shops; exclusive resorts also arouse the envy of locals who see the wealth associated with tourism but fail to share in it. Petty crime rates start to increase and many tourists become nervous about spending much time outside their resorts. Hotels become more security-conscious and larger numbers of gated communities arise in some nations.

Increasing crime rates and a general decline in the quality of ecosystem services start to take their toll on the Caribbean tourism industry around 2035. As the world's population ages, so does the typical tourist. The new breed of older tourists is less tolerant of crime and insecurity and more concerned about their potential impacts on the environment, resulting in a decline in the popularity of Caribbean nations as tourist destinations. As tourists avoid the Caribbean, new markets open up in other parts of the world, and the hotel chains and cruise ships are quick to follow. By 2040, the Caribbean tourist industry is entering a recession. Governments are short of income and are forced to increase taxes on residents. Many of the brightest Caribbean people emigrate to nations where there is more opportunity, further exacerbating the situation.

In 2050, the situation in many Caribbean nations is a difficult one. Degraded natural resources have still not fully recovered from the tourist boom, and some fish stocks may be irretrievable. The impacts of climate change are becoming apparent, with the sea level rising and slow changes in water temperature. The beauty of many coastal areas has been marred by the unrestricted development of the 2010–2020 period. Many Caribbean governments lack the capital to undertake appropriate restoration measures, and the maintenance of infrastructure and buildings proves difficult. Tourism has brought higher human immune virus (HIV) rates to the region, and many people infected in earlier decades are now dependent on governmental health care. The agricultural sector continues to under-perform on most islands, with small numbers of crop varieties being exported to outside the region for low returns. Equity remains relatively low. On the positive side, some large areas of unexploited natural resources remain. The agricultural sector has not lost its potential for intensification. A few nations have navigated the tourist boom successfully and are now well placed to contribute to the development of a more integrated regional economy. Locals who have worked extensively with external companies have gained valuable skills that allow them to set up locally owned, small-scale tourism ventures. Although the outlook for the second half of the century is sobering, there is good reason to hope for improvements in the quality of life in the Caribbean region.

5.2.1.3 Potential Risks and Benefits of the Neo-plantation Economy Scenario

Risks	Risks
This scenario is vulnerable to global economic collapse, causing tourism to decline. The predominance of lower-paying jobs creates a population where human resources are under-developed and under-used. Outsiders may lose interest in the region, and the bottom will fall out of the economy. The health of the entire population may be negatively affected with increases in water-borne and air-borne diseases, as well as lifestyle health problems linked to lifestyle, such as obesity, heart attacks, and diabetes. Local crime may cause tourists to go elsewhere. The population is not encouraged to be critical thinkers and entrepreneurs. Pressure on near-shore fisheries increases and the industry collapses, unless Government provides direct protection and enforcement. Increased conflict for the use of near-shore fisheries.	More dependency on world markets for both food production and cash crops. The region becomes increasingly dependent on external inputs for this sector, such as seeds, fertilizers, and technology from foreign sources. Erosion of local genetic diversity. Increased polarization of population, causing disturbances and conflicts.
	Benefits
	High interest from outsiders can keep the area stable. Creation of employment, albeit for low-paying jobs. Outside investors contribute to improvements in infrastructure, for example, telephones and roads. Improved quality standards, e.g., food supermarkets.

5.2.2 Quality over Quantity

5.2.2.1 Logic

This scenario emphasizes the careful, sustainable management of scarce natural and market resources at a scale appropriate to the small island and developing states of the region. Management does, however, remain responsive to world markets and trends. Diversification and increased resilience to unforeseen changes is a primary goal of the overall management process, for both the public and private sectors. This model will be slow to start, because of the need to reform management systems and to create incentives for a development approach favouring selective or niche markets. By 2015, countries of the region have identified priority development and conservation goals. Over the period to 2050, the region specializes in sectors where returns to the local economies and societies are maximized. The longer-term, selective development of tourism in the region is likely to shift away from North American/European market dominance, and the selective marketing approach provides easier transitions to markets in South America (already significant in some seasonal markets for cruise ships and yachting).

5.2.2.2 Storyline

In the early 2000s, Caribbean nations are increasingly aware that much of their continued appeal as a tourist destination for the rest of the world comes from their natural resources and their diverse, friendly cultures. A period follows in which individual governments explore the potential for different kinds of specialized tourism, while challenging traditional industries such as agriculture and fisheries to reform, and to focus on their uniqueness rather than on products that are already common outside the region. Although there is still a lack of regional integration, a few early successes in niche tourism on particular islands set the stage for a wider regional adoption of this approach.

Around 2015, a number of Caribbean states will decide to limit the numbers of tourists granted entry on an annual basis. Local tourism companies are offered more favourable tax conditions and docking fees than international companies. An environment gradually develops in which local tourism businesses flourish, and more of the rents from tourism are captured locally. There are claims of unfair competition by multinational companies and hotel chains, and some move their focus to other areas, creating a short-term decline in tourism over a period of two to three years. In general, however, the Caribbean tourism market remains robust, and starts to appeal more strongly to selective tourists who seek authentic local experiences rather than those who prefer to visit fortress-type establishments for generic seaside holidays. Although there is a gradual expansion of the tourist market, it is monitored carefully by most national governments to ensure that local businesses are dominant, and that the carrying capacity of local ecological and cultural resources is not exceeded.

As higher-paying, more selective tourism takes root in 2020, states within the region start to differentiate their appeal to specific market segments, building on established environmental and cultural strengths. The diversity of languages and cultures within the Caribbean facilitates this niche differentiation, with different states appealing to tourists from different destinations. Market specializations include such obvious choices as yachting and a variety of marine recreation, nature tourism, agri-tourism, and various modes of heritage/cultural tourism, including specialties such as island cuisine and rum tasting. In some areas this creates a vibrant entertainment industry.

Significant improvements in waste disposal and mitigation of the environmental impacts of industry occur around 2025, in response to an increasingly demanding tourist clientele. Convention and conference tourism grows in some areas, stressing fields of special regional competence, such as health services or biotechnology.

The emphasis on sustainability and gradual growth in government policies has significant impacts on the agricultural sector. Although the decline in traditional crops such as sugar-cane and bananas continues, agriculture and other primary industries seek diversification, emphasizing uniquely Caribbean value-added processing of regional products. In some areas these changes lead to environmental degradation through erosion, pollution, and excessive use of fertilizers. The increased specialization of agricultural systems leads to a higher vulnerability to crop pests, and introductions of nonnative species increase as more agricultural products are translocated within the region. Although these trends have negative impacts on biodiversity, most agricultural development occurs on previously cultivated lands and so does not lead to large reductions in forest cover or habitat for endemic terrestrial species.

Value-added services such as sport fishing are favoured over the commercial extraction of fishery resources. The diving and snorkelling industry grows rapidly as divers recognize that the Caribbean now provides a high-quality experience with relatively low environmental impact. The appeal of diving in the region is further increased by over-exploitation and tourist crowding on reefs elsewhere in the world. Small-scale artisanal fishers are encouraged to exploit these trends, working as guides and running small supporting businesses rather than exploiting fisheries for food.

As this scenario implies an openness to outside market forces, some nations end up as clear losers by failing to compete successfully with their neighbours for the high-end tourist market. In general, the selective, diversified approach is less sensitive to shocks than the alternatives of monoculture agriculture or foreign-controlled tourism.

The exploitation of fisheries is already beyond sustainable limits in 2005. Production from fisheries decreases steadily until 2015, and remains low through to about 2030, when fish stocks slowly start to recover. Although industrial fish production declines, the value-added approach gradually weans Caribbean communities away from direct exploitation of fisheries and increases local food security. Some small-scale fishers continue to exploit near-shore fish stocks, preserving fishery-related jobs and the value of the overall product. The emphasis on quality over quantity places higher values on the resource base, leading to the development of more effective measures to conserve and restore essential habitats for the preservation of coastal water quality, including mangroves and fringing reefs. Starting in about 2025, greater care is taken over integrated catchment management to reduce sediment loads to the coast.

Human well-being improves slowly through much of this scenario. Once governments have started to reap some of the benefits of niche-based tourism, crime rates are forced down by strict enforcement of local laws as a means of creating a secure environment for tourists. The greater opportunities for local businesses reduce emigration rates, and more skilled Caribbean nationals return from overseas. The specialization of different sectors reduces competition for resources, and a number of win–win solutions are worked out between interests that previously

competed with one another. These changes take time, however, and the cost of living rises as the emphasis on local production reduces the number of lower-quality imported goods. In some Caribbean nations, a lack of patience with the slow rate of change leads to a backlash and a shift to a more exploitative economy around 2030. Competition between small Caribbean nations also results in conflicts in some areas, particularly as a consequence of attempts to undercut prices offered by competitors. In a few nations, this contributes to a shift back towards mass tourism and bulk production of a small number of crops.

By 2050, the economies of most Caribbean states are considerably more diverse than they were in 2000. Although there have been a number of expensive failures, the general trend has been towards improvements in the local quality of life and greater participation by Caribbean nationals in the higher-paying sectors of the economy. Expertise within the region is still lacking in some sectors, particularly in technology, and most Caribbean nations maintain a strong dependence on external nations for their income.

5.2.2.3 Potential Risks and Benefits of the Quality over Quantity Scenario

Risks	Benefits
Marketing costs may make small-scale tourism uneconomic.	Less vulnerable to natural disasters.
Property values continue to escalate, pricing land beyond local purchasing ability.	Increases local opportunities; decreases emigration pressures.
Continued stresses on natural systems and on watershed processes sensitive to development prevent recovery of key habitats such as reefs.	Shifts "rents recovery" of natural and cultural heritage from overseas to local economy.
Local income disparities may increase.	Improved education and physical infrastructure to support selective tourism.
Globalization pressures may restrict the ability to focus on small-scale resorts and development properties.	More community-level self-sufficiency.
Niche marketing may be more sensitive to crime and violence (although experience in yachting-based tourism does not support this).	Job base (variety of jobs) available in the region expands.
	Expanded protected areas systems increase environmental resilience.
	Improved food security.
	Landscape diversity.

5.2.3 Diversify Together

5.2.3.1 Logic

The Diversify Together scenario is based on the two themes of increasing regional levels of co-operation, and deepening regional economic integration. Faced with global changes in trade patterns and the perceived threat from trade liberalization, Caribbean countries trade more with one another, exploiting the potential for trade in the Wider Caribbean region (including the Central American nations). The initial driving forces for increases in regional collaboration have their roots in existing initiatives to form a Caribbean common market. The benefits of this approach encourage further regional integration, and by 2020 a regional community is in existence. The Caribbean continues to function as an integrated region until at least 2050.

5.2.3.2 Storyline

In this scenario, an increasing recognition of the unique vulnerabilities and diversity of the Caribbean leads to a number of initiatives to enhance regional co-operation. From 2005 onwards, a number of individual countries attempt to diversify their economies, while maintaining an awareness of their context and neighbours within the Caribbean. The regional perspective leads to increasing rationalization and integration of production, and a general increase in trade within the region. Caribbean nations start to trade more with one another in such areas as food products, raw materials, services, petroleum products, and energy. Many nations also continue to trade globally, producing competitive products in a small number of sectors.

The general diversification of Caribbean economies and collaboration between them results in substantial growth in a number of sectors. Agriculture (and related food and beverage production) diversifies as different countries cater to specific needs within the region. Growth in these industries is facilitated by infrastructure developments. Heavy manufacturing industries develop further in countries that have the necessary natural resources and energy supplies. Tourism remains important, diversifying further to appeal to niche markets, but becomes less prominent in the regional portfolio. The service sector expands, with increased productivity in the areas of information technology (IT), health, banking, sports, and entertainment.

From 2010 onwards, markets are largely controlled by regional agreements and policies, although the Caribbean continues to trade internationally. International participation is facilitated by the improved IT sector. Economic diversification is driven by infrastructure improvements, fiscal incentives, and revamped investment codes for member nations, which contribute to reducing the costs of intra-regional trade.

Improved regional co-operation allows for the development of regional management plans that successfully regulate the exploitation of deep-water fisheries. Although fish stocks continue to decline through to about 2025, better management practices introduced in 2010 allow for a gradual recovery of fish stocks in the second half of this scenario. Near-shore fisheries are exploited differentially in different locations, depending on the focus of the local economy. Some countries develop industries based on extraction of near-shore resources, while others preserve these resources in support of eco-tourism. The political and regulatory framework encourages experimentation by small businesses, while regulating the use of ecosystem goods and services. Around 2015, a substantial foreign investment in aquaculture/mariculture in Central America enhances local expertise and leads to an expansion of aquaculture through the mainland states of the Caribbean.

Legislative trends that are already evident in 2005 produce steady improvements in sewage processing. Land-based water quality deteriorates initially as industry diversifies, and people experiment with different crops and cropping methods. As regional wealth increases, people become more sensitive to water-related issues, and compliance with existing water quality protocols is enforced. Coastal water quality follows a similar trend, providing a further incentive for catchment-based management approaches and leading to restoration efforts in inland riparian zones. By 2020, water quality in the Caribbean is improving. Marine water quality is not influenced by regional events in this scenario.

The emphasis on diversity in this scenario produces variable environmental impacts. Extensive coastal development in some areas leads to strip malls, destabilization of coastlines, changes in sand deposition patterns, and changes to local ecosystems. This has impacts on turtle populations and the deposition of sediments on beaches. Poor farming practices in some countries allow substantial nutrient enrichment from agricultural runoff, creating algal blooms in coastal waters. In other areas, coastal habitats are treasured for their amenity value, and their condition is maintained or enhanced. The population of the Caribbean continues to grow, and much potentially arable land is lost to housing developments.

Poverty declines throughout the Diversify Together scenario, slowly at first and then more rapidly as the benefits of economic diversification start to pay dividends. There is greater equity by 2050, and a higher number of well-paying jobs and business opportunities exist. The diversification and expansion of the health sector results in an overall improvement in health care throughout the region.

As society becomes wealthier and enforcement improves, crime levels decrease in most areas. However, the improved regional infrastructure has some negative consequences for the movement of drugs and weapons.

Education levels improve throughout the scenario. By 2050, the benefits of policies initiated in 2020 are starting to become apparent. These positive trends feed on their own successes, leading to faster economic growth and a general increase in regional wealth in the period 2040–2050.

5.2.3.3 Potential Risks and Benefits

Risks	Risks
Regional homogenization as successful approaches spread rapidly though the region. Likelihood of producing winners and losers: some states may be net losers while others are net beneficiaries, creating political problems and conflict. Individual member states may opt out of the regional association. Uncertain international reaction by trading partners outside of the region, especially with respect to mainland nations included in the new regional association. Reduced efficiency as a consequence of multiple small-scale enterprises. Unbridled economic development may create environmental stresses – for this scenario to work out favourably, deliberate policies will have to be developed and enforced to maintain essential ecosystem functions. Speculation and naïve business developments may result in local business crashes, leading to economic instability.	Risk of a gradual loss of autonomy/policy control by Caribbean nations, either to regional institutions, or if the regional economy is slowly subsumed by larger markets.
	Benefits
	Greater political power by acting as a bloc. Lower vulnerability to external disturbances, because economic options are spread across a wider range of markets. Potential for better regulation and management of regional ecological processes, such as those affecting fisheries and water quality. Potential increases in productivity through use of a greater range of resources and multi-tasking/multi-cropping. Likely improvement in regional wealth and equity leading to greater human well-being (provided that environmental quality is maintained).

5.2.4 Growing Asymmetries

5.2.4.1 Logic

In this scenario, the Caribbean region reaps the consequences of increasing global trends towards market liberalization of goods, services, and capital with little recognition of differences and inequities among countries, regions, and social groups. The U.S.A. remains the dominant regional market for the next 20–30 years, and regional economics are dominated by a mixture of labour- and resource-intensive activities, mainly in areas of interest for transnational corporations. The flows of external investment increase, particularly in those countries with availability of natural resources such as energy (mainly oil and gas), biodiversity, and water. This scenario leads to growing disparities in the region, with clear winners and losers by 2050. Winners are mainly those sectors and elite groups associated with the offshore economy, dominated by companies based outside the region. The offshore economy provides the long-term thinking, strategy, and foreign capital. The national economies of the Caribbean states lose out, with raw materials extracted with little value added within the region, and natural resources are substantially degraded.

5.2.4.2 Storyline

At the start of the new millennium, an attempt is made to create an economic bloc that would span the Americas from Alaska to Patagonia, including the Caribbean Antilles. The main initiator of this effort is the U.S.A., seeking to expand into Latin America as it competes with China for global dominance of the world's economy. Under pressure from the U.S.A., a number of bilateral trade agreements are signed in the period 2005–2008.

These add further weight to arguments for economic integration. After several more years of negotiations and bargaining between the different countries in the Americas, a Free Trade Area of the Americas (FTAA) is formed in 2010. The final agreement allows for the free movement of goods, capital, and services across the region, while excluding the free movement of labour between countries. No special treatment is included for small economies.

The formation of the FTAA leads to increasing amounts of direct foreign investment in the Caribbean region from 2010 onwards. Initially, these investments seem largely beneficial: there is growth in many areas of the manufacturing sector, especially in low-education, labour-intensive industries. The economies of many nations in the Caribbean start to grow, and the number of extremely poor people in the region decreases as more jobs become available. Tourism continues to be an important income generator for the region, but its relative importance decreases—the market is dominated largely by all-inclusive package deals offered by multinational companies, returning little to local businesses.

As foreign investment in the region continues, competition between Caribbean nations increases. Many companies are not fully integrated into national economies, making it relatively simple for them to transfer elements of their businesses between countries in response to changes in the labour market. This results in pressure on Caribbean nations to keep labour costs low, and to offer a range of incentives to international companies, making it more difficult for local businesses to survive and jeopardizing the investment structure in weaker economies.

Forests, petroleum products, and some mineral resources remain attractive to investors from outside the region. Existing oil reserves are exploited intensively, and new reserves are discovered as demand for cheap energy from within the economic bloc grows, due to greater instability in the Middle East and other oil-producing regions. A number of mineral-extracting ventures open in different parts of the Caribbean, with differing environmental effects. For the biotechnology and pharmaceutical industries, access to biological resources becomes a priority. The high species diversity of mainland Caribbean countries attracts investors who purchase large tracts of forest, maintaining it in 'pristine' condition for bioprospecting. As pharmaceutical companies lobby for stronger protection of their investments, environmental protection laws are enforced more strongly in several countries and the further expansion of small-scale agriculture is prevented.

The perceived dominance of local environments by multinational companies gradually engenders feelings of resentment and xenophobia among the local population living in and around the protected areas, leading to rising social tension in these areas. Around 2020, a number of conflicts develop between local populations and foreign landowners, including deliberate acts of arson and vandalism. A third dimension is added to the conflict as forestry companies seek to open formerly protected regions for selective logging. Similar tensions arise over the use of marine resources: pharmaceutical and biotechnology companies seek the rigid enforcement of marine protected areas, competing with tourism companies and local fishers for rights to what were formerly common property resources. These conflicts are resolved in different ways in different areas, leading in some cases to equitable solutions and extractive reserves, and in other cases to the development of higher fences.

By 2025, differences in the capabilities of Caribbean countries to respond to the challenges of the FTAA start to become obvious. On a regional level, the continuous competition for foreign investment erodes efforts to co-operate within the Caribbean. Some countries with higher education levels and human capital are able to capture a number of high technology investments for assembling products such as computers and televisions. Nevertheless, most research and development is still done outside the region, and the associated intellectual property rights are not held within the Caribbean. The development of human capital in the region continues to be low and is of low priority for policy-makers. Large differences start to emerge between Caribbean nations. Richer countries slowly develop the capacity to compete on the global market, building on their own successes. By contrast, poorer countries continue to become poorer. There are large differences in the impacts on biodiversity between these countries, with poorer countries in 2030 having more areas of intact forest, but a far lower ability to manage and protect their resources from increasing external pressures.

Although the creation of many low-paying jobs in the manufacturing sector and in the mass tourism industry has provided new income opportunities for different parts of the population, the number of new jobs does not keep pace with the growth of the economically active population. In addition, rural-to-urban migration increases substantially as the market for local food crops declines. Agricultural imports from countries outside the Caribbean are cheap and plentiful, largely eliminating smaller farm businesses (with the exception of the dairy industry, which continues to grow to meet the demand for fresh milk). The decrease in food production within the Caribbean creates greater dependence on outside resources.

By 2050, the Caribbean region is a diverse patchwork of nations with very different conditions. Many of the natural resources of the region have been degraded, and many endemic species have gone extinct. In some exceptional countries, forest cover has increased and ecosystem services have been enhanced. Although the Caribbean remains a popular tourist destination, tourism continues to have high impacts on local ecosystems, and returns little by way of direct benefits. Crime rates in some areas are high, and there are substantial markets for drugs and prostitution. The potential for regional co-operation is low, with rich countries unwilling to deal with poor countries, and there are strong restrictions on the movements of people between rich and poor nations.

5.2.4.3 Potential Risks and Benefits

Risks	Risks
Increased economic fragmentation due to lack of integration of new industry in the local economy.	Local to regional impacts (degradation in one part of the area affecting a broader area).
Tendency to lower environmental standards where they conflict with investment opportunities.	**Benefits**
Increased polarization of societies.	Increased trade opportunities and development of non-traditional niche markets.
Decreased food security for smaller countries and dependence on food imports.	Increased protection of a number of ecological resources that prove to be of economic value.
Less regional co-operation in the Caribbean or with Central America.	Creation of new jobs in some areas.

5.3 Links to MA Global Scenarios

Although each of the Caribbean scenarios is plausible under each of the global scenarios outlined in the MA,[31] the changing global context will have a large influence on the ability of the Caribbean to pursue particular kinds of policies. The Caribbean region is considered particularly vulnerable to external influences because of its current and historically high reliance on international markets and expertise, and the effects of economies of scale on small nations.

Both the Neo-plantation Economy and the Growing Asymmetries scenarios seem most likely to proceed under conditions in which globalization processes continue; these scenarios would fall naturally within the MA global-scale Global Orchestration and Order from Strength scenarios. In both instances, the increasing dominance of the larger global economies would facilitate the exploitation of Caribbean markets and resources by businesses from outside the region. In Order from Strength, there is the possibility that tourism may suffer in some Caribbean regions, if the international community becomes nervous of travelling to 'foreign' countries. The regional response would probably be mixed: U.S. territories (Puerto Rico and the U.S. Virgin Islands) might see increased tourism, while areas outside U.S. control might suffer. An important question for the Caribbean region in both of these scenarios would be whether it joined the ranks of the wealthier or the poorer regions of the world, and consequently whether the barriers to integration that are currently faced by Caribbean economies were raised or lowered.

The Quality over Quantity and the Diversify Together scenario are not impossible under the Global Orchestration and Order From Strength scenarios. However, they seem more suited by conditions in the global Techno-Garden and Adaptive Mosaic scenarios. The Adaptive Mosaic, with its high emphasis on local learning and diverse, experimental approaches to managing economies and

[31]For a summary of the MA global scenarios, see the General Synthesis report at http://www.millenniumassessment.org/en/Synthesis.html

ecosystems, would create a favourable political and economic context for the Diversify Together scenario. Similarly, an increasing global emphasis on technological solutions (as in Techno-garden) would make it easier for Quality over Quantity to occur, with Caribbean nations using advanced technologies to monitor ecosystems and modify their targeted management and policy responses accordingly.

There are many ways in which changes in global social, economic, and ecological systems might impact the regional systems of the Caribbean. Four key areas have been identified in which global changes might have a large effect on the Caribbean region. These are (1) economic development; (2) global security; (3) climate variability and change; and (4) technological advances.

The global economy is likely to remain an important driver for Caribbean nations, which depend directly on overseas markets for commerce, and indirectly on national economies outside the region as providers of tourist income. Some of the biggest questions for the future of the region involve the connectivity of the global market, and the location of economic power. For example, will the U.S.A. continue to dominate the global economy, or will dominance shift to Asia or Europe? Will African and Asian coastal areas start to compete more effectively with Caribbean nations for the global tourist market? Will the Organisation for Economic Co-operation and Development (OECD) regulate the banking industry, focusing on the Caribbean? And how will World Trade Organization (WTO) negotiations proceed?

Global security will have a high impact on the Caribbean through its effects on tourism. The region currently relies heavily on a continuous flux of people. Although it has so far been robust to changes in global security, the long-term success of tourism in the Caribbean may ultimately rely on a successful resolution of the problem of international terrorism. There is also the possibility, however, that higher levels of insecurity might make the Caribbean region more appealing.

Climate change will inevitably have a high impact on the Caribbean. Changes in the intensity and frequency of hurricanes will impact the quality of life for both residents and tourists. Sea-level rise may flood low-lying areas, including ports, beaches, and swamps. Changes in wind and precipitation events are likely to influence erosion and the sedimentation of coastal areas, including the rate and magnitude of nutrient loading into near-shore zones. Changing sea temperatures will influence primary production and may have surprising effects on populations of fish, corals, and other organisms. In all of these instances, some of the key uncertainties concern the rate and magnitude of climate change, and the ability of ecosystems and human societies to adapt to, or mitigate, climate change impacts.

Lastly, technological development has the potential to change the regional status quo in novel and possibly unexpected ways. Better fishing technologies and fish-tracking devices may allow greater exploitation and more selective exploitation of fish stocks. Improvements in monitoring and enforcement technology make it easier to manage fish stocks sustainably. The safety and speed of travel technologies has the potential to influence the movements of people and goods at a variety of scales. Energy supplies will remain important in the region, and global shifts in the use of petroleum-based products and wind power could have substantial impacts on local livelihoods. Better bioprospecting technologies could lead to increased pharmaceutical involvement and development in the region, and mineral prospecting technologies will influence the discovery and use of oil supplies. Improvements in information technology will open up a range of possibilities for new industries based on such things as telecommuting, internet gambling, website design, and data entry.

6.0 RESPONSES FOR INTEGRATED MANAGEMENT OF THE CARIBBEAN SEA AND ITS RESOURCES

6.1 Introduction

As noted earlier in this report, decisions affecting the Caribbean Sea ecosystem are made by a complex set of institutions with overlapping responsibilities, ranging from national and colonial authorities to international treaty bodies, nongovernmental organizations (NGOs), and the private sector. It is not within the scope of the CARSEA project to assess the effectiveness of current programmes (Annex 3a) and institutional arrangements at each of these scales to address the driving forces of ecosystem change, nor to provide a comprehensive blueprint for better management in the future addressing all relevant players. This is partly because there is little routine monitoring and evaluation of policies and programmes linked to ecosystem management and, therefore, no existing body of research on which such an analysis might be based.

It is possible, however, to take an overview of current arrangements for managing the ecosystem as a whole, and to explore options for improved decision-making at the Caribbean-wide level and within existing subregional

institutions. This final chapter of the report assesses the overall effectiveness and shortcomings of current responses to the driving forces of ecosystem change, and proposes a new approach based on the need for a more holistic view of the processes affecting the ecosystem and its services to the Caribbean population. Specific response options for management of the priority services of fisheries and tourism amenity are also addressed.

6.2 Governance Framework

The 39 Caribbean Sea countries and territories[32] have for a long period of time made sporadic efforts, individually and in the context of various inter-governmental groupings, to anticipate or respond to issues relating to their marine and coastal resources. Much of this has been at the national level, although increasingly over the last two decades there have been attempts to organize on subregional and Wider Caribbean levels. Much of this effort has been stimulated by international agreements signed by Caribbean states and metropolitan countries.

For many decades, these countries and territories have been operating within various inter-governmental groupings, which exercise authority to make policies and develop legal instruments relating to Caribbean Sea issues. Among these are the UN system and its commissions and programmes, CARICOM, OECS, the Organization of American States (OAS), and, since 1996, the Association of Caribbean States (ACS). Not all Caribbean states and territories belong to these groupings, and there is considerable overlap of membership within them. Within this overarching governance framework, many policy-making bodies operate regionally and subregionally—for example, Heads of State and Government, Governing Councils, sectoral Ministerial bodies, Ministers for the Environment for Latin America and the Caribbean, and treaty bodies—each of which establishes policy directions and issues directives to an array of executive organizations which service the inter-governmental bodies.

Decisions taken within any one of the institutions have the ability to affect the Caribbean Sea ecosystem, whether directly or indirectly. Altogether this governance framework makes for much complexity. Its diversity could be advantageous, insofar as it offers a variety of opportunities for exercise of authority relating to shared interests and issues. At the same time, it presents numerous challenges—of coherence in vision and policies, harmony among legal instruments, duplication in decision and efforts, co-ordination of programme interventions, linkages with policy-making bodies, gaps in responses to the driving forces, and oversight of the entirety of efforts addressing the Caribbean Sea and its resources. These challenges are exacerbated in a region that already reflects a diversity in language, institutions, and culture, and in which individual countries, territories, and subregions have historically been more integrated with states and societies located outside of the Wider Caribbean region than with one another.

Alongside these inter-governmental bodies there is a range of NGOs representing the corporate (e.g., CTO)[33] and civic [e.g., Caribbean Conservation Association (CCA)][34] sectors of Caribbean societies. These develop policies and execute programmes on behalf of their own constituencies and interests, while contributing in ad hoc ways to the decisions of inter-governmental bodies through lobbying or consultation. Even in cases where they have observer status, nongovernmental bodies are not meaningfully integrated into the decision-making process which creates the framework in which they operate.

In spite of this fragmented governance structure, it is a conclusion of this assessment that the highest priority for examining new responses to the management of the Caribbean Sea ecosystem should be at an inter-governmental level representative of the Wider Caribbean. This is not to imply that the activities of the private sector or civic society are not relevant or important: it is a recognition of the central challenges which the region faces in *collectively* managing the Caribbean Sea and, therefore, of the location of the principal responsibility for responding.

Accordingly, this assessment also concludes that integrated management of the Caribbean Sea as an ecosystem requires the region to overcome this fracturing of resources and efforts, and to achieve more harmony in approach and collaboration across the Wider Caribbean. One option for achieving these is explored later in this chapter.

[32]For a list of these territories see Box 1.1.

[33]The CTO is an international development agency and the official body for promoting and developing tourism throughout the Caribbean.

[34]The CCA has individuals, NGOs, and states as members, drawn from the French, Dutch, Spanish, and English-speaking Caribbean. It undertakes activities in public awareness and education, and natural resources management. It executes or participates in several programme activities related to the Caribbean Sea and its resources. It does not make policy for its government members, hence it is classified as a civic organization.

6.3 The Role of the United Nations and its Resolutions Relating to the Caribbean Sea

The highest governance body to which all Wider Caribbean states (as well as other states with strategic or economic interests in the Caribbean Sea) adhere—the United Nations—has in recent years addressed attention directly to the Caribbean Sea and the need to manage this ecosystem more effectively. In 2006, the UN General Assembly passed the latest in a series of resolutions recognizing the unique importance of the Sea to the peoples of the region and its vulnerability to human and man-made disasters, and encouraging a more integrated management approach to address, amongst other things, pollution from land and marine sources, damage to coral reefs, and the impacts of competing socioeconomic activities associated with the Sea, its coasts, and resources.[35]

This resolution, which expands on antecedent resolutions advanced under the aegis of the ACS since 1999, might be regarded as the apex of the policy framework under which all governments should make decisions affecting the Sea and its resources. It offers a high-level and up-to-date common basis upon which the Wider Caribbean states might take concerted action among themselves, and upon which they might enlist global co-operation, in an effort to meet the objectives of better long-term management of the ecosystem. Yet, until very recently, there was no evidence that these states had collectively, or on a subregional basis, organized to advance the commitments of the resolutions since they were passed.[36] This may be because the resolutions are not of a binding nature and do not create an implementing mechanism to give effect to their provisions. However, they do provide a frame of reference to move towards integrated management of the Caribbean Sea, and could be a new impetus for the quality and scope of collaboration required in that effort.

Member States of the ACS in what came to be known as their Caribbean Sea Initiative had advocated in the UN General Assembly resolutions that would declare the Caribbean Sea a 'special zone in the context of sustainable development,' with the aim of giving some legal force to the measures advocated. This was not achieved as the proposition hinges on the case that might be made, through scientific analysis and indicators, of what constitutes a 'special zone,' and how the Caribbean Sea reflects those considerations. To date, the necessary information and analysis have not been adequately assembled and this, together with the lack of concrete action in relation to the series of earlier resolutions might have disadvantaged the proposal.

To some extent, the findings of this assessment relating to condition and trends of the Caribbean Sea ecosystem will contribute data and analysis relevant to the concept of a 'special zone.' However, since CARSEA has been limited to the use of existing data, its findings are not exhaustive in terms of the case that might be made. Nor has CARSEA undertaken the comparative assessment with other regions that would be necessary to distinguish the Caribbean Sea as a 'special zone.' To support further political efforts to continue to advance the proposition, the states of the Wider Caribbean need to promote and support the further scientific assessment and analysis required to underpin the concept of a 'special zone' in the context of sustainable development.'

It is not part of the remit of this assessment to judge whether a further UN resolution is justified or necessary. It is important to emphasize, however, that the efforts to achieve this new status for the Caribbean should be seen as a means to an end—the better management of the ecosystem—and not as an end in itself.

6.4 Legal Framework

There is an impressive array of global and regional legal instruments and agreements that are directly relevant to the Caribbean Sea, covering issues as diverse as the dumping of garbage, shipment of toxic wastes, the conservation of biodiversity, and compliance with fisheries regulations.[37] Despite this, the Sea is a stressed environment, as revealed in the findings of this assessment. It is evident, however, that application of these instruments, nationally and subregionally, and implementation of their provisions, is rudimentary. They are often not reflected in national legislation. Some countries have not even taken the first step of ratification or accession. Nor have the Wider Caribbean states grasped the possibilities under the various instruments for forging the kind of subregional and regional co-operation required for better management of the Caribbean Sea and its resources. Lack of political will, lack of resources, and lack of awareness have been suggested as explanations for this implementation deficit.

[35]UN General Assembly Resolution A/RES/61/197, entitled *Towards the sustainable development of the Caribbean Sea for present and future generations*. The full text can be found at http://daccessdds.un.org/doc/UNDOC/GEN/N06/506/19/PDF/N0650619.pdf?OpenElement

[36]During preparation of this report, the Ministerial Council of the ACS established a Follow Up Commission for the Caribbean Sea Initiative, the concept of which is discussed in more detail in Section 6.6.1.

[37]For a summary of the principal instruments affecting the Sea, and the record of Caribbean states in implementing them, see Annex 3b.

Whatever the cause, the potential of these instruments to make a significant difference to the matters which they address is not being realized.

Some existing legal instruments were set up before the recent progress in promoting the concept of sustainable development, which calls for holistic and integrated approaches to the management of resources. Such an approach is imperative in an ecosystem which has so many interconnections. One option is to expand the scope of these instruments to make explicit sustainable development principles and objectives (for example, in the Cartagena Convention). Another option is to consider a new, overarching, legal instrument for the Caribbean Sea, to be developed by, and for, Wider Caribbean states, encompassing and reflecting as appropriate the range of issue-specific treaty law that exists. But the expected cost in terms of finances, time, human capacity, and deferment of action which may be urgently required, would argue against these two options. Moreover, the poor performance to date in application of existing treaty provisions does not encourage the expectation that a new or amended agreement for the region would make much difference. Political commitment by Wider Caribbean states to implement the legal frameworks that already exist is a necessary condition for achieving better and integrated management of the Caribbean Sea.

6.5 Responses

6.5.1 Responses Specific to Tourism

As this assessment has demonstrated, the tourism industry connects the Caribbean Sea to the livelihoods and well-being of the peoples of the region, in both positive and negative ways. The income derived from tourism is an indirect product of the ecosystem functions which make the region an attractive place to visit. At the same time, the very large numbers of visitors and massive tourism infrastructure place strains on the ecosystem which could potentially threaten its long-term capacity to sustain the livelihoods of Caribbean peoples. As the scenarios suggest, the current structure of the industry, with its ownership overwhelmingly outside the region, leaves open the possibility that unrestrained growth will eventually degrade the environment to the extent that visitors will choose alternative destinations. Policy responses must therefore address key questions to ensure that the region derives sustainable benefits from the tourism sector, including:

- How to enhance the value added to local economies from tourism-related activities, such as through indirect employment, investment, and foreign-exchange earnings (for example, by ensuring that regionally produced manufactured goods and food, rather than imports, are used by tourists). While there are no detailed studies of this, empirical observations suggest that there is a high level of "import leakage" from tourism income.
- How to maximize the capture of economic rents[38] from both land- and marine-based tourism. There is virtually no recognition by governments in the region that the tourism sector generates such rents. The principle is straightforward: there should be no "free ride" on the vulnerable ecosystem services of the Caribbean.
- How to optimize the investment of economic rents from the tourism sector, to support policies and management tools to ensure that economic activity remains within the long-term carrying capacity of the region's ecology and culture. It is one thing to capture rents, and another to ensure that they are efficiently expended.
- How to ensure that trade agreements on services through WTO do not jeopardize attempts to channel tourism rents into ecological, social, and economic benefits for the region. The frontier of services is the new arena for global trade negotiations, and the Caribbean faces the danger of not having a sufficiently clear grasp of all the relevant concerns.

Economic policy instruments can be used to address most of these challenges. Incentives and disincentives can help meet objectives to keep tourism within the region's carrying capacity, and to maximize the domestic value derived from the industry. The use of assurance bonds[39] can address areas of likely long-term environmental impact from tourism investment. The capture of rents depends on fiscal policy decisions, including the use of instruments such as user fees.

To keep open the maximum number of options for adopting these responses, those involved in trade negotiations on services need to be aware of the implications of the provisions under discussion—including on investment policy—for efforts to create a more sustainable Caribbean tourism industry.

As noted in Chapter 4, tourism is highly vulnerable

[38]Economic rents are profits in excess of the competitive level.

[39]An assurance bond is a sum of money deposited by a developer to cover the ecological or other damage which the proposed activity could potentially cause. If such damage does not occur over time, the bond is returned with interest, thereby creating an incentive for environmentally responsible behaviour.

to climate change, both through sea-level rise and the increased destructive force of hurricanes anticipated by climate models, and this presents a major challenge for policy-makers. The Caribbean Community has set up a Climate Change Centre to respond to the need for adaptation in ways which anticipate such impacts. It is important to explore and put in place the economic and precautionary measures that would relate specifically to the climate-related vulnerabilities of the highly sensitive tourism industry.

6.5.2 Responses Specific to Fisheries

Many Caribbean fisheries, like others across the globe, are organized and conducted in ways which will inevitably lead to overfishing. As discussed earlier in this report, the symptoms of overfishing and marine habitat degradation are evident throughout the region. The populations of many species have declined and are, therefore, not making an optimum contribution to the well-being and economic development of the Wider Caribbean. There are other fish stocks and marine species in the region about which there is little information, and it is therefore impossible to judge their potential contribution to the economy. Finally, there are some stocks about which there is enough information to know that they are undeveloped or underdeveloped as a sustainable resource and, consequently, are not making any significant social or economic contribution (Haughton 2001).

It is vitally important that the countries of the Caribbean find ways of developing and using the region's fishery resources in a sustainable manner. Fisheries development must be based on sound ecological principles and preserve the integrity of the environment, while contributing to economic advancement and human development. The traditional management approaches are not in themselves going to transform Caribbean fisheries into sustainable, dynamic systems capable of meeting future demands for food and employment.

A combination of traditional and new, innovative approaches is needed to overcome existing constraints and to improve the contribution of fisheries to the development of the region. This is the subject of a new project which looks at fisheries management systems for the Caribbean Sea.[40]

As noted in Chapter 4 of this report, one of the most marked features of Caribbean fisheries is the high uncertainty about the status of even the most important fish stocks of the region. According to a recent report from the UN FAO, unless urgent steps are taken to collect sufficient data to ensure that resources are used responsibly, there is a high risk that landings will continue to decline (WECAFC 2003). In the absence of such information, fisheries exploitation needs to proceed very cautiously and should be accompanied by concrete efforts to improve the collection of adequate data on stocks. As so many of the resources are shared between two or more countries, close co-operation will be necessary at a variety of international, regional, and subregional levels to ensure the sustainable development and conservation of the region's fisheries.

A major shortcoming of most approaches and programmes for fisheries management is that they tend to follow a "state-centred" paradigm, which does not necessarily follow the way that nature or society operates (Nichols 1999), and which is not conducive to integrated management which draws in all users, uses, resources, and efforts. Many living marine resources are trans-boundary in nature, and require governance structures that are capable of operating at different geographic scales depending on the specific type of fishery (see Table 6.1).

Only the oceanic pelagic stocks are currently served by a working international governance mechanism: the International Commission for Conservation of Atlantic Tunas (ICCAT). Caribbean participation in ICCAT is weak, particularly by the small developing states (Mahon and McConney 2004). Governance mechanisms for protection of unexploitable trans-boundary living marine resources, such as corals and seabirds, are minimal to non-existent. Various agreements, such as the Convention on Biological Diversity (CBD), the Cartagena Convention, and the Specially Protected Areas and Wildlife (SPAW) Protocol[41] provide a basis for collaboration, but such agreements need to be more effectively used.

As demonstrated in Chapter 2 of this report, fisheries are directly linked to the many components of the Caribbean Sea ecosystem, including coastal habitats such as seagrass beds, coral reefs, and mangroves. The adverse impacts on these habitats from human activities,

[40]The Global Environment Facility (GEF) funded, Caribbean LME project.

[41]The SPAW Protocol has been internationally recognized as the most comprehensive treaty of its kind. Adopted in Kingston, Jamaica by the member governments of the Caribbean Environment Programme on 18 January 1990, the Protocol preceded other international environmental agreements in using an ecosystem approach to conservation. The SPAW acts as a vehicle to assist with regional implementation of the broader and more demanding global Convention on Biological Diversity (CBD).

TABLE 6.1 — Examples of the different governance scales required for fisheries

Resource	Governance scale
Shrimp and groundfish on the Guianas – Brazil Shelf	Six countries and territories (Brazil, French Guiana, Suriname, Guyana, Trinidad and Tobago, and Venezuela)—note that this extends beyond the boundaries of the CARSEA region
Eastern Caribbean flying fish	Seven countries and territories (Trinidad and Tobago, Grenada, St. Vincent and the Grenadines, Barbados, St. Lucia, Martinique, and Dominica)
Lobster and conch	25-plus countries and territories
Coastal large pelagics	All Wider Caribbean countries and territories
Oceanic large pelagics	All Wider Caribbean countries and territories, plus other Atlantic countries and distant-water fishing nations

including from fishing itself, are therefore a major concern for the long-term future of the industry. The ecosystem approach to fisheries management, which recognizes that marine resources are dependent on the ecological systems in which they occur, is increasingly being seen as the most effective strategy for management and conservation of stocks.

The key challenges in better management of fisheries include:

- Estimation of the extent of overfishing—whether of particular species or fishing grounds—and the development of measures to redress the problem. The latter can benefit from the use of economic policy instruments.
- Management of land-based sources of marine pollution which impact negatively on fishing grounds and hatcheries—particularly coral reefs—and development of economic instruments to assist in better management of the activities responsible, to reduce their impacts significantly and urgently. Such an approach would also benefit tourism through conservation of prized coastal habitats.
- Provision of alternative livelihoods for fishers displaced by more modern fishing techniques and/or international fisheries exploitation. Economic instruments that could be used here include fees for the right to fish; incentives for non-exploitative activities such as sports fishing and tour guiding; public expenditure on retraining of fishers; and incentives for investment in alternative economic activity in fishing communities, such as small-scale tourism. Here again, the objectives and needs of fisheries and tourism services are aligned.
- Economic measures to achieve compliance with regulations: for example, the imposition by the U.S.A. of Turtle Excluding Devices on shrimp trawlers as a way of avoiding incidental capture of other species (turtles, dolphins). The penalty for failure to comply was a ban on entry of all shrimp from the offending country into the U.S. market. This economic sanction has operated to achieve a high level of compliance with that regulation. Caribbean states could take an example from this.

An adequate governance framework for fisheries in the Wider Caribbean requires that there be management mechanisms for all relevant resources. This could be achieved through a networked system based on existing organizations, such as the Caribbean Regional Fisheries Mechanism (CRFM), or as a single Regional Fisheries Management Organisation, as has been suggested on occasion for the FAO Western Central Atlantic Fisheries Commission (WECAFC). The international legal basis for the formation of such an organization is well established in the Law of the Sea Convention, and in the UN Fish Stocks Agreement. Increasing attention is being given to the establishment of similar bodies in several other regions of the world (Sydnes 2002).

Given the wide diversity in size and economic development among Caribbean countries, the capacity to participate in collective mechanisms to manage fisheries will vary considerably. For any new system to work well, there is therefore a need for co-operation at the subregional level, and this could be done through bodies such as the CRFM or the Environment and Sustainable Development Unit of the Organization of Eastern Caribbean States (OECS ESDU). It is also important to strengthen national fisheries departments and to improve the capacity of communities to participate in management both at the

coastal and offshore level, given the prevalence of small-scale fisheries in the Caribbean (Berkes et al. 2001; Mahon and McConney 2004).

A number of initiatives have emerged in recent years to improve trans-boundary fisheries management in the Caribbean, but these have been based on various efforts by existing institutions to focus on specific stocks, rather than any proposal to create a new all-encompassing body for the entire ecosystem. This reflects the fact that the Caribbean does not have any major fish stocks attracting large commercial fleets, revenues from which can be expected to support a fisheries management institution. In other parts of the world, large valuable tuna or clupeid[42] stocks have provided the incentive to establish management regimes to protect indigenous rights and to extract rents from non-indigenous fleets. The emerging approach in the Caribbean is more suited to the large diversity of resources that are already mostly exploited by indigenous fleets, so that the issues relate primarily to conservation, optimization of stocks, and equity within the region.

Among these fledgling initiatives are:

- Regional management of conch stocks through the Caribbean Fisheries Management Council. Some countries have difficulty taking part in this process to the extent required for successful management.
- Ad hoc working groups of the FAO WECAFC becoming the lead agencies for shrimp, groundfish, and flying fish.
- The newly established CRFM within CARICOM identifying large pelagics as a priority topic, and the possibility that this body could take the lead for these resources (FAO 2003b).

While some limited progress has been made, important gaps remain, and these emerging arrangements need strengthening and better co-ordination. Among the priorities to achieve effective and truly collaborative management are better information gathering and sharing, analysis and interpretation, provision of advice, management decision-making, and implementation. The approach that is considered most likely to be successful in the Caribbean for shared living marine resource management is that of "strengthening by doing."

The guiding principle should be that management should not use the lack of complete information as an excuse for not taking action. There is, in most cases, adequate knowledge available for preliminary planning that identifies the strategic approach to be adopted, while better data collection and analysis are assembled. By taking this approach, information, advisory, decision-making, and implementation capacity can be strengthened in parallel.

The option proposed later in this chapter, through which the overall governance of the Caribbean Sea ecosystem might be made more complete and coherent, will encompass this approach for fisheries management.

6.6 Further Responses

A wide variety of programmes exist at the inter-governmental, regional, subregional, national, and nongovernmental levels aimed at improving the condition of particular components of the Caribbean Sea ecosystem. Some of the key examples are set out in Annex 3b. When these are added to the various governance arrangements outlined earlier in this chapter, it is clear that there is a great deal of activity relating to the management of the resources and ecosystem services of the Sea. However, these are largely parallel and disconnected efforts with little synergy among them, and in totality they have an insignificant effect on the driving forces leading to ecosystem change. This final section therefore identifies further responses which might make existing efforts for managing the resources more synchronized, informed, efficient, and effective.

In framing these responses, the various scenarios outlined in Chapter 5 have been taken into account. The scenarios demonstrate the need for policy-making to be adaptable and responsive, using continuous monitoring and analysis to achieve desirable outcomes, and to avoid those which threaten the long-term well-being of the Caribbean peoples. The responses also encompass the generic requirements for fisheries and tourism management that emerged in the discussion above. The ultimate proposal for a Caribbean Sea Technical Commission seeks to respond to these needs in a composite way. Among these needs the assessment gives highest priority to the following:

1. The need to improve, enhance, and fill gaps in existing programmes

The programmes relating to the Caribbean Sea and its resources are specific to particular sectors and issues and are not comprehensive in their coverage in either spatial or programmatic terms. As noted at the start of this chapter, there is no existing body of analysis about their respective or collective effectiveness. In the context of the 2002 UN

[42]Clupeids are the family of fish species including herrings, shads, sardines, and menhadens.

resolution on integrated management of the Sea, it behoves the bodies to which these programmes are accountable to undertake evaluation of their operation, effectiveness, and adequacy to identify ways in which they may better achieve their stated objectives.

2. The need to achieve more synergy among programmes

This is a major requirement, given that the programmes currently work in isolation. They need to become more collaborative: to communicate activities and findings, to receive feedback from one another, to address research findings to the policy process, to make the whole greater than the sum of its parts.

3. The need to monitor, evaluate, and integrate programme results into the policy-making process

Responsive policies and adaptive management have to be based on continuous monitoring and evaluation of changes in the driving forces, and the condition and trends.

6.6.1 Proposal for a Caribbean Sea Technical Commission

To respond to the above needs for integrated management of the Caribbean Sea and its resources, this assessment proposes that a technical group be assembled and dedicated to these functions.

Purpose

The central purpose of such a Commission would be to achieve coherence within the policy-making bodies of the Wider Caribbean by addressing the three generic needs identified above. It would be technical in nature and advisory in function, and would relate to the needs of the range of governance bodies (global, regional, and subregional) for policy analysis and policy recommendations relating to the Caribbean Sea that emerge from its monitoring, assessment, synthesizing activities. It would keep track of findings and results but not be accountable for performance of the various programmes in place. It would be responsible for having the big picture of what is happening to the ecosystem, and for guiding users of Caribbean Sea resources and the policy-makers of the region in the discharge of their responsibilities. As such this group would operate with links to programme activity centres, to corporate and civic organizations, and to governments and inter-governmental groupings.

Functions

Specific functions of the Commission might be to:

- Monitor and assess the condition of the Caribbean Sea as an ecosystem, drawing upon the results of the various sector-specific programmes.
- Assess the policy and legal frameworks affecting the ecosystem, and advise how they might be made more comprehensive, integrated, and adequate to improve the condition of the Sea and its resources.
- Provide analysis that would lead to more coherence in policies and programmes.
- Initiate studies that would help develop policy in areas where there is no established programme or organization with that specific responsibility, for example, with respect to economic instruments suggested earlier in this chapter.
- Advise financial institutions with interests in the Caribbean Sea, for example, the World Bank, Inter-American Development Bank (IDB), Caribbean Development Bank, GEF, OAS about their programme interventions. It could also advise on financial needs and allocations.
- Help set up processes for resolving conflicts arising from the use of resources in the Caribbean Sea.
- Advise on the needs of individual programmes to improve their capacity and resources, and to guide the programmes themselves on what opportunities and resources are available.
- Promote, through the above functions, co-ordination within and outside the Wider Caribbean to achieve the stated policy objectives.
- Feedback the outcomes and analysis of the various programmes and processes affecting the Sea, to enable the continuous improvement of policy and steer it towards desirable, and away from undesirable, long-term scenarios.

Composition

The Commission would reflect the range of scientific and technical expertise appropriate to the monitoring and policy analysis functions outlined above, and would reflect inter-governmental, corporate, and civic interests. It would be representative of the Wider Caribbean.

Organization

To be effective, the Commission would need to be free-standing and independent, to initiate the substantive activities to guide and service the policy-making agenda. It could be administratively placed within an existing inter-governmental entity which encompasses the Wider

Caribbean (such as the ACS or the UN). The model of a Secretariat to a UN treaty body could be used or modified as appropriate.[43]

Benefits and Costs

If operated effectively, the benefit of such a Commission would in due course be a coherent and more effective approach to the management of the Caribbean Sea, and ultimately a more robust ecosystem with the capacity to sustain long-term development of the region and its peoples. It could lead to more efficient and effective use of the financial resources invested in that management. Its costs would be small in relation to the benefits of sustaining economies and livelihoods across the region. It could be partially staffed through secondments from existing organizations. Part of its costs could be met from the strategic advice it would make available to financial institutions and part from economic rents or user fees charged for the use of Caribbean Sea resources (see Section 6.5.1).

During the preparation of this report, the Ministerial Council of the ACS agreed to set up a multi-disciplinary Follow Up Commission for the Caribbean Sea Initiative, in part to advance the case for a new UN resolution as described earlier in this chapter.[44] It is too early to judge whether this new body might be adapted to fulfil some or all of the functions outlined here. However, the decision must be seen as a positive step in the light of previous failures to act on the need expressed in existing resolutions for integrated management of the Caribbean Sea.

While advancing the case for a Technical Commission as described in this section, a cautionary note must be struck. It would serve no purpose to set up a new "talk shop" merely to give the appearance that action is being taken in response to the many challenges facing the Caribbean Sea ecosystem. For it to achieve the objectives outlined here, decision-makers will need to value and act on its advice or, if they ignore it, to be accountable to the citizens and constituents whom they represent.

[43]Secretariats to international treaties are generally administratively associated with a programme or organization, but function in substantive matters in relation to the needs, expressed and anticipated, of the treaty Parties.

[44]ACS Agreement No. 6/06, March 28th 2006. For an analysis of this initiative see S. A. McDonald *A Framework for the Implementation of Ministerial Council Agreement No. 6/06: Creation of the Follow-Up Commission for the Caribbean Sea Initiative*. ACS Secretariat Working Document.

6.7 Constraints to Response Effectiveness

Constraining factors abound. The Caribbean as a region has historically been divided by non-Caribbean imperial powers vying for acquisition, settlement, or control of many of the Wider Caribbean states. The legacy of that experience is a variety of languages, cultural influences, institutional norms, and legal systems. The legacy is also of patterns of trade, commerce, and engagement between these states and their respective dominant metropolitan authorities, to the neglect of similar relationships with one another. This reality operates as the most entrenched set of constraints to collaboration across the Wider Caribbean region, and it can be expected to be among the most serious set of obstacles to be overcome, in trying to achieve effective management of the Sea and its resources.

The fact that the Eastern boundary of the Caribbean Sea is made up of an archipelago of extremely small island states gives rise to a series of further constraints. They provide easy passage for the drugs trade between main regions of supply and demand, with extremely serious consequences for governments and societies, while their respective capacities to monitor, police, and enforce regulations pertaining to their EEZs are very limited. These states are, moreover, not important players or voices in matters affecting the hemisphere.

To be effective, responses to the needs of the ecosystem will require participation by all the states and subregions of the Wider Caribbean; collective and individual commitment to undertakings entered into through treaties, regulations, or programmes; greater international co-operation to give effect to policy responses; capacities and financing that would sustain the effort; and better integration of initiatives from the corporate and civic sectors into the whole mosaic.

Conflicts of interest could inhibit implementation of many responses. It may be said that conflict is inherent in use of the resources and services of the Caribbean Sea: it is an international waterway which services the economic interests of many states, including those outside the Caribbean and including the transit between them of nuclear and other hazardous wastes. All Caribbean states compete to make use of fisheries and tourism assets: there are periodic hostile encounters relating to fishing grounds, and cruise ships play off destinations against one another to secure most favourable terms and the lowest standards of practice. These conflicts can only be overcome if there is a collective recognition that co-operation is in the long-term interests of all the states, which make use of the services of the Caribbean Sea as an ecosystem.

ANNEX 1: Description of Caribbean Sea Fisheries

Coral Reef and Reef-associated Fishes

Reef fisheries are the most socioeconomically important fisheries in the Caribbean. These fisheries are small-scale and are targeted by low-income, often part-time fishers, using traps and lines. Fish catches are generally landed at a large number of small landing sites and are often an important source of protein for rural communities. Despite the lack of stock-assessment studies, in many instances the low catch rates, small sizes of fish caught, and scarcity of large, most valuable species are clear indicators of over-exploitation throughout the Caribbean region. Only in a few countries with large areas of coral reef on their shelves, for example, the Bahamas, Belize, and possibly Antigua and Barbuda, are the reef resources not yet over-exploited. Rehabilitated and properly managed reef fish resources are those most likely to provide a continuous, stable yield that is easily accessible with minimum investment in fishing gear (Sale 1991; Munro 1983; Huntsman et al. 1982). Generally, knowledge of the status of reef fish stocks is very poor. In countries where the fisheries are primarily small-scale, data on landings are inaccurate because of the widely dispersed nature of the fishery. Estimation of fishing effort is also difficult because of the multi-species, multi-gear nature of the fishery. The extreme vulnerability of spawning aggregations to fishing is a serious problem contributing to over-exploitation. Although this problem is well known for groupers, it is also a concern for other families of reef fish (Auil-Marshalleck 1993). Ciguatera poisoning[45] continues to be an impediment to effective use of reef fish resources in the northern Lesser Antilles and Puerto Rico.

Deep-water Snappers and Groupers

Fisheries for deep-water snappers, groupers, and associated species in the Caribbean occur along the slopes at the edges of island platforms, on deep banks, and along the edge of the continental shelf off Guyana and Suriname. These species are high-priced and are primarily exported or sold to restaurants. They are harvested with lines or traps. Although there are reports of local depletion in various islands, particularly of known spawning aggregations, there is little quantitative information on the state of exploitation of these resources. There are preliminary biomass estimates for the slope of the continental shelf off Guyana, Suriname, and Trinidad and Tobago from surveys conducted by the RV *Fridtjof Nansen* (Institute of Marine Research 1989). Since the area is heavily fished by snapper boats from Venezuela (up to 150 off Suriname alone), a more detailed study of the fishery is required to relate biomass to potential yield. For other areas, there are only rough yield estimates which have been based on observed yields per unit drop-off multiplied by the length of the drop-off. These can provide guidelines for development, and for the Eastern Caribbean islands they suggest that a small increase in exploitation can be accommodated. There is probably scope for expansion of these fisheries in many countries and thus a need for policy decisions regarding the mix of commercial versus small-scale fishing which would be desirable. However, deep-slope and bank habitats are small in area relative to shelves and open ocean. Thus the total abundance of these resources will be relatively small, and they will be particularly susceptible to over-exploitation.

Large Pelagic Fishes

Large pelagic fishes, primarily tunas, support substantial commercial fisheries throughout the world's oceans, but most catches are taken in tropical and subtropical waters (Longhurst and Pauly 1987). Large pelagic resources are considered to hold the greatest potential for fishery development in Caribbean countries, particularly in the Eastern Caribbean. Most countries are increasing their effort in these fisheries or intend to do so. Large pelagic fishes are further subdivided into coastal species and oceanic species.

Coastal species (small tunas, mackerels, and dolphinfish) are thought to be more local in distribution than oceanic pelagics, occurring primarily on island or continental shelves. They are targeted by boats ranging from canoes to launches, which use mainly troll lines (Goodbody 1986; SEFSC 1993). They are also caught in the by-catch of longlines deployed by the semi-industrial (12 to 15 m) boats of several islands, as well as large industrial longliners from distant-water fishing nations, the U.S.A., and Venezuela. Around Trinidad, the fishery for coastal pelagics also targets the mackerels, *Scomberomorus* spp., using gillnets. This resource is believed to be fully exploited. Similar resources occur in unknown quantities in the waters off Guyana and Suriname and are probably under-exploited. Except for dolphinfish, the assessment of coastal pelagic species falls under the mandate of ICCAT, whose emphasis on assessment of large tunas, billfish, and swordfish, as well as a lack of data, has resulted in little

[45]Ciguatera fish poisoning (or ciguatera) is an illness caused by eating fish that contain naturally occurring toxins produced by marine microalgae called *Gambierdiscus toxicus*. People who have ciguatera may experience nausea, vomiting, and neurologic symptoms such as tingling fingers or toes. They also may find that cold things feel hot and hot things feel cold. Ciguatera has no cure. Symptoms usually go away in days or weeks but can last for years. People who have ciguatera can be treated for their symptoms.

attention given to assessment of coastal pelagic species. Apart from species such as blackfin tuna, dolphinfish, little tuna, wahoo, and king mackerel within U.S. waters, there is currently little or no information on the status and potential of coastal pelagic species. These stocks are shared among the countries of the Wider Caribbean and support major commercial fisheries. Therefore, management measures implemented by Caribbean countries alone could probably have a significant impact on their status and sustained yield, but will also require collaboration among countries.

The stocks of oceanic pelagic species (tunas, billfish, swordfish) are widely distributed in the Atlantic Ocean. Fisheries for offshore pelagics expanded within the region throughout the 1980s. This was primarily due to purse seine and longline fishing for tunas by Venezuela and swordfish fishing by U.S. longline vessels. In the mid 1980s, many of the Venezuelan vessels shifted their area of operation from the West Central Atlantic (WCA) to the Eastern Pacific, and recent fluctuations in tuna landings from the WCA are primarily determined by the movement of the vessels between these areas. From 1982 through 1990, the U.S. swordfish longline fleet expanded its operations into the South-east Caribbean as far as the north coast of South America. The effort by artisanal and small commercial fisheries for offshore pelagics also increased through this period, particularly in the Eastern Caribbean islands (Mahon 1996). Although these species are assessed by ICCAT, the status of the stocks is poorly known in the Western Atlantic, where the database is weak. Assessments by ICCAT indicate that the potential for expansion of offshore pelagics varies considerably among species. The major stocks are considered to be fully exploited (yellowfin tuna, bigeye tuna, albacore) or over-exploited (bluefin tuna, swordfish, blue marlin, and white marlin; ICCAT 1995).

Management of both coastal and oceanic pelagics will require close collaboration among countries within and outside the region, as specified by the UN Agreement Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (United Nations 1995). The expansion of offshore pelagic fisheries creates new problems associated with the migratory, seasonal nature of the resources. Fishers either have to switch to fishing other kinds of resources when the migratory species are absent, or follow the fish from one EEZ to another. Most often the switch in effort is directed at the bottom-dwelling species that are already overfished. Although deep-water resources, mainly high-valued snappers, are the only stocks with potential for expansion, these resources are also easily overfished. Therefore, to avoid overfishing them, management will need to strike a delicate balance between the expansion of fleets for pelagic fishing and those allowed to fish the deep-water snappers during the off-season. The most significant problem regarding the expansion of fleets into offshore areas is that the target pelagic fish are already being extensively exploited. Distant-water fishing nations such as Japan, Korea, and Taiwan as well as large commercial vessels of countries within the region fish both on the High Seas to the east of the region and within the EEZs of Caribbean countries (Singh-Renton and Mahon 1996). The ultimate management question concerns the fraction of the potential yield that is already being taken by distant-water and regional fisheries. If current catches are already at, or close to, the maximum sustainable yield, then the problem is to decide how the countries of the Caribbean will be able to access the share of the resource that their EEZs entitle them to, without the resource becoming overfished.

Small Coastal Pelagic Fishes

In the Caribbean, the term small coastal pelagics refers mainly to jacks, robins, and ballyhoo (*Caranx* spp., *Decapterus* spp., *Hemirhamphus* spp.) as well as herrings (Clupeidae) and anchovies (Engraulidae). Some small tunas and mackerels are also caught in these fisheries. These species are fished primarily using seine nets and vary greatly in importance among islands. Jacks, robins, and ballyhoo account for about 30% of the catch in Grenada and for less than 1% in Barbados. In most countries, there are small-scale fisheries for near-shore shoaling clupeids for bait and food (Goodbody 1986). Although several islands report declining catches of small coastal pelagics, neither the extent of the decline nor the species involved are documented. There is very little information on the distribution or migration of these species. Acoustic surveys by RV *Fridtjof Nansen* indicated that there are substantial stocks of small pelagics off the north coast of South America from Suriname to Colombia. These consist primarily of clupeids, engraulids, and carangids, and are virtually unexploited, except by Venezuela in the Isla Margarita area (Institute for Marine Research 1989).

Flyingfish

In the southern Lesser Antilles, the four-winged flyingfish is the single most important small pelagic. The species is used as food and as bait in the developing longline fishery targeting large pelagics. The flyingfish is targeted by artisanal boats (pirogues), launches, and iceboats using gillnets and dipnets or scoop nets. The fishery in the Eastern Caribbean ranges from Dominica in the North to Tobago in the South. However, Barbados and Tobago are the main exploiters of the resource. The status of the resource is uncertain. A 1992 study on the fishery off

Tobago suggested that the resource was heavily exploited (Samlalsingh and Pandohee 1992), while a 1993 study in the Eastern Caribbean yielded no evidence of over-exploitation despite considerable fluctuations in abundance (Oxenford et al. 1993). It is suggested that countries which exploit the four-wing flyingfish probably share a common stock (Gomes et al. 1999). Therefore, the fate of the resource and hence the fishery could depend largely on management measures implemented by these countries. Results of a regional flyingfish assessment program, the Eastern Caribbean Flyingfish Project, suggested that owing to their short lifespan (they are annual) and considerable inter-annual variability in the abundance, traditional deterministic stock-recruitment assessment methods will not be applicable to flyingfish. Instead, an approach which attempts to evaluate the risks of, and returns from, various fishing options was recommended.

Groundfishes

Groundfishes are targeted by fisheries on the continental shelf adjacent to Central and northern South America. These areas, especially from the eastern part of Venezuela extending to Brazil, have extensive and diverse soft-bottom habitats, which support high levels of marine biodiversity and productivity. This area has the most extensive fisheries in the Caribbean.

Shrimp

Penaeid prawns (shrimps) are one of the most valuable resources of the tropics, particularly in areas where there are coastal mangroves and wide shallow shelves (Garcia 1988). The Guyanas–Brazil shelf area and the northern Gulf of Mexico are two of the major penaeid shrimp-fishing areas of the world. Shrimp resources are fished primarily by an industrial fleet of trawlers (25–30 m). There are also artisanal, coastal fisheries for shrimps on the Guianas–Brazil shelf area (FAO 1995; CFRAMP 1996). Other small, localized marine shrimp fisheries occur in the coastal waters of many of the larger Caribbean islands (for example, Cuba, Dominican Republic, Jamaica) and mainland countries such as Venezuela, Nicaragua, and Belize. Shrimps from Guyana, Suriname, Trinidad and Tobago, and Belize are exported and earn significant foreign exchange in these countries. One of the primary problems with the shrimp industry in Suriname and Guyana is foreign ownership. In Suriname, only 10–15% of the U.S. $21 million/year earned by the fishery is retained by the country. With domestic ownership, the percentage would be expected to increase to about 40–50 per cent.

Lobster

Spiny lobsters support valuable fisheries throughout the tropics (Phillips et al. 1994). In the Caribbean, lobster (mainly the Caribbean spiny lobster) is a high-priced resource distributed in coral-reef and associated habitats. They are caught by divers, lobster traps (for example, in Belize), and frequently together with reef fish in fish traps. Most are either exported as frozen tails or sold locally to hotels and restaurants for tourist consumption. In the Bahamas, the value of lobster export for 1992 was U.S. $35 million. Lobsters are considered to be fully or over-exploited throughout the Caribbean. Possible exceptions are some offshore banks. The situation is worse on the south shelf of Jamaica and in the Eastern Caribbean islands, where shelf areas are small. If properly managed, lobster stocks should recover and provide valuable sustainable yields. This species has the potential to earn foreign exchange as an export, and through the tourist industry. For Eastern Caribbean islands, rough estimates of potential yield indicate a potential export value of U.S. $3.8 million. If this catch were retailed locally in restaurants, the value would be about U.S. $14 million (Mahon 1990).

Conch

The queen conch is a large marine snail found only in the Caribbean region. Conch, like lobster, is a high-priced resource, which is either exported or sold to hotels and restaurants for tourist consumption. Conch are usually harvested by divers. In Haiti, tangle nets are also used. Conch occur in specific, easily identifiable habitats with limited distribution and are therefore even more susceptible to over-exploitation than lobster. Except in the Bahamas, this resource is considered to be fully or over-exploited throughout the region, with areas of severe local depletion (Appeldoorn 1994). Some unexploited conch stocks probably exist on offshore banks in relatively deep water (25–30 m). In most areas, intensive fishing has depleted conch populations to the point of forcing permanent (U.S.A., Mexico, Bermuda) or temporary (Cuba) closure of the fisheries. Reseeding programmes to rebuild conch stocks have been tried in many countries but have not been demonstrated to enhance fishery yields (Stoner 2005). With proper management, conch stocks should also recover and provide valuable sustainable yields. Rough estimates of potential yield from the Lesser Antilles indicate a total export value of U.S. $5 million and a restaurant retail value of about U.S. $40 million (Mahon 1990). Stocks in Cuba seemed to recover quickly after a temporary closure of the fishery. In Bermuda, however, in spite of more than 10 years of protection, stocks have not recovered from overfishing.

ANNEX 2a: Key Questions and Uncertainties Addressed by the CARSEA SCENARIOS

The following forces, uncertain and difficult to control, were identified as important variables shaping the future of the Caribbean Sea and its coastal zones:

- Tourism—forms (mass vs. niche tourism sensitive to the carrying capacity of the ecosystem), numbers
- Fisheries—resource mining vs. sustainable use
- Land use change—habitat change and loss of valued ecosystems
- Population dynamics, equity, and consumption patterns
- Governance mechanisms
- Climate variability and change.

These concerns were formulated into a number of key questions, viz.:

- What governance mechanisms can be used to reduce the economic, social, and environmental vulnerability of the region?
- How can maintenance and management of ecosystem services proceed to improve human well-being in the Caribbean?
- How can economic activity be organized and managed so that natural resource benefits are distributed equitably between local and extra-regional interests, relative to costs? How can we link the interests of users of services with their investments in the region?
- Will current trends in the decline of Caribbean Sea coastal and marine ecosystems exceed ecological thresholds that may result in significant consequences for human well-being?

These questions fall into clusters of issues, related to whether development in the region will be sensitive to the capacity of the Sea to provide ecosystem services. Major axes of uncertainty affecting the possible answer to this question are whether the region goes along the path of:

- Externally controlled vs. internally driven development
- Regionalization vs. fragmentation

Scenarios were primarily targeted at the regional level, with a link down to the subregional level to ensure plausibility, and a link up to the global level to provide boundary conditions. The global level boundary conditions were taken to be the four MA Global Scenarios, although we also briefly explored linkages with the four scenarios used by the GEO of the UN Environment Programme.[46] Two of the uncertainties identified relate to governance mechanisms and methods for capturing resource rents locally; these are exogenous in nature; in other words they are driven from outside the Caribbean. The third uncertainty relates to whether there are ecological thresholds that can result in catastrophe; this is basically endogenous in its relationship with the major drivers of the system. These uncertainties were chosen because they addressed the key issues affecting ecosystem services and links with human well-being. These were regional governance of the Caribbean Sea as it relates to the tragedy of the commons and the parallel problem of the capture of resource rents from tourism.

[46]For a summary of the GEO scenarios, see http://www.unep.org/GEO/geo3/english/overview/020.htm

ANNEX 2b: Scenarios for Caribbean Sea Fisheries

Relationship of Fisheries Governance to the Scenarios

Scenario	Probability of achieving full fisheries governance	Realization of fisheries benefits under full fisheries governance regime
Neo-plantation economy	Low: • Increasing prevalence of private sector in harvesting and exporting • Trans-boundary management mechanism not given high priority	Low: • Most yields exported as raw material • Minimal value added from processing and tourism consumption • Availability of fisheries products locally diminished
Quality over quantity	Medium: • National/local governance mechanisms achieve some success, despite low regional co-operation	High: • Local tourism markets supplied first • Value added through processing and speciality products
Diversify together	High: • Governance mechanism for trans-boundary resources given high priority	Medium: • Good sustainable yields achieved, but local benefits and opportunities to add value may not be realized
Growing assymetries	Medium: • Governance mechanisms in small islands and the poorest countries may be overwhelmed by larger partners	Medium • Incentives to develop fishery products may be limited

Scenario 1: Neo-plantation Economy

The Neo-plantation Economy scenario has varying effects on fisheries. Many poor people resort to fishing when they are unable to obtain food by other means. Near-shore fishers, who are mainly small-scale, find fewer and fewer fish in the coastal area. Offshore fishing is based on high capital investment, much of which comes from extra-regional sources. As small-scale fishers venture further out to offshore fisheries to find fish, they come into conflict with offshore fishers and put themselves at risk. The offshore fishers have better technology and equipment and out-compete the small-scale fishers. Tourism company owners are worried about the depletion of stocks because they know that many tourists come to see fish and enjoy the Caribbean cultural environment, of which small-scale fishing is an integral part. Countries increase the use of Marine Protected Areas (MPAs) as a means of protecting fish populations for tourism use, thus displacing fishers, further depleting non-MPA areas, and increasing conflict in the coastal zone. By 2030, there is high conflict both within the Caribbean and between Caribbean nations and external countries over management of fisheries.

Scenario 2: Quality over Quantity

In this scenario, there is an emphasis on small-scale fisheries, producing a quality product for both local and overseas niche markets. The emphasis on quality over quantity places higher values on the resource base, leading to the development of more effective measures to conserve and restore essential habitats for the preservation of coastal water quality, including mangroves and fringing reefs. Most fisheries already have been exploited beyond sustainable levels in 2005. Production continues to decline in many fisheries for some years. Increased awareness of the importance of management leads to improved arrangements for small-scale fisheries, with an emphasis on stakeholder participation and co-management by 2015. Fish stocks slowly recover, and by 2025 there are increased profits to individual fishers, and greater equity. Fishers support MPAs, other management tools, and integrated coastal zone management because they appreciate their importance of maintaining healthy fishery resources. By 2050, fishery resources are sufficiently healthy to provide greater resilience in times of economic hardship and natural disaster. Targeting niche markets leads to value-added processing, with an emphasis on local small business development. Industrial production declines, and the value-added approach gradually weans Caribbean communities away from direct exportation of unprocessed fishery products, increasing benefits to the region. Fishery products may be too high-priced for lower-income local consumption, leading to increased dependency on imported substitutes. The overall use of the range of near-shore resources is more efficient because it is more targeted, and there is less wastage and habitat destruction. By 2035, the value of sport fisheries for offshore pelagics is more appreciated, and management orients itself to protecting this resource for tourism. Charter and tournament fishing with tag-and-release programmes increasingly contribute to the tourism product.

Scenario 3: Diversify Together

The trends in this scenario are very similar to those in the quality over quantity scenario. The main difference is that there is much greater emphasis on regional co-operation. This allows for the development of regional management plans and access arrangements that successfully regulate the exploitation of shared resources. Regional co-operation in fisheries management facilitates a shift towards ecosystem-based management at the level of the Caribbean Large Marine Ecosystem. It also leads to greater sharing of technical expertise and information in the fisheries sector, and enhances marine science and technology capacity in the region. Caribbean countries are better able to bargain collectively for fair access to more wide-ranging internationally managed stocks. Policies that favour trade within the region lead to the use of most fisheries products in the region to meet local and tourist consumption demand. This improves food security within the region and also ensures that most tourism demand for high-quality seafood products is met from within the region. The trade in fisheries within the Caribbean is part of an integrated trade in goods, and is sensitive to perturbations in other sectors or nations in the region. Although fish stocks continue to decline through to about 2025, better management practices introduced in 2010 allow for a gradual improvement in fish stocks in the second half of this scenario. Near-shore fisheries are exploited differently in different locations, depending on the focus of the local economy. Some countries develop industries based on extraction of near-shore resources, while others preserve these resources in support of eco-tourism. The political and regulatory framework encourages experimentation by small businesses, while regulating the use of ecosystem goods and services. In this economic climate, it is easy for small businesses to receive loans and make substantial investments, and the local banking sector grows.

Scenario 4: Growing Asymmetries

With regard to fisheries, this scenario is likely to be the most unpredictable and variable, with strong elements of both the 'Neo-plantation Economy' and 'Quality over Quantity' scenarios. The removal of subsidies will, in the long term, lead to a general improvement in over-exploited fisheries resources. However, in the short term, many fishers will be displaced and experience hardship, while those who can afford to remain in the fishery will be better off. The way in which the improved fishery yields are used by countries will determine which of these possibilities prevails. Arrangements within the Caribbean could favour predatory exploitation by a few countries with the capital to invest. Countries that take control of their resources to meet tourism niches may achieve a situation described in the 'Quality over Quantity' scenario.

The perceived dominance of local environments by multinational companies gradually engenders feelings of resentment and xenophobia among the local population living in, and around, the protected areas, leading to rising social tension. Around 2020, a number of conflicts develop between local populations and foreign landowners, including deliberate acts of arson and vandalism. Further tensions arise as pharmaceutical and biotechnology companies seek the rigid enforcement of marine protected areas, competing with tourism companies and local fishers for rights to what were formerly common property resources. These conflicts are resolved in different ways

in different areas, leading in some cases to equitable solutions and extractive reserves, and in other cases to the development of higher fences.

ANNEX 2c: Details of Scenarios for Tourism in the Insular Caribbean

NB. These findings are the result of modelling carried out for CARSEA by OEF, using current data from the World Travel and Tourism Council (WTTC). They present results for the Insular Caribbean as a whole, a sample island state (Trinidad and Tobago), and a sample continental state (Honduras).

Baseline

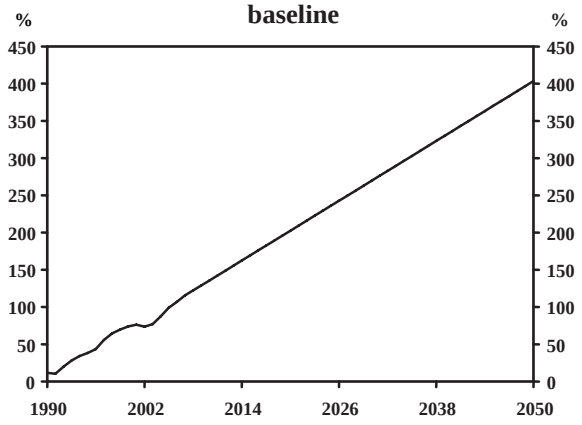
GDP growth of 6% per annum in the long term…

- The CARSEA/OEF baseline forecast shows insular Caribbean GDP rising by 6.2% pa in the long run (in nominal U.S. $ terms)—slightly lower than recent growth rates, although the impact of Hurricane Ivan undoubtedly hit some areas hard in 2004. With population growth estimated at around 1% pa and inflation settling down to 2.5%–3% in the later part of the forecast, GDP per head is likely to increase around 2½% pa in real terms.

…with a marginal increase in the share of tourism

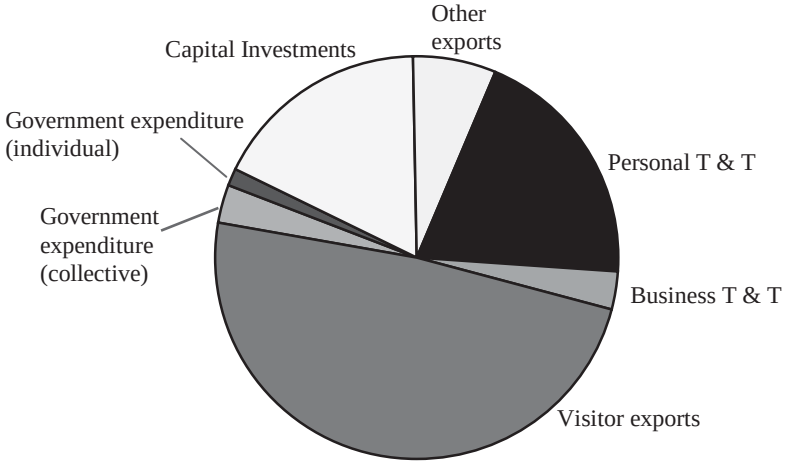
- The baseline forecast is constructed to be broadly neutral, in the sense that the trends seen in 2014 (the extent of current WTTC projections) are expected to continue. Travel and tourism (T&T) is expected to be slightly more important in the Caribbean economy than it currently is, with T&T whole economy GDP at U.S. $603.8 billion by 2050, some 20% of the total. Accordingly, employment is projected to account for 22.4% of total employment. These assumptions partly reflect demand for tourism—itself a reflection of increasing living standards—from the rest of the world.
- And while visitor spending is expected to grow around 6.8% in nominal U.S. $ terms each year (faster than GDP), the contribution it makes to overall exports is expected to fall marginally over the forecast horizon —there is some diversification of the economy.

Caribbean: T&T GDP (cumulative growth) baseline



SOURCE: OEF.

Caribbean: T&T demand baseline, 2005



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	8.8	16.8	30.6	55.7	136.9
Business travel	1.5	2.7	4.9	8.9	22.0
Government expenditures	2.0	3.9	7.4	13.9	36.2
Capital investments	7.8	14.6	26.9	49.5	123.7
Visitor exports	21.6	43.4	84.1	162.7	438.3
Other exports	2.9	5.9	11.8	23.5	66.4
Travel & tourism demand	44.6	87.3	165.6	314.3	823.5
Travel & tourism industry GDP	9.8	19.7	37.9	73.2	196.9
Travel & tourism economy GDP	31.7	62.4	119.2	228.0	603.8
Travel & tourism industry employment	874.1	1121.0	1457.6	1897.4	2824.9
Travel & tourism economy employment	2555.4	3252.2	4185.6	5381.0	7851.0
As % of total					
Personal travel & tourism	6.8	7.2	7.1	7.1	7.1
Business travel	—	—	—	—	—
Government expenditures	7.8	8.8	9.1	9.5	10.1
Capital investments	20.6	22.4	22.8	23.2	23.8
Visitor exports	14.8	16.5	15.6	14.8	13.6
Other exports	2.1	2.2	2.2	2.1	2.1
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.8	5.2	5.5	5.9	6.4
Travel & tourism economy GDP	15.5	16.6	17.4	18.3	19.7
Travel & tourism industry employment	5.5	5.9	6.5	7.1	8.1
Travel & tourism economy employment	16.1	17.2	18.6	20.0	22.4

Scenario 1. The Neo-Plantation Economy

In this scenario, the economy is driven by a demand for goods and services that are mostly enjoyed by people outside the region. Relatively few benefits are captured locally. While positive trends emerge around 2015, these developments carry the seeds of their own downfall, and the economy moves into recession around 2035.

Key points:

- A lack of diversification and an over-reliance on tourism.
- Overseas business dominates the local economy.
- Agriculture produces exports, but processing is done abroad, so high-value end products have to be imported.
- Tourism grows, in fact booms, but the profits are not reinvested.
- Other industry shares a similar pattern.
- From 2015 onwards costs start to weigh. The adverse effect of too much low-value tourism is seen in environmental and cultural damage.
- The proportion of the population under the poverty line has increased by 2030.
- Tourism declines beyond 2035 as other areas appear more attractive. Industry is in recession by 2040 and most educated residents are emigrating to places where there is more opportunity.

Inputs for travel and tourism modelling:

- More spending by (more) visitors between now and 2015 to create the boom.
- The creation of lots of low-productivity jobs implies an expansion in general consumer spending.
- More investment and more government spending supplement this.
- This implies more exports, but the over-reliance on imported finished goods mitigates this to a certain extent.
- Tourism and spending start to level off from 2015, and so does employment. But the reliance on expensive imports of finished goods does not. Consequently living standards start to fall.

CARIBBEAN

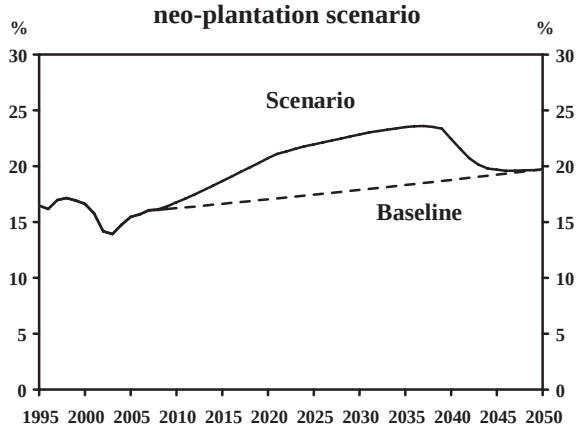
An investment-led boom…

- During the period 2007–2017, investment pours into the Caribbean, mostly into the tourism sector. During this period, capital spending in the sector grows 2% points faster than in the baseline forecast. But spillovers into the wider economy are rather muted. Along with the expansion of tourist facilities come more visitors, and by 2020 this part of the economy is booming, with spending by visitors growing by around 10% every year. As a consequence, the economy comes to rely on tourism more and more, with the share of export revenue from this source rising from 16.1% of the total in 2004 to 21.3% in 2025, nearly 5% points above the level in the baseline. Tourism accounts for 23.5% of the whole economy in 2035.

…sows the seeds for a subsequent bust

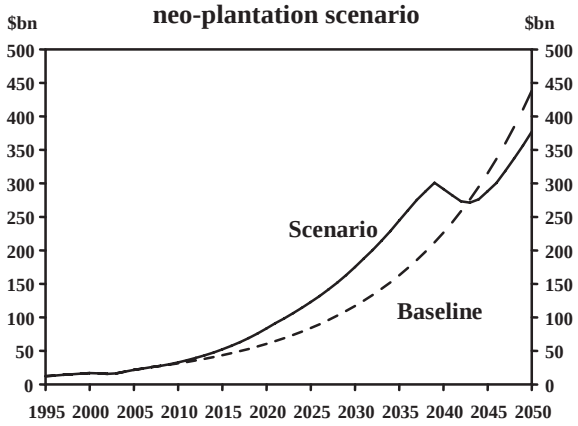
- But by this time, the economy has been in deep trouble for some time. The investment surge is long over, and the firms that have poured money in are looking elsewhere heading towards 2030. Visitor numbers hold up for a time, but tastes change and over-exploitation becomes an issue. Visitor numbers slump in 2040, and spending drops 30% relative to baseline in just three years. Domestic consumer spending follows as employment shrinks.
- The economy suffers a recession, and real GDP and spending per head falls for several years. Despite some recovery towards the end of the forecast horizon, overall GDP is 15% below the baseline in 2050.

Caribbean: Share of tourism in total GDP
neo-plantation scenario



SOURCE: OEF.

Caribbean: Visitor spending
neo-plantation scenario



SOURCE: OEF.

Summary Table					
In U.S. $ billion and 000s	**2004**	**2015**	**2025**	**2035**	**2050**
Personal travel & tourism	8.0	18.2	36.1	66.5	129.1
Business travel	1.3	2.8	5.1	9.2	20.2
Government expenditures	1.9	4.1	8.0	15.0	30.8
Capital investments	7.4	17.2	32.8	56.0	80.5
Visitor exports	19.0	52.2	122.8	244.5	377.2
Other exports	2.7	5.9	11.8	23.5	66.4
Travel & tourism demand	40.3	100.5	216.7	414.8	704.3
Travel & tourism industry GDP	8.7	23.4	54.6	108.9	173.6
Travel & tourism economy GDP	28.4	73.3	163.1	316.4	514.2
Travel & tourism industry employment	814.5	1336.2	2108.1	2831.8	2473.6
Travel & tourism economy employment	2416.5	3840.0	5817.9	7624.6	6702.9
As % of total					
Personal travel & tourism	6.5	7.1	7.0	6.9	7.1
Business travel	—	—	—	—	—
Government expenditures	8.2	8.8	9.1	9.5	10.1
Capital investments	21.7	24.7	25.6	24.9	18.4
Visitor exports	16.1	19.2	21.3	20.7	11.9
Other exports	2.3	2.2	2.0	2.0	2.1
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.5	6.0	7.4	8.1	6.6
Travel & tourism economy GDP	14.8	18.7	21.9	23.5	19.7
Travel & tourism industry employment	5.2	6.7	8.6	9.7	8.3
Travel & tourism economy employment	15.5	19.4	23.7	26.2	22.6

TRINIDAD AND TOBAGO

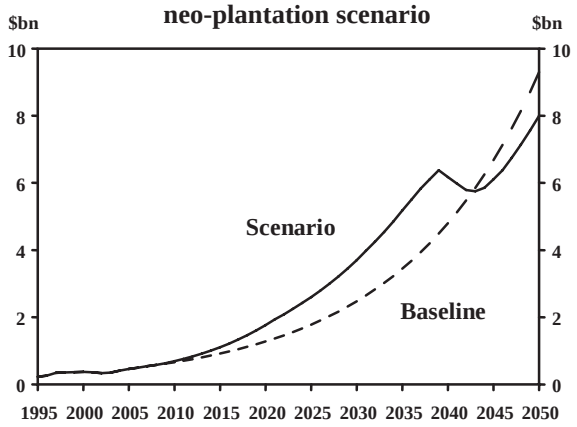
After a prolonged period of expansion

- The economy first sees 20 or so years of improvement from the surge in overseas investment and tourism revenues. The oil industry—around 40% of GDP in 2005—also sees rapid growth, and the expansion there adds to exports generated by the tourism boom. By 2035, total exports are 80% higher relative to baseline, but imports are also strong, hence the impact on GDP is less pronounced. On the tourism side, the growing numbers of visitors boost spending to U.S. $5,178 million (up by 50% relative to baseline), and tourism's share rises to 30% of whole economy GDP. But while the local economy benefits for many years, positive impact fades as profits from foreign investment leak overseas and the tourist sector becomes jaded.

… the tourism industry enters recession

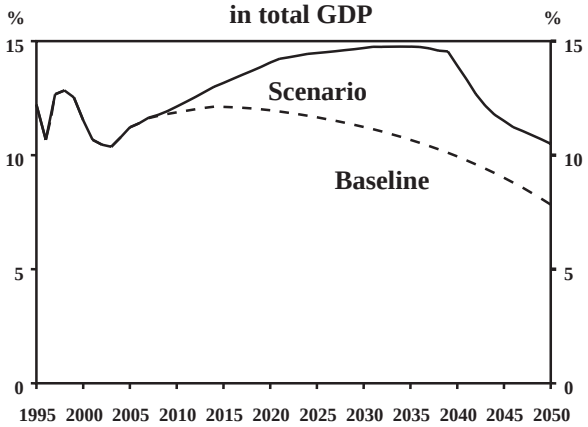
- The tourism economy collapses, with GDP in decline for a number of years. Travel and Tourism capital spending is hit hard—around 35% below baseline by 2050—as foreign investment inflows dry up. Visitor spending also declines as other tourist destinations look more attractive—by 2050 it is some 14% below baseline. The drop in tourism demand results in a prolonged contraction in employment. Over-reliance on high value-imported goods, which mirrors years of underdevelopment in local enterprise, begins to undermine living standards and consumer demand. By 2050, domestic consumption is 15% below baseline and overall GDP is down 18 per cent.

Trinidad & Tobago: Visitor spending neo-plantation scenario



SOURCE: OEF.

Trinidad & Tobago: Share of tourism in total GDP



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.483	0.960	1.885	3.475	6.883
Business travel	0.122	0.214	0.364	0.606	1.198
Government expenditures	0.050	0.090	0.164	0.285	0.518
Capital investments	0.435	0.961	1.712	2.736	3.546
Visitor exports	0.459	1.105	2.599	5.178	7.998
Other exports	0.454	1.007	2.167	4.662	14.713
Travel & tourism demand	2.003	4.337	8.890	16.941	34.857
Travel & tourism industry GDP	0.270	0.525	1.020	1.690	1.930
Travel & tourism economy GDP	1.251	2.490	4.634	7.671	10.853
Travel & tourism industry employment	15.5	22.3	31.4	37.4	26.9
Travel & tourism economy employment	62.1	91.3	122.4	144.1	119.9
As % of total					
Personal travel & tourism	7.4	8.1	8.4	8.8	10.1
Business travel	—	—	—	—	—
Government expenditures	3.9	4.2	4.3	4.3	4.4
Capital investments	17.6	23.2	23.6	22.5	15.9
Visitor exports	6.0	6.9	7.1	6.2	2.8
Other exports	6.1	6.3	5.9	5.6	5.2
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	2.4	2.8	3.2	3.3	1.9
Travel & tourism economy GDP	11.2	13.2	14.5	14.8	10.5
Travel & tourism industry employment	2.7	3.1	3.7	3.8	2.4
Travel & tourism economy employment	10.9	12.7	14.3	14.7	10.5

HONDURAS

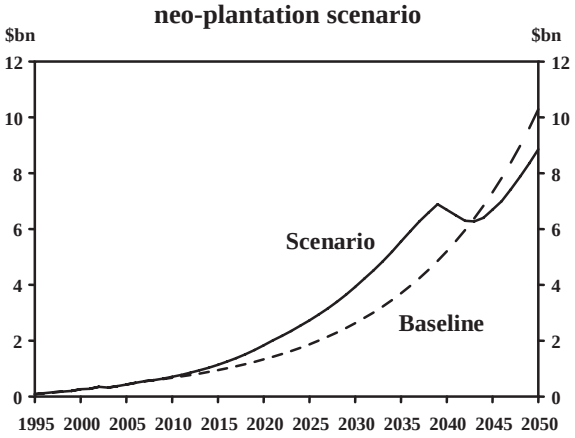
Mass tourism spurs activity…

- Despite attempts to promote its attractions, tourism is still one of the least developed industries in Honduras. In this scenario, the surge in overseas investment leads to the improvements in infrastructure and communications needed to develop mass tourism. By 2010, capital spending on travel and tourism is some 19% higher relative to baseline. The growing number of visitors boosts visitor exports to U.S. $1,134 million (up nearly 20% relative to baseline) as tourism's share rises to 13% of whole economy GDP. While the benefit to the local economy is sustained for many years, the positive impact peters out as tourism profits leak abroad and overdevelopment means the sector itself becomes less attractive to both investors and visitors.

… but growth is not sustainable

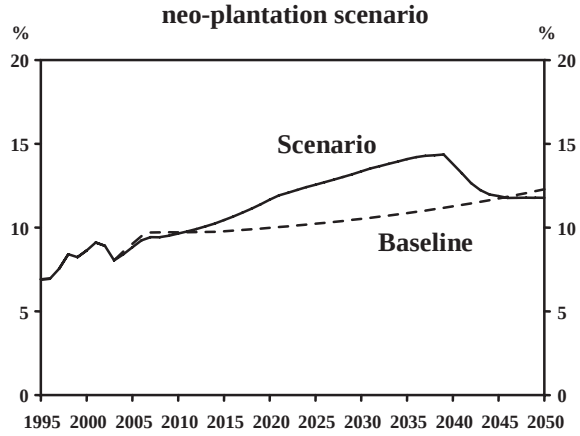
- By 2040 the tourism economy enters recession. There is retrenchment in travel and tourism investment as foreign interest dwindles—capital spending is some 35% below baseline by 2050. Visitor spending also declines—by 2050 it is some 14% below base. And as tourism demand slumps there is a prolonged contraction in travel and tourism employment. The dependence on imported consumer goods and finished manufactures erodes living standards. As a result, consumer demand also suffers. By 2050 domestic consumption and overall travel and tourism GDP are 7% below baseline.

Honduras: Visitor spending neo-plantation scenario



SOURCE: OEF.

Honduras: Share of tourism in total GDP neo-plantation scenario



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.5092	1.1493	1.7835	2.5868	3.6114
Business travel	0.1374	0.2398	0.3949	0.6393	1.2326
Government expenditures	0.0441	0.0824	0.1514	0.2668	0.4936
Capital investments	0.1631	0.2621	0.4089	0.5712	0.6014
Visitor exports	0.4279	1.1344	2.7251	5.5459	8.8550
Other exports	0.0540	0.1380	0.3269	0.7740	2.8199
Travel & tourism demand	1.3357	3.0060	5.7907	10.3838	17.6139
Travel & tourism industry GDP	0.3082	0.6979	1.5272	2.9307	4.4288
Travel & tourism economy GDP	0.7280	1.5679	3.3150	6.2868	10.3099
Travel & tourism industry employment	81.4	147.0	249.6	368.4	368.0
Travel & tourism economy employment	193.2	332.0	545.7	799.1	881.4

Summary Table					
In U.S. $ billion and 000s	**2005**	**2015**	**2025**	**2035**	**2050**
As % of total					
Personal travel & tourism	8.0	10.0	8.6	7.5	6.6
Business travel	—	—	—	—	—
Government expenditures	3.7	4.1	4.3	4.5	4.7
Capital investments	8.8	9.2	9.5	9.1	6.2
Visitor exports	11.8	13.9	13.5	11.3	4.9
Other exports	1.7	1.7	1.6	1.6	1.5
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	3.7	4.6	5.8	6.6	5.1
Travel & tourism economy GDP	8.8	10.4	12.6	14.1	11.8
Travel & tourism industry employment	3.0	3.8	4.6	5.1	3.8
Travel & tourism economy employment	7.2	8.5	10.1	11.1	9.0

Scenario 2: Quality over Quantity

There is a shift to more selective, higher-quality tourism combined with careful sustainable management of natural resources at a level appropriate for the small island states of the region. The process starts slowly, as reform of management systems occurs and then expands gradually.

Key points:

- By 2015, quotas applied to tourism inflows.
- Local businesses favoured over foreign—tax breaks and lower docking fees.
- Tourism profits stay local.
- Foreign firms react by relocating—short-lived two to three years decline in tourism.
- Around 2020, emphasis switching to local supply reduces imports but raises the cost of living.
- By 2020 high-value niche-based tourism takes root—conferences/conventions tourism develops—spillovers.
- Greater opportunities lead to net inward migration. Fewer skilled people leave and overseas nationals return. The improvement in workforce quality enhances productivity.

Inputs for travel and tourism modelling:

- Slower growth in visitor numbers by 2015, but visitor spending is higher.
- Weaker tourism investment as foreign direct investment is hit.
- Then visitor spending recovers, despite fewer tourist arrivals than in the baseline, reflecting more 'up-market' tourism.

CARIBBEAN

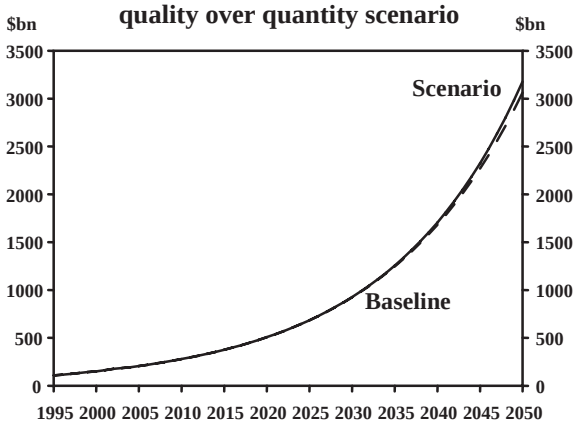
Balanced growth…

- With "quality over quantity" successfully achieved, the economy grows in a sustainable way, which does not put pressure on the environment. The gains made in macroeconomic terms are rather modest, GDP growth is around 0.4% pa higher than in the baseline, but over a generation these gains will cumulate up to produce significant improvements in living standards.
- With visitor numbers restricted from 2011, there is a very small dampening effect on the economy—visitor numbers do not expand as strongly as in the baseline projections, and overall spending falls. But by 2020, investment in the industry is starting to pick up. And, from 2030 onwards, this investment—which is assumed to be at the upper end of the market—pays off, with spending by tourists first recovering to previous levels and then growing by nearly 7.5% pa (0.5% points higher than in the baseline) towards the end of the scenario, reflecting the move into high value-added areas.

…and better living standards

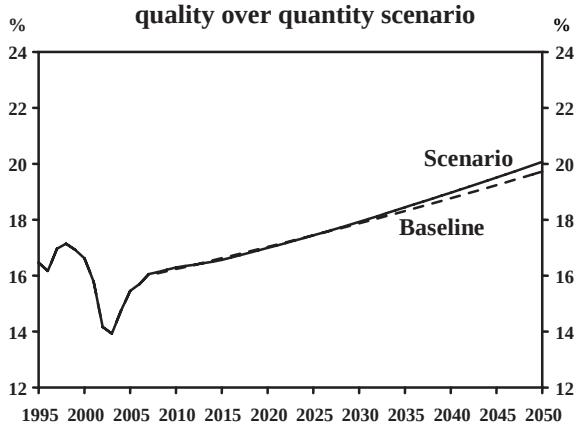
"Balance" is the key in this scenario. Tourism in 2050 has the same importance in the overall economy as it did in the baseline, but the total size of the economy has grown. Employment is around 4% above base in the economy as a whole, and 6% higher in travel and tourism. The GDP per head (in U.S. $ terms) grows 4.4% per year over 2040–2050, rather than 4.2% in the baseline, with the gains continuing to accrue.

Caribbean: GDP quality over quantity scenario



SOURCE: OEF.

Caribbean: Share of tourism in total GDP quality over quantity scenario



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2004	2015	2025	2035	2050
Personal travel & tourism	8.0	16.9	30.8	56.4	139.5
Business travel	1.3	2.7	4.9	9.0	22.4
Government expenditures	1.9	3.9	7.5	14.1	36.7
Capital investments	7.4	14.1	26.4	49.5	127.2
Visitor exports	19.0	43.4	84.1	165.1	466.4
Other exports	2.7	5.9	11.8	23.6	67.3
Travel & tourism demand	40.3	86.9	165.5	317.7	859.5
Travel & tourism industry GDP	8.7	19.7	38.1	74.6	209.8
Travel & tourism economy GDP	28.4	62.2	119.4	231.4	637.7
Travel & tourism industry employment	814.5	1123.1	1464.2	1930.3	3007.2
Travel & tourism economy employment	2416.5	3243.5	4192.1	5460.3	8307.9
As % of total					
Personal travel & tourism	6.5	7.2	7.2	7.1	7.0
Business travel	—	—	—	—	—
Government expenditures	8.2	8.7	9.1	9.5	10.1
Capital investments	21.7	22.0	22.6	23.2	24.2
Visitor exports	16.1	16.4	15.6	14.9	14.1
Other exports	2.3	2.2	2.2	2.1	2.0
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.5	5.2	5.6	5.9	6.6
Travel & tourism economy GDP	14.8	16.6	17.4	18.4	20.1
Travel & tourism industry employment	5.2	5.9	6.5	7.1	8.3
Travel & tourism economy employment	15.5	17.2	18.6	20.2	22.8

TRINIDAD AND TOBAGO

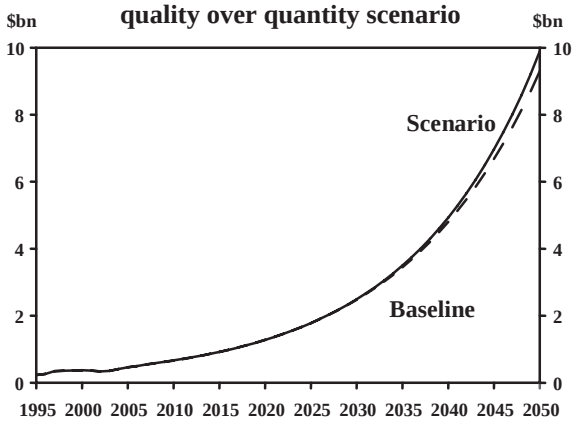
After a slow start …

- The economic benefits over the next decade are mildly negative as the tourism industry faces restructuring and reorganization. The renewed focus on local business sees some flagship foreign tourism operators cut investment and run down their operations as taxes and other charges increase relative to base. But the government ploughs these revenues back into the local economy, cushioning the impact. By 2015, travel and tourism capital investment is down around 3% and overall travel and tourism demand is down around 1 per cent.
- Despite the restrictions placed on visitor numbers, by 2015 the impact on visitor spending is pretty muted—at U.S. $1,780 million visitor exports are down less than 0.5% relative to baseline. By 2015 there are signs that the switch to up-market tourism, especially in secluded and unspoilt parts of Tobago, is generating higher revenues per head and higher tourism employment relative to the baseline scenario.

… the shift to quality tourism bears fruit

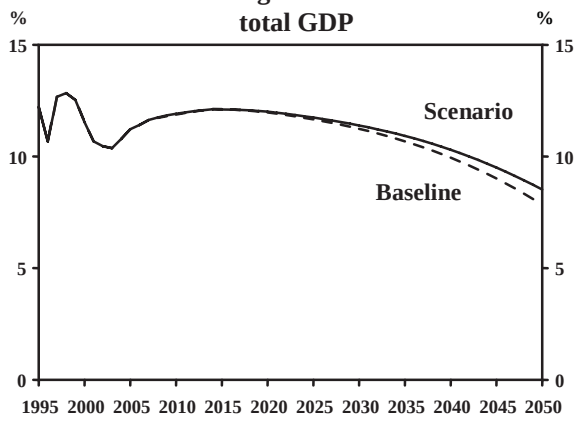
- Higher-quality niche tourism continues to bear fruit through to 2050. Tourism revenues grow faster than in the baseline scenario. While managed growth is modest (relative to baseline) it is sustainable and balanced with that in non-tourism enterprise elsewhere. By 2050, the travel and tourism economy is 10% larger relative to baseline, employing 119,000 people, and visitor exports rise to just under U.S. $10 million.

Trinidad & Tobago: Visitor spending quality over quantity scenario



SOURCE: OEF.

Trinidad & Tobago: Share of tourism in total GDP



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.483	0.899	1.647	3.008	7.450
Business travel	0.122	0.206	0.350	0.596	1.324
Government expenditures	0.050	0.087	0.152	0.267	0.619
Capital investments	0.435	0.787	1.375	2.417	5.630
Visitor exports	0.459	0.917	1.780	3.497	9.890
Other exports	0.454	1.007	2.167	4.675	14.895
Travel & tourism demand	2.003	3.903	7.471	14.460	39.807
Travel & tourism industry GDP	0.270	0.461	0.748	1.163	1.957
Travel & tourism economy GDP	1.251	2.226	3.727	6.000	10.643
Travel & tourism industry employment	15.5	19.6	23.0	25.7	27.4
Travel & tourism economy employment	62.1	81.4	97.0	110.6	119.0
As % of total					
Personal travel & tourism	7.7	8.8	8.9	9.3	9.9
Business travel	—	—	—	—	—
Government expenditures	4.1	4.2	4.3	4.3	4.4
Capital investments	18.4	20.6	20.8	20.9	21.2
Visitor exports	6.5	5.9	5.0	4.3	3.5
Other exports	6.6	6.4	6.0	5.7	5.2
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	2.5	2.6	2.4	2.1	1.6
Travel & tourism economy GDP	11.8	12.8	11.7	10.9	8.5
Travel & tourism industry employment	2.8	2.9	2.7	2.5	2.0
Travel & tourism economy employment	11.1	11.9	11.4	10.7	8.6

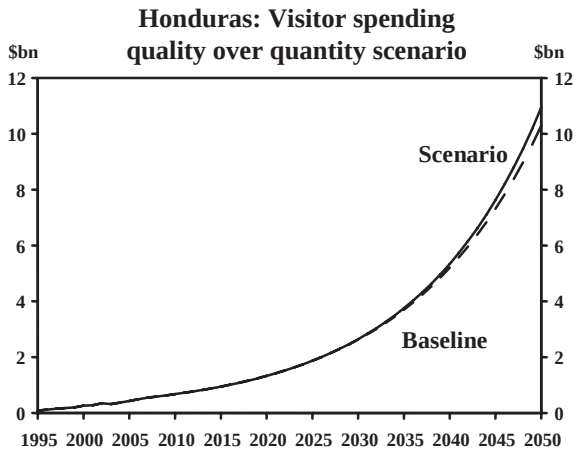
HONDURAS

The focus on quality…

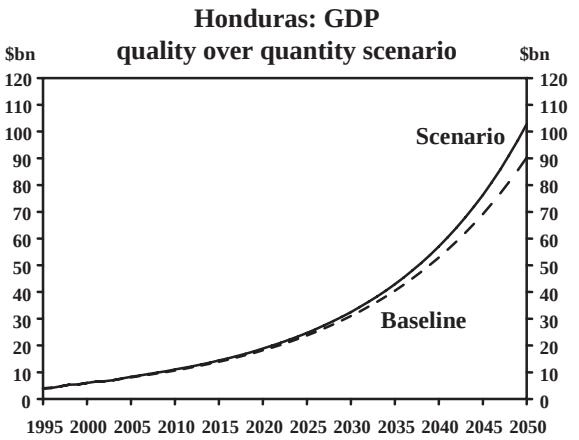
- While there is plenty of scope to develop high-value niche tourism along the extensive Caribbean coastline of Honduras, the lack of infrastructure presents obstacles, and activity is initially further hindered by restructuring in the tourism sector. In addition, foreign tourism companies trim capital spending as government policy begins to favour development of local enterprises. Even so, by 2015 the economic impact is only mildly negative, travel and tourism investment is down just 3% relative to baseline, and travel and tourism GDP is broadly unchanged as higher government spending (relative to baseline) manages to cushion the impact in the sector.
- Despite the restrictions on visitor numbers towards the end of the decade, by 2015 the impact on visitor spending is pretty muted, since quality tourism is able to generate higher revenues per head. Visitor exports are only down to U.S. $942 million. And as a share of total exports visitor spending declines by around 0.8% points. Employment in the travel and tourism sector is also slightly below base, but that partly reflects job opportunities created elsewhere.

…delivers higher sustainable growth

- By 2050, the travel and tourism economy is around 7% higher than base. Visitor spending rises to just above U.S. $10 million. At U.S. $11,846 million, travel and tourism GDP accounts for nearly 12% of the economy and generates an additional 43,000 jobs compared to the baseline.



SOURCE: OEF.



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.5092	1.0627	1.5234	2.2040	3.9261
Business travel	0.1374	0.2328	0.3831	0.6324	1.3414
Government expenditures	0.0441	0.0797	0.1412	0.2500	0.5890
Capital investments	0.1631	0.2133	0.3261	0.5017	0.9570
Visitor exports	0.4279	0.9420	1.8679	3.7487	10.9433
Other exports	0.0540	0.1380	0.3269	0.7762	2.8545
Travel & tourism demand	1.3357	2.6684	4.5687	8.1129	20.6112
Travel & tourism industry GDP	0.3082	0.6035	1.0876	1.9915	5.1723
Travel & tourism economy GDP	0.7280	1.3606	2.4438	4.4898	11.8457
Travel & tourism industry employment	81.4	127.0	177.3	249.5	429.4
Travel & tourism economy employment	193.2	287.8	401.8	570.5	1011.8
As % of total					
Personal travel & tourism	8.9	10.7	8.9	7.8	6.5
Business travel	—	—	—	—	—
Government expenditures	4.0	4.1	4.3	4.4	4.7
Capital investments	9.6	8.0	8.1	8.3	8.5
Visitor exports	12.5	12.1	9.7	7.9	5.9
Other exports	1.8	1.7	1.7	1.6	1.5
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.0	4.4	4.4	4.6	5.0
Travel & tourism economy GDP	9.5	10.0	9.9	10.5	11.5
Travel & tourism industry employment	3.1	3.5	3.5	3.6	3.7
Travel & tourism economy employment	7.5	8.0	8.0	8.3	8.7

Scenario 3. Diversify Together

This scenario outlines a possible upside for the Caribbean region, with clear benefits for the population in the form of improved living standards towards the end of the forecast horizon. One of the key themes is a co-ordinated move throughout the whole region to diversify the economy. So travel and tourism plays a slightly lesser role by 2050.

Key points:

- Increase in trade within region (not necessarily outside).
- Regional co-operation.
- More growth in agriculture.
- Greater spending on infrastructure.
- Better exploitation of fish stocks.
- Strong population growth as opportunity increases—including the return of people who emigrated previously.
- Better standard of living—more higher-paid jobs.

Inputs for travel and tourism modelling:

- Increased exports. The pattern reflects a move away from both tourism and goods. Services—including some in more high-tech fields—are developed.
- This is reflected in an increase in investment spending. Again this is consistent with a move of the economy into more high value-added areas.
- Although the benefits take a long time to emerge, eventually incomes and hence spending reflect the move 'up-market.'
- It is assumed that population growth can be increased to head off any pressure on wages and prices from a more buoyant labour market. Thus the scenario is consistent with higher, but stable and sustainable, growth.

CARIBBEAN

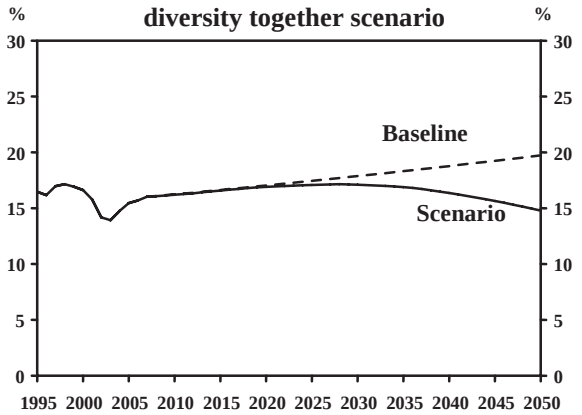
Increased co-operation…

- The key driver in this scenario is an expansion of trade, both within and outside the region. Underlying this story is move away from the production of more basic commodities and manufactures, towards the service sector. Non-tourism-related exports of services start to pick up from 2007 onwards, achieving growth rates around 8½% pa for the first decade, with this growth gradually picking up to 11% pa by around 2035. With imports of services also improving, the overall impact on GDP is offset somewhat.
- But with diversification comes investment. Underlying the results is a move towards more high-tech, high value-added activities and this means a large rise in the capital stock. With output expanding, firms take on more workers, with employment growth around 1% point above baseline in 2020–2030 and 2½% points higher in 2040–2050. This places some strain on the labour market, threatening to push up wages. But this in itself, along with the opening up of greater opportunities, means workers start to return to the Caribbean from overseas.

…and less reliance on tourism

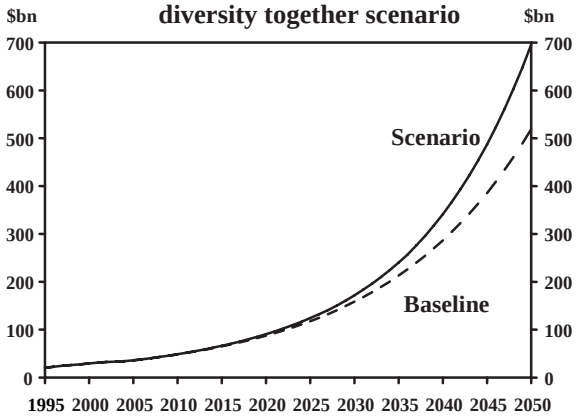
Although tourism continues to grow, it does less so than the economy as a whole, while overall GDP is some 70% higher by 2050.

Caribbean: Share of tourism in total GDP diversity together scenario



SOURCE: OEF.

Caribbean: Investment diversity together scenario



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2004	2015	2025	2035	2050
Personal travel & tourism	8.0	17.0	32.1	61.9	168.4
Business travel	1.3	2.7	5.0	9.5	25.5
Government expenditures	1.9	4.0	7.9	17.0	61.9
Capital investments	7.4	14.7	27.3	51.3	135.0
Visitor exports	19.0	44.2	89.7	186.9	571.0
Other exports	2.7	6.0	12.3	25.8	79.2
Travel & tourism demand	40.3	88.6	174.4	352.5	1040.9
Travel & tourism industry GDP	8.7	20.0	40.3	83.4	254.8
Travel & tourism economy GDP	28.4	63.5	125.9	256.4	770.1
Travel & tourism industry employment	814.5	1143.6	1555.0	2181.7	3738.2
Travel & tourism economy employment	2416.5	3312.5	4440.4	6124.6	10280.6
As % of total					
Personal travel & tourism	6.5	7.3	7.4	7.4	7.1
Business travel	—	—	—	—	—
Government expenditures	8.2	8.8	9.1	9.5	10.1
Capital investments	21.7	22.2	22.0	21.4	19.4
Visitor exports	16.1	15.9	13.8	11.3	8.0
Other exports	2.3	2.1	1.9	1.6	1.1
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.5	5.2	5.5	5.5	4.9
Travel & tourism economy GDP	14.8	16.6	17.1	16.9	14.8
Travel & tourism industry employment	5.2	5.9	6.4	6.6	6.1
Travel & tourism economy employment	15.5	17.1	18.2	18.5	16.9

TRINIDAD AND TOBAGO

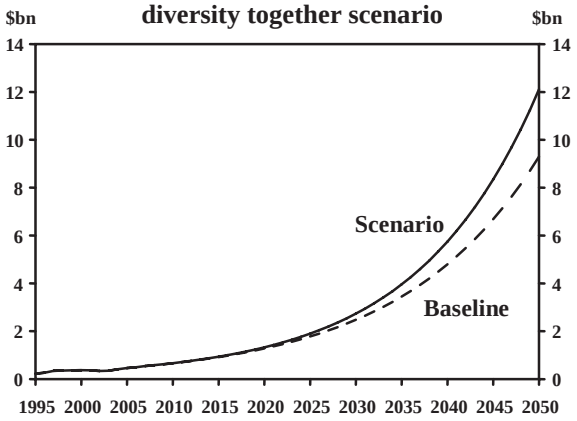
Less tourism…

- With less initial reliance on tourism than the region as a whole, Trinidad and Tobago would seem to be in an advantageous position given the chance to diversify the regional economy. This reflects its advantages in natural gas and petroleum. And as one of the most prosperous economies in the region—giving it a good starting point—the story outlined here assumes Trinidad and Tobago is able to benefit more than most in the region, although of course greater co-operation brings improvements to all.
- Initially, investment is centred on the oil industry, and then, as this runs out, the gas industry, which is assumed to be viable for several decades yet. By 2030, GDP growth is some 2.5% pa above the baseline projection of 5.7% per annum. Eventually, the economy reaches an almost virtuous circle—increased investment means more labour is required, and the creation of more high-value jobs stimulates consumer spending, which grows 1% pa faster by 2040–2050.

…but more wealth

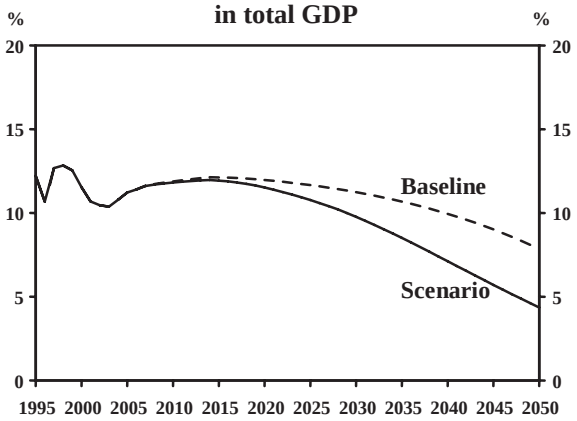
- There is a potential that this could bring problems. Our scenario assumes the increased demand for labour can successfully be met through a reduction in the unemployment rate (from around 10%), an increase in labour-force participation, and a reversal of the current trend of emigration. If these problems can be managed, then GDP per head in nominal terms could be around twice as high as would be the case under the baseline scenario.

Trinidad & Tobago: Visitor spending diversity together scenario



SOURCE: OEF.

Trinidad & Tobago: Share of tourism in total GDP



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.483	0.903	1.686	3.225	8.748
Business travel	0.122	0.209	0.359	0.628	1.510
Government expenditures	0.050	0.088	0.163	0.322	1.048
Capital investments	0.435	0.817	1.424	2.505	5.975
Visitor exports	0.459	0.935	1.898	3.959	12.108
Other exports	0.454	1.019	2.261	5.109	17.520
Travel & tourism demand	2.003	3.971	7.791	15.748	46.909
Travel & tourism industry GDP	0.270	0.466	0.777	1.266	2.331
Travel & tourism economy GDP	1.251	2.267	3.878	6.501	12.563
Travel & tourism industry employment	15.5	19.8	24.0	28.4	33.7
Travel & tourism economy employment	62.1	82.8	101.4	121.4	145.0
As % of total					
Personal travel & tourism	7.7	8.8	8.9	9.4	9.8
Business travel	—	—	—	—	—
Government expenditures	4.1	4.2	4.3	4.3	4.4
Capital investments	18.4	20.7	20.2	19.2	16.8
Visitor exports	6.5	5.7	4.3	3.2	1.9
Other exports	6.6	6.2	5.2	4.1	2.7
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	2.5	2.6	2.2	1.7	0.8
Travel & tourism economy GDP	11.8	12.6	10.8	8.5	4.3
Travel & tourism industry employment	2.8	2.8	25	1.9	1.0
Travel & tourism economy employment	11.1	11.8	10.5	8.3	4.4

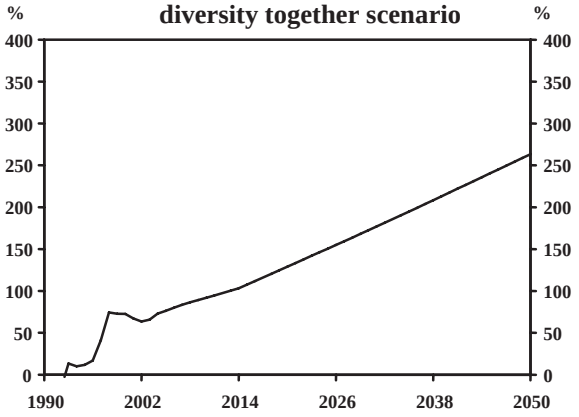
HONDURAS

A way out of poverty?

- As one of the poorest countries in the western hemisphere (ranked 144 in the world on GDP per head by the World Bank's Development Indicators), Honduras has much to gain from a more diversified economy. The natural resource base is limited; there is basic agriculture produce such as bananas and coffee, and some minerals and basic metals extraction. But it lacks the value added created by intermediate manufacturing and low-level processing.
- In this scenario there is a gradual shift away from basic commodities facilitated by a pick-up in investment. That itself is biased away from the tourism sector. By 2015, non-tourism capital spending is 3% above baseline, and the travel and tourism sectors' share of investment is down slightly. The carefully co-ordinated approach within the Caribbean region also boosts bilateral trade flows. Honduran total exports are 12% higher relative to base, but tourism's share declines by around 1% point relative to baseline.

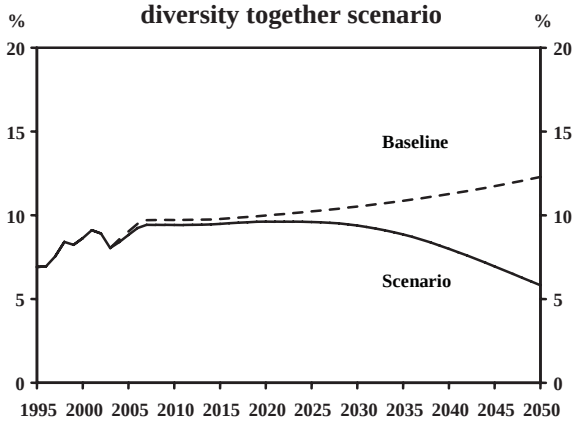
The output gains are sustained: whole economy GDP more than doubles by 2050 and total employment rises to around 28.5 million by 2050. Additional labour demand is met by lowering unemployment (some 30% of the work force), increased participation, and (net) inward migration as the Caribbean region attracts workers from overseas.

Honduras: Travel and tourism investment (cumulative growth) diversity together scenario



SOURCE: OEF.

Honduras: Share of tourism in total GDP diversity together scenario



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.509	1.074	1.585	2.409	4.629
Business travel	0.137	0.236	0.394	0.670	1.550
Government expenditures	0.044	0.080	0.150	0.302	0.997
Capital investments	0.163	0.222	0.338	0.521	1.018
Visitor exports	0.428	0.961	1.992	4.243	13.392
Other exports	0.054	0.140	0.341	0.847	3.352
Travel & tourism demand	1.336	2.713	4.801	8.991	24.938
Travel & tourism industry GDP	0.308	0.611	1.141	2.212	6.302
Travel & tourism economy GDP	0.728	1.382	2.562	4.972	14.440
Travel & tourism industry employment	81.4	128.7	186.5	279.6	536.3
Travel & tourism economy employment	193.2	292.5	422.3	637.0	1262.7
As % of total					
Personal travel & tourism	8.9	10.8	9.1	7.9	6.3
Business travel	—	—	—	—	—
Government expenditures	4.0	4.1	4.3	4.5	4.7
Capital investments	9.6	8.1	7.9	7.5	6.6
Visitor exports	12.5	11.7	8.5	5.9	3.2
Other exports	1.8	1.7	1.5	1.2	0.8
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.0	4.4	4.3	3.9	2.5
Travel & tourism economy GDP	9.5	10.0	9.6	8.8	5.8
Travel & tourism industry employment	3.1	3.5	3.4	3.1	1.9
Travel & tourism economy employment	7.5	8.0	7.7	7.0	4.4

Scenario 4. Growing Asymmetries

Towards the end of this decade, the FTAA is agreed. But no special concessions are given to the smaller countries, and the U.S. remains the key driving force in the regional economy. The agreement allows for the free movement of goods and capital, but not labour. There are winners and losers in the region, depending on who can attract capital and who is restricted to more traditional activities.

Key points:

- Asymmetries increase over the projection horizon.
- Energy producers are amongst the winners.
- Amongst the losers, low-value raw materials are produced and natural resources are degraded.
- The FTAA boosts inward investment from 2010.
- The manufacturing sector grows faster.
- Employment growth lowers the number of (very) poor people.
- Tourism continues but relative importance declines.
- All-inclusive packages dominate—so little local benefit.
- Competition for FDI keeps wages low, and it is not long before the strong presence of foreign capital leads to local resentment.
- By 2050, the region is a diverse patchwork of nations. Foreign capital exploits local resources. There is low-value mass tourism supporting low-wage jobs.

Inputs for travel and tourism modelling:

- Both export and import growth head higher after the agreement is signed.
- There is also a surge in Foreign Direct Investment.
- There is little diversification. Low-value tourism still holds sway.
- The corporate sector tends to be the winner—it can capture most of the gains.
- Although employment rises, it is assumed firms hold wages down—consumer spending is almost unaffected, falling slightly as a proportion of overall economic activity.

CARIBBEAN

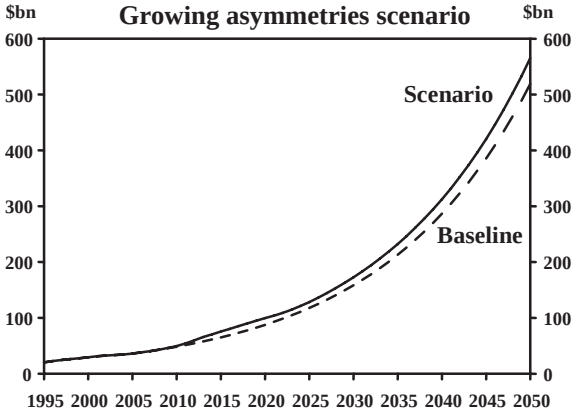
More trade…

- The formation of the FTAA in 2010 brings quick benefits through increased trade. Export growth in non-tourism-related goods moves briefly above 10% at the start of the next decade and stays permanently higher than in the baseline scenario. And there is a similar surge in import growth. The opening up of capital markets is also reflected in a surge in FDI, with growth in overall investment heading above 10 per cent.
- This brings clear, but modest, gains in terms of GDP growth, without any significant move away from the traditional structure of the economy. In fact, for the regional economy as a whole, the importance of travel and tourism is slightly greater in the middle years of the scenario, reflecting in part more spending on travel by corporations.

…but little diversification

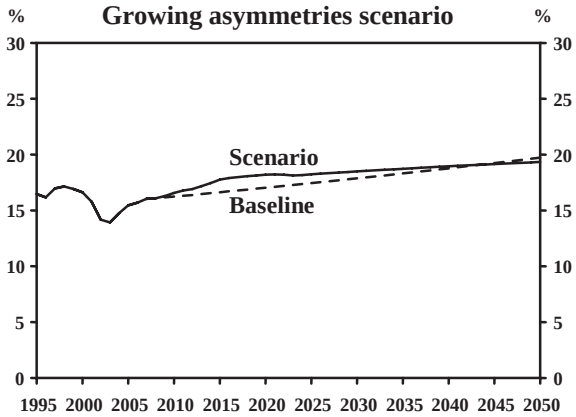
- By the final years, the freeing of markets and increase in investment (which of course is the key to faster potential growth) means there are modest increases in living standards measured in nominal GDP per head. This is some 17% higher than in the baseline scenario. But this is a corporate success rather than a personal one. Consumer spending is actually slightly lower than in the baseline, reflecting the fact that there has been no real move into high valued-added areas, which would bring higher wages. In fact tourism plays much the same role by the end of the scenario as it does had no trade agreement been signed.

Caribbean Investment
Growing asymmetries scenario



SOURCE: OEF.

Caribbean: Share of tourism in total GDP
Growing asymmetries scenario



SOURCE: OEF.

Summary Table					
In U.S. $ billion and 000s	**2004**	**2015**	**2025**	**2035**	**2050**
Personal travel & tourism	8.0	16.9	30.4	54.8	132.8
Business travel	1.3	2.9	5.1	9.3	22.5
Government expenditures	1.9	4.1	7.9	15.0	39.7
Capital investments	7.4	15.4	27.8	51.2	128.1
Visitor exports	19.0	52.2	99.8	193.2	520.3
Other exports	2.7	6.0	12.2	24.5	70.2
Travel & tourism demand	40.3	97.6	183.2	348.1	913.7
Travel & tourism industry GDP	8.7	23.6	44.8	86.4	231.5
Travel & tourism economy GDP	28.4	72.6	136.8	261.6	692.9
Travel & tourism industry employment	814.5	1352.4	1730.2	2249.8	3344.8
Travel & tourism economy employment	2416.5	3828.0	4855.6	6247.7	9131.6
As % of total					
Personal travel & tourism	6.5	7.2	7.1	7.1	7.1
Business travel	—	—	—	—	—
Government expenditures	8.2	9.0	9.4	9.8	10.5
Capital investments	21.7	20.4	21.7	22.1	22.7
Visitor exports	16.1	18.0	16.7	15.6	14.0
Other exports	2.3	2.1	2.0	2.0	1.9
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.5	5.8	6.0	6.2	6.5
Travel & tourism economy GDP	14.8	17.8	18.2	18.7	19.3
Travel & tourism industry employment	5.2	6.5	7.0	7.4	8.1
Travel & tourism economy employment	15.5	18.5	19.6	20.6	22.2

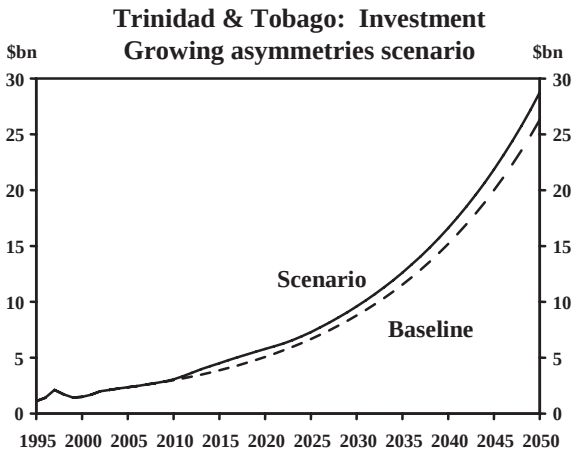
TRINIDAD AND TOBAGO

Inward investment surges…

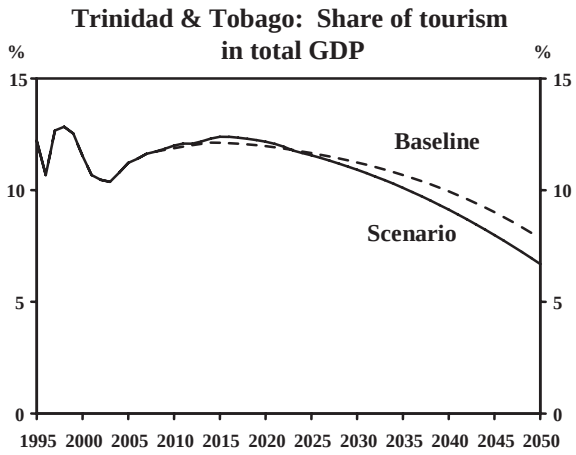
- The creation of the FTAA stimulates goods and capital movements. Compared to the fortunes of other Caribbean island states, Trinidad and Tobago is a winner as it is well endowed with oil and natural gas resources—some 40% of GDP is generated by production in the energy sector. By 2015 whole economy GDP is up by 10% relative to the baseline scenario, fixed capital investment is around 17% higher while exports are up 8 per cent.
- The sustained rise in GDP—up 40% relative to baseline by 2050—is driven by booming investment and exports, though we doubt the reliance on energy is ultimately sustainable. Tourism also benefits. Travel and tourism GDP is 20% higher by 2050, but weaker relative growth means it loses out somewhat thanks to the energy-sector boom. Both the travel and tourism share of investment and GDP are below baseline by 2050.

…but consumers lose out

The lack of diversification generates fewer opportunities in the poorly paid manufacturing and agriculture sectors. And while the persistence of low-value tourism boosts travel and tourism employment to 134,500 by 2050, intense competition for inward foreign direct investment keeps local wages down. As a result incomes are depressed and by 2050 consumers expenditure (and local spending on tourism) is down around 3% relative to baseline.



SOURCE: OEF.



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.4826	0.9014	1.6122	2.9055	7.0540
Business travel	0.1222	0.2226	0.3653	0.6124	1.3293
Government expenditures	0.0504	0.0912	0.1612	0.2849	0.6696
Capital investments	0.4351	0.8573	1.4515	2.5024	5.6665
Visitor exports	0.4591	1.1046	2.1117	4.0912	11.0327
Other exports	0.4538	1.0303	2.2374	4.8588	15.5491
Travel & tourism demand	2.0032	4.2072	7.9393	15.2552	41.3012
Travel & tourism industry GDP	0.2696	0.5389	0.8619	1.3406	2.2124
Travel & tourism economy GDP	1.2514	2.5076	4.1503	6.7043	11.8429
Travel & tourism industry employment	15.5	23.0	26.6	29.9	31.5
Travel & tourism economy employment	62.1	92.4	109.0	125.1	134.5
As % of total					
Personal travel & tourism	7.7	8.7	8.8	9.2	9.9
Business travel	—	—	—	—	—
Government expenditures	4.1	4.3	4.4	4.5	4.6
Capital investments	18.4	19.1	19.9	19.8	19.7
Visitor exports	6.5	6.5	5.3	4.4	3.3
Other exports	6.6	6.1	5.7	5.3	4.7
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	2.5	2.8	2.4	2.0	1.3
Travel & tourism economy GDP	11.8	13.2	11.6	10.1	6.7
Travel & tourism industry employment	2.8	3.1	2.8	2.4	1.6
Travel & tourism economy employment	11.1	12.3	11.3	9.9	6.8

HONDURAS

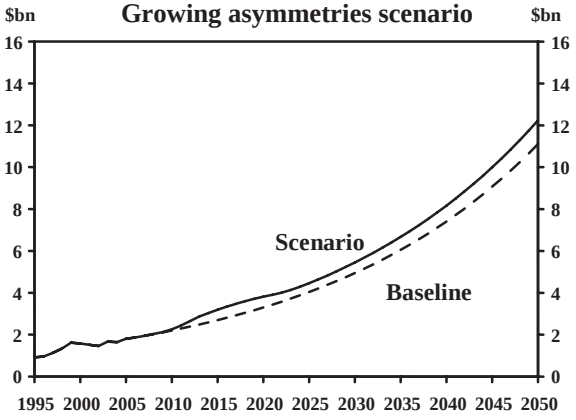
Trade and investment booms…

- The creation of the FTAA leads to an increase in inter-regional trade flows. Honduras' fortunes depend heavily on trade links with the U.S.—the destination for more than two-thirds of its exports. By 2010 total exports are 15% higher than baseline, but imports also surge during this period—a reflection of the lack of diversity in the domestic manufacturing base.
- Meanwhile improved market access and investor confidence trigger inward investment into both manufacturing and tourism. But there's little interest in the energy sector—it's too small to compete with likes of Trinidad and Tobago—the Caribbean's largest energy producer. By 2010 capital spending is 18% above baseline, but travel and tourism share of investment is down around 1% point compared to base. Visitor exports are 19% above baseline and travel and tourism GDP is 17% higher.

…but tourism eventually loses out

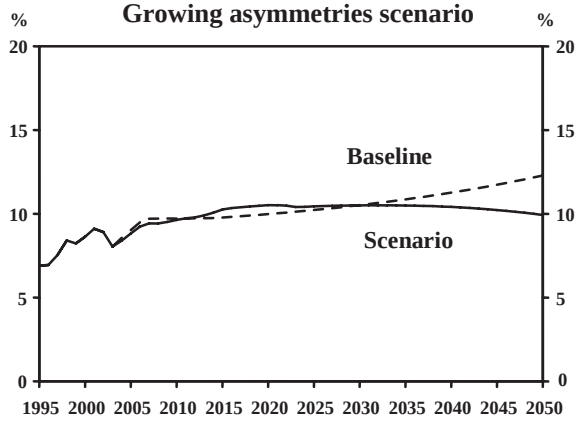
- The advent of mass tourism creates plenty of jobs—employment in the travel and tourism sector grows rapidly from below 200,000 in 2005 to more than a million by 2050. But wages are kept low by the need to attract foreign investment, hence the tourist industry does not benefit from extra spending by residents—consumer spending is 3% below baseline by 2050. The tourism sector is less dynamic than the rest of the economy. By 2050, the travel and tourism GDP share in total GDP is 2% points below that in the central projection.

Honduras: Investment
Growing asymmetries scenario



SOURCE: OEF.

Honduras: Share of tourism in total GDP
Growing asymmetries scenario



SOURCE: OEF.

Summary Table

In U.S. $ billion and 000s	2005	2015	2025	2035	2050
Personal travel & tourism	0.5092	1.0682	1.4986	2.1361	3.7112
Business travel	0.1374	0.2525	0.4008	0.6515	1.3503
Government expenditures	0.0441	0.0835	0.1492	0.2667	0.6374
Capital investments	0.1631	0.2331	0.3452	0.5208	0.9653
Visitor exports	0.4279	1.1344	2.2154	4.3842	12.2055
Other exports	0.0540	0.1412	0.3374	0.8063	2.9784
Travel & tourism demand	1.3357	2.9128	4.9466	8.7655	21.8481
Travel & tourism industry GDP	0.3082	0.7165	1.2707	2.3095	5.7468
Travel & tourism economy GDP	0.7280	1.5902	2.8108	5.1291	13.0439
Travel & tourism industry employment	81.4	151.1	207.8	291.0	482.2
Travel & tourism economy employment	193.2	336.9	463.2	654.6	1123.5
As % of total					
Personal travel & tourism	8.9	10.6	8.8	7.7	6.5
Business travel	—	—	—	—	—
Government expenditures	4.0	4.2	4.4	4.6	4.9
Capital investments	9.6	7.4	7.8	7.8	7.9
Visitor exports	12.5	13.1	10.4	8.2	5.7
Other exports	1.8	1.6	1.6	1.5	1.4
Travel & tourism demand	—	—	—	—	—
Travel & tourism industry GDP	4.0	4.9	4.7	4.7	4.4
Travel & tourism economy GDP	9.5	10.9	10.4	10.5	9.9
Travel & tourism industry employment	3.1	3.9	3.8	3.7	3.2
Travel & tourism economy employment	7.5	8.7	8.4	8.3	7.6

ANNEX 3a. Existing Programmes Linked to Management of the Caribbean Sea Ecosystem

Inter-governmental Programmes

The Global Programme of Action (GPA) — Land Based Sources, 1995 is a non-binding action plan adopted by 108 governments and the European Union in response to the recognition that about 80% of all marine pollution originates on land. It aims to prevent degradation of the marine environment from land-based sources of pollution; advocates an integrated policy approach to the multi-sectoral challenges to coastal and marine degradation; and provides for addressing the interface between land, freshwater, and coast and ocean. It is particularly relevant to Wider Caribbean states insofar as threats to sources of income (e.g., fishing and tourism) through degradation to traditional lifestyles, food security, and public health are bases for action under the GPA at the national level. The GPA also envisages regional and subregional co-operation since countries of semi-enclosed seas share marine and coastal areas.

Caribbean Monitoring and Management Programme (CARICOMP) for monitoring and management of coral reefs, mangrove swamps, and seagrass beds in the Caribbean. It was developed from the 35-year-old Association of Marine Laboratories of the Caribbean (AMLC), and to date 29 sites in 22 countries and territories of the Wider Caribbean have joined this network.

Caribbean Environmental Health Institute (CEHI) was initiated by Caribbean Community states in 1986 to monitor the coastal waters for pathogens that could be detrimental to human and environmental health.

[47]A. R. Carnegie. Caribbean Sea Proposal Consultancy Report.

CARICOM Fisheries Resource Assessment and Management Programme (CFRAMP) was designed to provide a scientific assessment of the fisheries of the Caribbean Community states, as a step towards implementation of the Straddling Stocks Agreement and the FAO Compliance Agreement. This programme contributed significantly to improvement of fisheries management capacity in the CARICOM subregion, provided improved knowledge of the state of stocks, and demonstrated the need for, and feasibility of, a regional fisheries mechanism. This has led to the establishment by CARICOM of a CRFM to assist the CARICOM countries in the management of their fisheries and aquaculture resources, in collaboration with stakeholders.

Marine Protected Areas: The adoption in 1990 of the Protocol to the Cartagena Convention for SPAW provided the basis for an extensive protected areas programme in the Wider Caribbean. Activities include:

- Promotion of best practices and training for sustainable coastal tourism
- Coral-reef monitoring, management, and conservation
- Strengthening of protected areas through technical assistance and a training programme for trainers
- Development of a regional network of Caribbean Marine Protected Area Management (CaMPAM)
- Development and implementation of guidelines and recovery plans for species conservation
- Development and implementation of guidelines for establishment and management of protected areas and reserve generation.

By 1996, UNEP had identified 324 protected areas in the Wider Caribbean region containing coastal or marine components. However, only 15% were considered to have complete protection, 51% were considered to have partial protection, and 32% were deemed to be unprotected.

Regional Seas Programme

The Regional Seas Programme was launched in 1974 in the wake of the 1972 United Nations Conference on the Human Environment held in Stockholm. It aims to address the accelerating degradation of the world's oceans and coastal areas through the sustainable management and use of the marine and coastal environment, by engaging neighbouring countries in comprehensive and specific actions to protect their shared marine environment. The Wider Caribbean is one of 13 seas participating in the programme, which involves more than 140 countries.

Corporate, NGO, and Community-based Programmes

These three sectors are actively involved in programmes and projects that seek to contribute to better management of the Caribbean Sea and its resources. Some operate at subregional levels, but most of their activities take place at the national level. Two examples of regional organizations representing the corporate and civic constituencies, respectively, have already been noted (CTO and Caribbean Conservation Association). They make valuable contributions not only to their own membership, but also to public awareness and education, consciousness-raising, involvement of a range of stakeholders in taking responsibility for action, and to good practice.

An outstanding example of community management of mangrove forests was initiated in the late 1980s in several states of the Eastern Caribbean by a not-for-profit NGO, Caribbean Natural Resources Institute (CANARI). The objectives were to teach communities dependent on this resource about its ecology, and to build their capacity to manage the resource sustainably. Results were quite impressive: for example, in St. Lucia the Mankote mangrove had been traditionally used as a source of wood for charcoal production, but over-harvesting as well as the declaration of the island mangroves as Marine Reserve Areas led to scarcity of this resource. The CANARI project worked with communities to develop a fuel-wood reforestation project using *Leucaena* sp. as an alternative.

Another example of good practice relates to the white-spined sea urchin (*Tripneustes ventricosus*) which is harvested in the Caribbean for its edible roe. The demand for the delicacy has led to severe over-harvesting especially in St. Lucia, Barbados, the Tobago Cays, Martinique, and Guadeloupe. In 1990 the Government of St. Lucia introduced a co-management arrangement of the fishery with community groups. These groups are licensed for the harvesting season, in return for their observing minimum size limits and restrictions on harvest location.

ANNEX 3b: International Legal Instruments Affecting Management of the Caribbean Sea

A recent review (Carnegie 2003)[47] of treaty law to which Wider Caribbean states subscribe in principle provides the most structured and up-to-date analysis of the legal framework that may be said to apply collectively to the Caribbean Sea, even though many of the states do not

yet formally adhere to, or reflect, these treaties in their national legislation. The review covers a wide range of legal instruments that relate to the issues emerging in this assessment relating to the condition and trends of the ecosystem services of the Caribbean Sea. These legal instruments have originated at the global level (e.g., UNCLOS, Biological Diversity, and Climate Change), as well as within the Wider Caribbean [e.g., the Cartagena Convention, its Protocols on Specially Protected Areas and Wildlife and on Land-based Sources of Pollution (LBS)]. The instruments surveyed in the review are too many to reflect and describe in this summary, and only the major ones of direct relevance are presented below.

United Nations Convention on the Law of the Sea (UNCLOS), 1982: This Convention recognizes that the problems of ocean space are closely interrelated and need to be considered as a whole. It sets out rights and obligations of states for the management of oceans and seas such as the Caribbean. States bordering such a sea are required to co-operate with each other in the exercise of their rights and in the performance of their obligations under the Convention. Most Wider Caribbean states have become Parties to the United Nations Convention on the Law of the Sea. They are therefore entitled to claims of up to twelve (12) miles as their territorial sea, two hundred (200) miles of EEZ, and two hundred (200) miles or more of continental shelf. However, Caribbean states have not applied this Convention to forge the regional co-operation that is essential for management of the Caribbean Sea, and conflicts between them (e.g., Trinidad and Tobago and Barbados; Trinidad and Tobago and Venezuela) on the exploitation of Caribbean marine resources continue.

Agreement relating to the Conservation and Management of Straddling Stocks and Highly Migratory Species, 1995: To date, this agreement for the implementation of UNCLOS has been ratified or acceded to by only four states of the Wider Caribbean. Similarly, the ***FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, 1993*** has been ratified by only four Wider Caribbean states. Adherence to these agreements is the first formal step required to benefit from their provisions and possibilities.

International Convention for the Prevention of Pollution from Ships 1973 as amended by the Protocol of 1978 relating thereto (MARPOL 73/78), in which the Caribbean Sea was designated as a 'Special Area' with respect to Annex V of the Convention which deals with garbage. Countries of the Wider Caribbean are required to put the necessary legislation in place for implementing the Convention, as well as the necessary reception facilities for receiving the waste which ships using the Caribbean Sea discharge. While a number of the states have become parties to MARPOL 73/78 including Annex V, they have not been able to benefit from the Special Area status as they have not yet met the requirements of the Convention to introduce the necessary legislation and reception facilities.

Achieving the objectives outlined under MARPOL 73/78 Annex V will take care of problems of garbage from vessels. It does not, however, cover the problems of oil and sewage pollution, and noxious liquid substances. These problems are covered in annexes I, II and IV, but the Caribbean Sea has not so far been designated a special area under these annexes. Even if the Caribbean Sea were to be so designated with respect to sewage under Annex IV, this will not cover land-based sources, which are by far the more significant contributor to marine pollution. MARPOL 73/78 is predicated on the existence of adequate arrangements for land-based sources of pollution.

Protocol on Land-based Sources of Pollution (LBS 1999) to the Convention for the Protection and Development of the Marine Environment for the Wider Caribbean (Cartagena Convention) represents the response of the Wider Caribbean for dealing with pollution from land-based sources. The Protocol contains two technical annexes on domestic sewage and agricultural non-point sources of pollution. However, since its adoption in 1999 only two countries have ratified. The Protocol requires ratification or accession by nine States to come into force. Annex III on Sewage requires Parties to meet certain effluent limitation standards. Two Regional Activity Centres (RACs) in Cuba and Trinidad and Tobago, located within pre-existing organizations, have recently been named to assist in the development and implementation of projects under this Protocol, and have already conducted exercises in effluent limitation, but Regional Activity Networks to assist the RACs have not yet been established. National Programmes of Action have also not been developed.

United Nations Framework Convention on Climate Change, 1992: All Wider Caribbean states are Parties to this Convention, no doubt due to recognition that islands and low-lying coastal countries are particularly vulnerable to global climate change, climate variability, and sea-level rise. Twelve of them which comprise the Caribbean Community subregion have taken programmatic steps to manage adaptation to the anticipated effects of climate change, by setting up the Caribbean Community Climate Change Centre (CCCCC).

United Nations Convention on Biological Diversity, 1992: Most Wider Caribbean States are Parties to this

Convention. But despite the fact that marine and coastal biological resources are important to their tourism industry, not many National Biodiversity Strategy and Action Plans have been developed or implemented.

Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal, 1989: A number of Wider Caribbean states have ratified or acceded to this Convention, though they have not enacted the legislation or made the regulations which are necessary for implementation.

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