The European Union's European Development Fund Programme

"STRATEGIC ENVIRONMENTAL ASSESSMENT OF THE SEA DEFENCES SECTOR POLICY IN GUYANA"

Letter of Contract N° 2008/150593

FINAL REPORT

Authors:

David Lees
François Marie Joseph Wernerus
Murray Charles Simpson

July 2009

The project is financed by the European Union

The project is implemented by IBF International Consulting

"The contents of this publication are the sole responsibility of the contractor and can in no way be taken to reflect the views of the European Union."

Table of Contents

1 EXECUTIVE SUMMARY 12
1.1 Background 12
1.2 Sea Defence Sector Policy Framework 12
1.3 Strategic Environmental Assessment 12
1.4 Key Issues 12
1.5 Analysis of Policy Framework 13
1.5.1 Research and Data Collection 13
1.5.2 Indicators 13
1.5.3 Warning Systems 13
1.5.4 Priorities 14
1.6 Recommendations for Sector Policy Support Program Formulation 15
1.6.1 Legislative Framework 15
1.6.2 Administrative Boundaries 15
1.6.3 Land Tenure Consolidation 16
1.6.4 Combine Other Sector Policies 16
1.6.5 Budget Support 16
1.6.6 Knowledge base 16
1.6.7 Integrating Stakeholders Concerns 17
1.6.8 Mainstream Climate Change Issues 17
1.6.9 Economic Exit Strategy 17
1.7 Institutions 18
1.7.1 Sea Defence Board 18
1.7.2 Sea and River Defence Division 18
1.7.3 Regional and Neighbourhood Democratic Councils 19
1.7.4 Link with S&RDD and NDIA 19
1.7.5 Link with Hydromet 19
1.7.6 Link with Civil Defence Commission 19
1.7.7 Link with the GFC 19
1.7.8 Link with NCC and NCU 19
1.7.9 Link with EPA and other Agencies 19
1.8 Sea Defences 19
1.8.1 Alternatives 19
1.8.2 Mangroves 20
1.8.3 Inland Watersheds 20
1.9 Conclusion 20
2 Scope of the SEA 21
2.1 Background 21
2.2 Sea Defence Programs 21
2.3 EDF Support 21
2.4 Objective of the SEA 22
3 Background 24
3.1 Sector Programme Justification and Purpose 24
3.2 Main Components of Existing Sea and River Defences 25
3.2.1 The “Three Pillars” 25
3.2.2 Priorities 25
3.2.3 Sea and River Defences 25
3.2.4 Drainage and Irrigation 27
3.2.5 Water Conservancies 28
3.2.6 Sea Defences Programs 29
3.2.7 Drainage and Irrigation Programs 29
3.2.8 Conservancy Programs 29

3.3 Environmental Policy, Legislative and Planning Framework 30
3.3.1 Environmental Policy and Plans 30
3.3.1.1 National Development Strategy 30
3.3.1.2 National Climate Change Policy 30
3.3.1.3 Integrated Coastal Zone Management Action Plan 30
3.3.1.4 National Mangrove Management Action Plan 31
3.3.2 Legislative Framework 31
3.3.3 Planning Institutions 32
3.3.3.1 Ministry of Public Works and Communications (MPW&C) 32
3.3.3.2 Ministry of Agriculture (MoA) 33
3.3.3.3 Environmental Protection Agency (EPA) 35
3.3.3.4 Land and Survey Commission (LSC) 36
3.3.3.5 Guyana Forestry Commission (GFC) 36
3.3.3.6 Central Housing and Planning Authority (CHPA) 36
3.3.3.7 Guyana Geology and Mines Commission (GGMC) 36
3.3.3.8 Civil Defence Commission 36
3.3.3.9 Office of the President 36
4 Approach and Methodology 37
4.1 General Approach 37
4.1.1 Scoping Phase 37
4.1.2 SEA Phase 37
4.1.3 The Severity Matrix 38
4.1.4 PSR - Framework 38
4.1.5 Stakeholder Engagement 38
4.2 Geographical or Environmental Mapping Units 39
4.2.1 The Coastal Zone 39
4.2.2 The Major Geographical Units 39
4.3 Assumptions, Uncertainties, Opportunities and Constraints 40
4.3.1 Timing of Sector Policy 40
4.3.2 Available Data Coverage 40
4.3.3 Data Needs 41
5 Environmental Baseline Study 42
5.1 General Climate 42
5.2 Rainfall 42
5.3 Wind 42
5.4 Watersheds 43
5.5 Coastal Currents 45
5.6 Wave Patterns 45
5.7 Sedimentation 45
5.8 Sea Level Rise 46
5.9 Biodiversity 46
5.10 Marine Environment 47
5.11 Mangrove Habitats 49
6 Projection of Environmental Trends 53
6.1 Rainfall 53
6.2 Coastal Erosion 53
6.3 Saltwater Intrusion 53
6.4 Soil Salinity 53
6.5 Coastal ecosystems degradation 53
6.6 Agricultural Stress 54
6.7 Forestry 54
6.8 Vector- and water-borne diseases 55
6.9 Extreme Events 55
6.10 Sea Level Rise 55
6.11 Land Development 55
6.12 Modelled Trends 55

7 Draft Sector Policy Framework 57
7.1 Description of the Draft Sector Policy Framework 57
7.2 Sector Institutional Needs Assessment 57
8 Impact Identification and Evaluation 59
8.1 Key stakeholder concerns 59
8.1.1 Legal Issues 59
8.1.2 Institutional Issues 59
8.1.3 Ecological Issues 59
8.1.4 Social Issues 60
8.1.5 Economic Issues 60
8.1.6 Long-term Sustainability 61
8.2 Impacts of Sea Defences on the Environment 61
8.2.1 Sediment budget 61
8.2.2 Water Balance 61
8.2.3 Mangroves 62
8.2.4 Biodiversity 62
8.2.5 Fisheries 62
8.2.6 Public Health 63
8.2.7 National Economy 63
8.2.8 Sea Defences Impact Severity Matrix 63
8.3 Impacts of the Environment on Sea Defences 64
8.3.1 Nearshore hydrodynamics 64
8.3.2 Winds 64
8.3.3 Rainfall 65
8.3.4 Sea Level Rise 65
8.3.5 Saltwater Intrusion 65
8.3.6 Soil Salinity Increase 66
8.3.7 Coastal Erosion 66
8.3.8 Coastal Ecosystems Degradation 66
8.3.9 Changing Precipitation Levels 66
8.3.10 Extreme Events 67
8.3.11 Impact of Environment on Sea Defences Severity Matrix 67
8.4 Impacts of Draft Sector Policy Framework (i.e. policy analysis) 68
9 Analysis of Alternatives 69
9.1 Policy Timing Alternatives 69
9.2 Alternative Infrastructure Design 71
9.3 Alternative Maintenance Design 72
9.4 Alternative Development 73
10 Mitigation or Optimising Measures 74
10.1 Mitigation of impacts of the Sea Defences on the Environment 74
10.1.1 Sediment Budget 74
10.1.2 Water Balance 74
10.1.3 Mangroves 74
10.1.4 Biodiversity 74
10.1.5 Fisheries 74
10.1.6 Public Health 74
10.1.7 National Economy 74
10.2 Mitigation of impacts of the environment on the sea defences 75
10.2.1 Nearshore Hydrodynamics 75
10.2.2 Winds 75
10.2.3 Rainfall 75
10.2.4 Sea Level Rise 75
10.2.5 Saltwater Intrusion 75
10.2.6 Soil Salinity Increase 75
10.2.7 Coastal Erosion 76
10.2.8 Coastal Ecosystems Degradation 76

10.2.9 Changing Precipitation Levels 76
10.2.10 Extreme Events 76
10.2.11 Strategic Planning 77
10.2.12 No-regrets Options 77
11 Environmental PSR Indicators 78
11.1 Uncertainties 78
11.2 Performance Indicators 79
11.2.1 Verifying Indicators 79
11.2.2 Use of Lessons Learned 79
12 Capacities to Address Environmental Challenges 99
12.1 Legislative Framework 99
12.2 Institutional Capacity 99
12.2.1 Lack of Coordination 99
12.2.2 The Sea Defence Board 100
12.2.3 The Sea and River Defence Division 100
12.2.4 The Regional and Neighbourhood Democratic Councils 100
12.3 Linkages 100
12.3.1 S&RDD and NDIA 100
12.3.2 Hydromet 101
12.3.3 Civil Defence Commission 101
12.3.4 Guyana Forestry Commission 101
12.3.5 National Climate Committee 101
12.3.6 EPA and ICZM 101
12.4 Technical Capacity 102
12.5 Budgetary Capacity 102
12.6 Public Awareness 102
13 Conclusions and Recommendations 104
13.1 General 104
13.1.1 Recommendations on Institutions 106
13.2 Recommendations for Sector Policy Support Program Formulation 106
13.2.1 Legislative Framework 106
13.2.2 Administrative Boundaries 106
13.2.3 Land Tenure Consolidation 106
13.2.4 Combine Other Sector Policies 106
13.2.5 Budget Support 107
13.2.6 Knowledge Base 107
13.2.7 Mainstream Climate Change Issues 107
13.2.8 Integrating Stakeholders Concerns 108
13.2.9 Sea Defence Alternatives 108
13.2.10 Mangroves 108
13.2.11 Inland Watersheds 109
13.2.12 Sea Defence Board 109
13.2.13 Sea and River Defence Division 109
13.2.14 Regional and Neighbourhood Democratic Councils 110
13.2.15 Link with S&RDD and NDIA 110
13.2.16 Link with Hydromet 110
13.2.17 Link with Civil Defence Commission 110
13.2.18 Link with the GFC 110
13.2.19 Link with NCC and NCU 110
13.2.20 Link with EPA and other Agencies 111
13.2.21 Economic Exit Strategy 111
14 ANNEX 1 Legislation 112
14.1 The Sea Defence Act (CAP 64:01) 112
14.2 The Sea Defence Act (CAP 64:02) 112
14.2.1.1 The Drainage and Irrigation Act (CAP 64:03 and Act 10 of 2004) 112
14.2.1.2 The Environmental Protection Act (CAP 20:05) 112

14.2.1.3 The Land and Survey Commission Act (1999) 113
14.2.1.4 The Water and Sewerage Act (2002) 113
14.2.1.5 The Guyana Forestry Commission Act (CAP 67:01) 113
15 ANNEX 2 Stakeholders 114
15.1 Potential Stakeholders 114
15.2 Stakeholders Consulted 114
16 ANNEX 3 Actions under the Draft Sector Policy Framework 120
17 ANNEX 4 Impacts of Actions under Draft Sector Policy Framework on Sea Defences 124
18 ANNEX 5 Discussion on Indicators to be used in SEA and Policy Framework 133
19 ANNEX 6 Map The continuous mangrove belt of Guyana in 1787 138
20 ANNEX 7 Marine life survey data for Guyana (FAO 1988a) 139
21 ANNEX 8 List of Stakeholders consulted/engaged 140
22 ANNEX 9: Recommendations on Stakeholders Participation 145
23 ANNEX 10 Strategic Directives: Draft Regional Strategy for Climate Change in the Caribbean 147
24 ANNEX 11 Methodology 151
25 ANNEX 12: Consultants Work Plan and Itinerary 152
26 ANNEX 13 Consultants Itinerary (SEA Study) 153
27 ANNEX 14: List of Documentation cited and consulted 154
28 ANNEX 15: Curriculum Vitae of the Consultants 156
29 ANNEX 16: Terms of Reference for the SEA 160

List of Figures

Figure 3-1 Mixed sea defences....26
Figure 3-2 Mangroves and seawalls....26
Figure 3-3 Mixed defences....26
Figure 3-4 Foreshore Erosion....26
Figure 3-5 Sluice gate, mangroves and sea wall....27
Figure 3-6 Hope sluice gate and siphon (Demerara/Mahaica, Region 4)....28
Figure 3-7 The East Demerara Water Conservancy (Region 4)....30
Figure 4-1 The 8 Sea Defence Districts (CAP 64:02, VI)....40
Figure 5-1 Minimum and maximum average monthly temperature for Georgetown (Hydromet)....42
Figure 5-2 Average monthly rainfall for Georgetown (Hydromet)....42
Figure 5-3 The main rivers of the Guyana Basin (Administrative Map of Guyana)....43
Figure 5-4 The Essequibo River at approximately 150km from the coast....44
Figure 5-5 Surface water withdrawals by sector in Guyana in 1992 (WRI 2003c)....44
Figure 5-6 Amazon dominated sediment budget (after Augustinus, 1999)....45
Figure 5-7 The accretion/erosion cycle along the coast of Guyana (after Augustinus, 1999)....46
Figure 5-8 Ecological zones of Guyana (FAO/AGL)....46
Figure 5-9 The vegetation of Guyana (GFC, 2001)....47
Figure 5-10 Threatened species recorded in Guyana (WRI, 2003a)....47
Figure 5-11 Bathymetric map of Guyana....48
Figure 5-12 Seafront mangrove in West Demerara, Region 3....50
Figure 5-13 Black mangrove....50
Figure 5-14 Red mangrove....51
Figure 5-15 Palm forest at the back of the mangrove (Region 5)....51
Figure 8-1 Sea Defences Impact on Environment - Severity Matrix....64
Figure 8-2 Impact of Environment on Sea Defences - Severity Matrix....68

List of Tables

Table 1-1 Timeline for Implementation of Strategic Objectives....15
Table 3-1 S&RD Sector Legislation, Institutions and their Responsibilities....32
Table 5-1 : The most common fish, shrimp, prawn and crab species (after Geer, 2004)....48
Table 6-1 : Synopsis of projection and trends affecting the environmental baseline....55
Table 7-1 POLICY FRAMEWORK GLOBAL AIMS AND STRATEGIC OBJECTIVES....58
Table 9-1 Timeline of Policy Options....71
Table 11-1 Summary of Activities, PSR and Indicators....80
Table 15-1 List of Stakeholders consulted/engaged....115

Abbreviations and Acronyms

ACCC	Adaptation to Climate Change in the Caribbean, regional project
ACS	Association of Caribbean States
AGL	Agriculture and Land Department (FAO)
A-O GCM	Atmosphere-Ocean General Circulation Model
AOSIS	Alliance of Small Island States
ASSP	Agricultural Support Services Programme (IDB)
CANARI	Caribbean Natural Resources Institute
CAP	Chapter, Laws of Guyana (GoG)
CARICOM	Caribbean Community (Secretariat)
CBD	Convention on Biological Diversity
CCCCC	Caribbean Community Climate Change Centre
CDB	Caribbean Development Bank
CDERA	Caribbean Disaster Emergency Response Alliance
CEP	Country Environmental Profile
CGPS	Continuous Global Positioning System
CHPA	Central Housing and Planning Authority (MH&W)
CMO	CMO Radar Project (Regional Weather Radar System project)
COP	Conference of the Parties (for most MEA)
COP	Conference of Contracting Parties (for particular conventions)
CSP	Country Strategy Paper (EDF)
CPACC	Caribbean Planning for Adaptation to Climate Change, project
D&I	Drainage and Irrigation
DFID	Department for International Development (United Kingdom)
DHI	Danish Hydraulic Institute
DHV	DHV BV (Netherlands)
DPSIR	Drivers, Pressure, State, Impacts, Response model (EEA)
DSR	Driving force, State, Response indicators (UNDPCSD)
EC	European Commission
EC	Electrical Conductivity (of soils)
ECLAC	Economic Commission for Latin America and the Caribbean
ECORYS	ECORYS BV (Netherlands)
EDF	European Development Fund
EDWC	East Demerara Water Conservancy
EEA	European Environmental Agency
EEZ	Exclusive Economic Zone (UNCLOS)
EIA	Environmental Impact Assessment
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
ES	Environmental Score (RIAM)
ETZ	Equatorial Trough Zone
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FRA	Flood Risk Assessment
FEWERS	Flood Early Warning and Emergency Response System
GAHEF	Guyana Agency for Health Sciences and Food Policy
GCM	General Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility (UNDP)
GFC	Guyana Forestry Commission (GoG)
GGMC	Guyana Geology and Mines Commission (GoG)
GIS	Geographic Information System
GoG	Government of Guyana
GPS	Global Positioning System

GuySuCo	Guyana Sugar Co-operative
HDI	Human Development Index (UNDP)
HDR	Human Development Report (UNDP)
Hs	Significant Wave Height
Hydromet	The Hydrometeorological Services (GoG)
IAST	Institute of Applied Science and Technology
IBF	IBF International Consulting (Belgium)
ICBA	Institutional Capacity Building Activities (EDF)
ICZM	Integrated Coastal Zone Management
ICZMC	Integrated Coastal Zone Management Committee
IDA	International Development Association
IDB	Inter-American Development Bank
ILUP	Integrated Land Use Planning
IPCC	Intergovernmental Panel on Climate Change
IRBM	Integrated River Basin Management
ISZM	Integrated Shore Zone Management, project
ISZMC	Integrated Shore Zone Management Committee
ITCZ	Inter Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature
IWRM	Integrated Water Resources Management
LSC	Land and Survey Commission (GoG)
MACC	Mainstreaming Adaptation to Climate Change, project
MCA	Multi-Criteria Analysis
MEA	Multilateral Environmental Agreement
M&E	Monitoring and Evaluation
M&O	Maintenance and Operation
MH&W	Ministry of Housing and Water (GoG)
MMA	Mahaica, Mahaicony, Abary, agricultural region and watershed area
MoA	Ministry of Agriculture (GoG)
MoF	Ministry of Finance (GoG)
MPW&C	Ministry of Public Works and Communications (GoG)
NAO	National Authorising Officer
NAPA	National Adaptation Programme of Action (UNFCCC)
NARI	National Agricultural Research Institute
NCC	National Climate Committee (GoG)
NCU	National Climate Unit (GoG)
NDC	Neighbourhood Democratic Council (local GoG)
NDIA	National Drainage and Irrigation Authority (GoG)
NDIB	National Drainage and Irrigation Board, formerly (GoG)
NDS	National Development Strategy
NEEPAS	National Environmental Education and Public Awareness Strategy (EPA)
NHSN	National Hydrological Stations Network (Hydromet)
NIP	National Indicative Programme (EDF)
NMSN	National Meteorological Stations Network (Hydromet)
NREAC	Natural Resources and Environment Advisory Committee
OECD	Organisation for Economic Cooperation and Development
PEO	Public Education and Outreach
PMU	Project Management Unit
PRSP	Poverty Reduction Strategy Paper (WB)
PSIP	Public Sector Investment Plan
PSR	Pressure, State, Response diagram (OECD)
RDC	Regional Democratic Council (regional GoG)
RIAM	Rapid Impact Assessment Matrix (DHI)
RV	Range Values (RIAM)
SDB	Sea Defence Board (GoG)
SDSP	Sea Defence Sector Policy

SDSP	Sea Defence Sector Programme (EDF)
SEA	Strategic Environmental Assessment
S&RD	Sea and River Defence
S&RDD	Sea and River Defence Division
SIDS	Small Island Developing States
SMART	Specific, Measurable, Attractive, Realistic and Timely
SNC	Second National Communication (in response to the UNFCCC)
SO	Strategic Objective
SPSP	Sector Policy Support Programme (EDF)
SZMS	Shore Zone Management System
TA	Technical Assistance, Technical Assistant
TDEM	Time Domain Electromagnetic Method
TFIR	Task Force for Infrastructure Recovery
UNCLOS	United Nations Commission on the Law of the Sea
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNDPCSD	United Nations Department for Policy Coordination and Sustainable Development
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	The World Bank
WBCAP	World Bank Water Conservancy Adaptation Project
WMP	Water Management Plan
WRI	World Resources Institute
WSG	Works Services Group (GoG)
WUA	Water Users Association(s)

1 EXECUTIVE SUMMARY

1.1 Background

The coastal zone of Guyana has the highest population density and the greatest level of economic development of the country. Nearly 90% of the population live in the coastal area and about 30% live in the immediate vicinity of sea defences. Hence, the Government of Guyana places a high priority on the construction, rehabilitation and maintenance of sea defences. However, lack of public investments and the absence of a clearly defined sector policy, have prevented the authorities and agencies responsible for the sea and river defences from reaching their operational objectives.

Until the mid-1970s sea defences works accounted for a major part of Guyana's capital expenditure but the last 10 years have seen an increasing deterioration of the defence network and an increase of flood-related damage and losses. In the past, investments at project level have too often led to fragmentary and disconnected funding, despite the critical importance of the sea and river defences necessitating a sector wide approach. Hence, donors have since the late 1990s taken steps to ensure the maximisation and co-ordinated use of resources. In line with this approach, EC intend to achieve final hand-over of responsibility to the national authorities through EDF funding giving specific Budget Support of 14.8 million Euros.

1.2 Sea Defence Sector Policy Framework

To improve upon a comprehensive sector policy, the European Commission funded the development of a Sea Defence Sector Programme and Sector Policy Framework. The rationale behind the Sea Defence Sector Programme is :

- Consolidate the legal boundaries of areas affected by the sea and river defence network
- Align all relevant but often fragmented and dispersed policies and laws within the sector policy
- Consolidate the jurisdiction of institutions related to sea defence
- Define an institutional framework and level of participation of the institutions
- Establish links among institutions and administrative structures in order to avoid overlapping functions
- Establish a financial forecast and donors list for the sea defence sector.

The Draft Sector Policy Framework defines a series of 5 high level targets or Policy Aims, 10 Strategic Objectives and a series of corresponding Actions.

1.3 Strategic Environmental Assessment

The Strategic Environmental Assessment describes, identifies and assesses the likely significant impacts and implications of the implementation of the policy and programme. In short, this Strategic Environmental Assessment provides:

- An environmental assessment of the Sea Defence Sector Policy Framework formulation taking into account environmental constraints and opportunities as well as the potential impacts from its implementation
- Recommendations for the Sector Programme (Budget Support) formulation including Pressure, State and Response performance indicators and accompanying measures to be taken during the implementation of the programme.

The approach combines two phases, a Scoping Phase and the SEA Study. The Scoping Report constitutes the basis for the SEA Study, giving an outline of the scope of the study, required baseline and methodology, as well as the initial plan of work. The SEA Study is placed in its environmental and geographical context of coastal zone management and climate change, and emphasises the link with the water conservancies and drainage and irrigation network.

The SEA Study reviews the current ***state of the environment*** as it relates to the sea defence sector. The emphasis is put on the meteorological factors, the main watersheds, the coastal biological diversity, hydrodynamics and sediment budget, the specificity of mangroves and of the marine environment.

1.4 Key Issues

The fact that most of the population and nearly all the major agricultural and industrial activities are on the coast puts Guyana at high risk from effects of sea level rise. Safe and secure sea defences are recognised as being essential to the growth of the national economy and the improvement of the human development index for the population who live on the coastal strip. Hence, the Government of Guyana places a high priority on the construction, rehabilitation and maintenance of sea defences.

However, the inability of the economy to sustain higher levels of public investment in sea defences prevents these objectives from being attained. A further constraint is that the objectives for sea defences have not yet been effectively transferred from national to sector level. The institutions lack definition concerning scope and responsibilities, there is no planned development strategy and maintenance work does not abide by a program, but is carried out in an ad hoc fashion. As a result there are no clear and defined objectives to guide those responsible for the management of sea and river defences.

The proposed Draft Sector Policy Framework meets some of the identified stakeholders concerns, in that it covers many environmental aspects raised by the consulted stakeholders, as well as institutional or legal aspects. However it is lacking in technical details and it needs to be established whether the choice of technical options, with associated environmental impacts, should be left to the departments and local authorities or more explicitly stated in the policy document.

Critical works on sea defences, drainage infrastructure or conservancy dams can only provide a temporary respite from the risk of more catastrophic failures in the system. The core issue is in the improvement of disaster preparedness and management on the basis of sound operation and maintenance of the system, adequate environmental monitoring, timely early warning and effective population.

Climate change is a cross-ministerial and cross-sectoral issue and this fact must be taken into consideration by all government departments and institutional stakeholders when relating to the sea defence policy. A key element in responding to climate change is flexibility and responsiveness in seeking the best options to react to changes over time. In order to achieve this, climate change considerations should be integrated at every stage of decision-making processes and climate change should be one of the core factors woven into all government policy actions identified in the sea defence sector policy. The mainstreaming of climate change into Guyana's sea defence policy, including resource and budget allocation, will require dialogue between all government departments and commitment from all stakeholders.

Given the rather severe limitations in the availability of data concerning the key climate change impacts affecting the sea defences in Guyana, caution should be exercised when taking decisions which may be based on limited information.

1.5 Analysis of Policy Framework

1.5.1 Research and Data Collection

There is a strong emphasis in the policy document on data gathering and research. The SEA has confirmed that even where raw data is collected it is not analysed to give useful information. Data should be robust and reliable and is best based on parameters which are simple to measure. Data collection should be well planned and thought out; it should be repetitive so that trends may be established and based on a few key parameters.

1.5.2 Indicators

Data collection should be based on Objectively Verifiable Indicators – OVIs. These are simple to measure, easy to understand by a non expert, and lead to clear unambiguous conclusions. The emphasis should not be on ***Impacts*** (*What happened?**)*** but on ***Consequences*** (*So what?**).***

For example, tide gauge readings from the harbour are OVIs. Satellite altimetry is not. Occurrence of heavy rain in times per year, intensity of rain in millimetres, and duration of storm in minutes is an OVI. Changing weather patters based on Climate change models are not. Indicators should be selected which are within the capabilities of the existing agencies to be measured and understood.

The emphasis should be placed on how interpreted information will be used. Analysis of data should lead to conclusions and then action. This can be in the short term e.g. an imminent storm or the long term e.g. beach erosion. Actions should also be reviewed after they have been implemented, and if seen to be ineffective, future similar actions should be modified. This feedback can be institutionalised as CAR – Corrective Action reporting. After any major incident an analysis should be made of successes and failures. Any policy decision should be similarly reviewed at least annually. The **Lessons Learned** should be used to guide future actions.

1.5.3 Warning Systems

Much emphasis is placed in the Policy on Flood Early Warning and Emergency Response Systems (FEWERS). These will not prevent flooding but will alert residents to a danger. However, as floods have occurred on the coastal strip for centuries this seems somewhat unnecessary. Even with prior warning,

residents are reluctant to leave their homes. Flood prevention would be preferable, but if this is impossible, then a realistic emergency evacuation plan with the full consent, approval and participation of local residents and community leaders is necessary. Otherwise there seems little point in spending a large amount of money on a sophisticated early warning system if the residents refuse to react. The FEWERS scheme alone, without a viable and workable evacuation plan, enthusiastically supported by affected persons, is not an effective solution to flood prevention.

1.5.4 Priorities

It is recommended that the priorities be grouped as follows :

Short Term

The major benefits are obtained from the planned operational changes. They flow from the setting up of realistic infrastructure budgeting, preventive maintenance, capital investment planning, and policy monitoring and evaluation. Institutional reform is essential. The current institutional arrangement is weak and cannot achieve progress. This is a priority action.

A program can be started to raise ***awareness*** on the dangers of inappropriate land use and lack of coordinated development planning. The measurement of local sea level rise can be initiated. This will add credibility to suggested mitigation measures and give "ownership" to the issue, rather than relying on secondary information from model predictions.

For the sea defence sector to function it requires operational tools, whereby lessons learned can be a **basis** for later research. Full research can come later. It is not necessary to have perfect knowledge before decisions can be taken. In fact, skilful decision makers make good decisions based on incomplete information. This stage is considered ***essential***. Water level management planning can commence as a medium to long term undertaking

Medium Term

Other benefits are the development of networking, awareness and identifying knowledge gaps and starting-up specific operational research. Training and capacity building of departments should progress to stop loss of qualified staff. Having raised awareness on the risks inherent in lack of coordinated development planning, inappropriate land use should now be actively ***discouraged***. Water level management planning can continue as a long term undertaking.

The upgrading of the knowledge base and awareness, the understanding of the value of ecosystems for livelihoods, and the design of new alternative or preventive measures are all useful actions. This stage is considered ***desirable.***

Long Term

Coordinated and comprehensive development planning should be ratified to the extent that inappropriate land use can now be ***Prohibited.***

There is a lot of emphasis in the Policy on research. This emphasis is considered wrong. The problems facing the sea defences sector are well known – it is the implementation of solutions that is problematic. Redressing the lack of targeted research and awareness regarding linkages between ecosystem conservation and community livelihoods is desirable in the long term, but given the critical nature of more pressing issues is, it is considered ***optional.*** The inherent potential value of ecosystems, such as mangroves, to communities is well documented worldwide. However, communities may cut mangroves for short term gains such as fuel wood and tanning, and by so doing, lose long term benefits such as fish nurseries and wave protection. It is considered ***essential*** in the long term that Guyanese communities ***appreciate*** the value of these ecosystems and understand why they should not destroy them.

The timeline for implementation is given in brief in Table 1.1 below. It should be noted that some strategic objectives are to be implemented in the short term because they are considered essential. Unless they are not addressed immediately then a major failure of the sea defences sector may be anticipated. However, their relevance does not end in the short term; these objectives must be pursued through the medium and long term. The timeline is intended to show which issues must be addressed in order of priority.

Table 1-1 Timeline for Implementation of Strategic Objectives

Strategic Objectives (SO)	Short Term	Medium Term	Long Term
SO1 Maintenance and Investment Plan of Sea and River Defences Infrastructure.	Implement in Short Term – preferably immediately.	Continue to implement in the Medium Term.	Continue to implement in the Long Term.
SO2 Improving Knowledge Base, Surveillance, and Monitoring & Evaluation of Sea and River Defence Infrastructure.	Accept decisions can be made despite lack of complete data	Implement M&E in the Medium Term.	Continue to implement in the Long Term.
SO3 Creating a Research Centre	Establish baselines	Define useful research	Implement in the Long Term.
SO4 Public Awareness, Training and & Capacity Building	Initiate ***"Awareness Raising"***	Implement in the Medium Term.	Continue to implement in the Long Term.
SO5 Assessment of Flood Risk	Use historical knowledge	Calibrate risk predictions against historical trends	Implement in the Long Term.
SO6 Create a Flood Early Warning and Emergency Response System (FEWERS)	Implement in Short Term **IF** civil defence response system is realistic and viable.	If civil defence response system is non viable cancel development of FEWERS.	
SO7 Institutional Reform	Implement in Short Term – preferably immediately.	Continue to implement in the Medium Term.	Continue to implement in the Long Term.
SO8 Law Enforcement & Regulation	Implement in Short Term – preferably immediately. Use existing regulations	Continue to implement in the Medium Term. Consolidate fragmented laws.	Continue to implement in the Long Term.
SO9 Land Use Restriction and Development Planning	Implement in Short Term – preferably immediately. "***Raise Awareness"***	Continue to implement in the Medium Term. ***"Discourage."***	Continue to implement in the Long Term. ***"Prohibit"***
SO10 Water Management and Planning	Implement in Short Term – preferably immediately. ***"Plan"***	Continue to implement in the Medium Term. ***"Implement & Manage"***	Continue to implement in the Long Term. ***"Modify by lessons learned"***

1.6 Recommendations for Sector Policy Support Program Formulation

1.6.1 Legislative Framework

The legislation is extensive, and there is no need for more regulations, but given the inadequacy of existing laws to cope, a comprehensive review of the relevant legislation is recommended. There is a need for a more cohesive legislation that removes the overlapping responsibilities and emphasises co-ordination between agencies. A single law which consolidates all aspects, supersedes previous legislation and fills the existing gaps on effective monitoring, implementation and enforcement is recommended.

1.6.2 Administrative Boundaries

The ***geographical boundaries*** of the regions with sea and river defences, as well as the definition of the limits and boundaries of the sea and river defences, should be consolidated in the Sector Policy. The choice of an adequate administrative envelope is required to enable the actual implementation of effective decisions.

1.6.3 Land Tenure Consolidation

In Guyana landless people are known to settle in coastal areas, having migrated from the interior to make a living from fishing, and eventually settling as permanent communities with assumed rights to the land they have cultivated for many years. On the other hand, business and industry have powerful interests in coastal development processes and land use arrangements. Land development and housing schemes are mostly disregarding land suitability or land use legislation. Encroachment into protected areas and state lands remains a major problem, and gives rise to frequent conflicts between different resource users, local communities, the private sector and government. Examples are numerous of the illegal or inappropriate location of coastal settlements and resettlement areas, of failure to incorporate environmental safeguards into infrastructure development and of the intense land use conflicts arising within the reconstruction process. The capacity to deal with conflict management should be enhanced across the sector. Unclear or absent land tenure arrangements were also stated as a critical issue requiring attention, and as a major source of land use conflict. The improvement of the land tenure system is therefore a key recommendation. Conflict management and land tenure consolidation should obviously be priorities in the SPSP.

1.6.4 Combine Other Sector Policies

Policy makers should also make use of the opportunity to integrate sector policies such as the Sea Defence Draft Sector Policy Framework within an integrative approach linking Integrated Coastal Zone Management (ICZM), Integrated Land Use Planning (ILUP) and Integrated River Basin Management (IRBM). This would allow development of a truly strategic approach, within an integrative framework combining the principles of ICZM, ILUP and IRBM and would address comprehensively many of the concerns expressed by the stakeholders consulted.

1.6.5 Budget Support

In order to improve the efficiency and effectiveness of a capital-intensive sector within a medium-term investment horizon such as the Sea and River Defence Sector, sustainable investment planning within a budget context is a must. Otherwise maintenance activities and rehabilitation cannot be planned in an effective and efficient manner. The major advantage of a sector wide approach is its budgetary transparency and coherence that constitute an excellent means for raising additional donor assistance. The investment plan is meant to clearly identify the needed funds and also can increase the perception of the urgency of the investment. Hence, it is recommended that the Ministry of Finance upgrade its current Public Sector Investment Plan (PSIP) to a full-fledged investment plan within a budget context. This would allow presenting expenditure estimates at project level for both donor financed and locally financed projects, and the same would apply to the publication of financial results and reports. This should also be a priority of the Sector Policy Support Programme.

Ministry of Finance intends to improve the PSIP in the future, and so the Sea and River Defence Sector should make an early start in participating and contributing its sector specific capital investment plan.

Substantial efforts need to be made to complete the development of the sector policy and strategy. The Draft Sector Policy Framework is a first step in this direction. The Sector Policy Support Programme still needs to be elaborated. Funding must be secured to cover the sector budget and medium-term expenditure. The financial capacity of the departments that cut across the sea defence sector needs to be strongly enhanced.

The Government of Guyana must reform and provide packages that attract professional staff and counteract external incentives in order to retain personnel in the public service, e.g. creating incentives and performance-related rewards that can prevent the current brain drain from the sector.

Repairing sea defences is a costly operation that does not include activities that are generating funds. Consideration should be given to land use plans when selecting locations for repair to facilitate income-generating activities that could help support the cost of the sector.

1.6.6 Knowledge base

A more coherent approach to database linkage and networking should be delineated in the policy as well as being supported by the SPSP. The statement that reports and data sets are often scattered across different sources (i.e. government agencies, research institutions, or stakeholders) and not available to decision-makers or the public would need to be followed by a more substantiated solution. More than making a general suggestion, the policy should propose avenues for common data sharing and networking. Clear specifications and recommendations for a data exchange and information-sharing platform are to be elaborated during the near development of the policy and should indeed be supported by the SPSP. More insights should be provided on the kind of data that are needed, currently and in the future, their cost-effective collection, availability and usage, and the benefits that can be expected.

1.6.7 Integrating Stakeholders Concerns

At present there are no regulations that enable community involvement in the construction, operation and maintenance of sea defences, although these are allowed for under the law. The major issue is in the definition of the roles and responsibilities of the different actors. A clear agreement should be reached between the various stakeholders involved in sea and river defences as to the limits and demarcation of responsibilities.

1.6.8 Mainstream Climate Change Issues

Climate change poses significant and wide-ranging challenges for Guyana and its sea defence policy. A number of policy-making sectors and ministries are engaged in climate change adaptation activities and capacity building. There remains a critical requirement for an integrated, cross-sectoral approach to climate change policy-making. Whilst functioning institutional structures, i.e. the National Climate Unit under the Ministry of Agriculture and the National Climate Committee that co-ordinates climate change activities in Guyana, appear to exist, it is widely accepted that institutional capacities are extremely low and require significant strengthening. Adapting to climate change will thus require significant institutional, technical and financial capacity and assistance.

Collecting environmental baseline data and measuring and monitoring climate change impacts, indicators and variables requires investing in the required technology. A sufficient level of technology and training of human resources in the use of the technology are fundamental. The policy would therefore need to provide for a budgetary allocation to acquire, maintain and operate equipment that will enhance Guyana's understanding of climate change issues and of their relationship to sea defences and the sector policy. The technologies could range from simple rain gauges and river water depth pressure sensors to sophisticated online sea level rise satellite altimetry systems. A policy decision must be made on achieving a balance between simple yet robust data collection systems, and complex systems which may provide more detail yet may be more susceptible to failure through lack of maintenance budget.

Mere collection of data is not sufficient. Data processing and analysis must be installed in order to integrate climate change related aspects into the sea defence policy. This requires ensuring that the data presented to staff is not so complex that it is beyond their abilities to interpret it.

The information should be made available to an extensive network of end-users, a core element for successful implementation, and not hoarded with one agency.

Crucial to an integrated approach to climate change and the development of pragmatic adaptation strategies is the awareness of policy-makers, government departments and the general public of the issues surrounding climate change. For example, the National Climate Committee comprises representatives from many government agencies. However, the importance of continually raising understanding and awareness of the issues and aspects of climate change and how they affect the sea defences cannot be understated as climate change threatens infrastructure, settlements, lives and livelihoods. Although the Policy aims at improving awareness, a broader canvas should be targeted.

Adaptation strategies due to climate change should be integrated into the sea defence policy. For the adaptation to be beneficial and cost effective for Guyana's sea defences it should not rely only on reactive principles but ought to be proactive and anticipatory. The process of climate change adaptation is not finite but cyclical and it is critical that the cyclical nature of adaptation be integrated into the sea defence policy.

1.6.9 Economic Exit Strategy

To support coastal conservation initiatives, the policy should promote economically sustainable approaches. The policy should identify financial and economic incentives for coastal conservation. This is of critical importance if the sea defences sector is to be sustainable without donor support. The concept of developing an exit strategy from reliance on external funding must be introduced.

Public awareness and education have unanimous support among officials as a technique for changing attitudes and building support for mangrove management. It is generally felt that public education should promote awareness, understanding, and new attitudes regarding the role of mangroves as natural protection against floods, as well as the value and appropriate use of coastal resources. Given the diversity of education level and socio-economic status of the audience, a broad-based approach to education is required, bringing together the groups who benefit from and who are damaging the mangroves, building participation in the planning process, and promoting vigilance and reporting of mangrove destruction.

1.7 Institutions

Although some ministries in Guyana are being engaged in capacity building and adaptation activities there remain significant gaps in institutional, technical and financial capacities to address many issues around sea defences. Institutionally there are many bodies involved in the sea defences sector but three main ones are discussed below.

1.7.1 Sea Defence Board

The **Sea Defence Board** has legal authority to implement sea defences and to control encroachment onto vulnerable coastal lands. It is irregular for a "Board" to enforce statutory powers and such enforcement is usually carried out nationally by an EPA, or locally by a municipality. These possibilities do not apply in Guyana as statutory powers are already delegated to S&RDD, who take limited action.

Reportedly the Sea Defence Board has never met. It is recommended that this Board be disbanded and a new board be created, or failing this, the existing Board be drastically overhauled and reduced to a workable membership size.

Policy Aim III is fully devoted to reactivating and reinforcing the Sea Defence Board through reform and empowerment. The current structure of the board responds to an old administrative organisation and there is an urgent need to review the existence of an institution, which is no longer responding to the challenges of a sector threatened by global warming, climate change and sea level rise.

A profound and dramatic institutional review is needed to respond to the scale and implications of the difficulties faced, and a reform aimed at making the sector fully operational is essential.

The policy should clearly establish the roles and responsibilities of the "New Board", detailing:

- Composition i.e. the members
- Institutional and legal capacity
- Power of law enforcement and enactment
- Financial powers and resource allocation
- Power to argue financial and long-term investment needs at MoF level,
- Procurement and project management rules
- Authority to assign responsibilities concerning performance of the sector.

In parallel with the creation of a "New Board", a "New Agency" should be created to tackle the multifaceted issues of the sea defences sector. (See 1.7.2) The new board should focus on policy issues and delegate its statutory enforcement and implementing powers to the new agency.

Key political level involvement (the president) will be required for the institutional framework to function properly. It should be noted that a Technical Advisor on Environmental Affairs *inter alia* already sits in the President's Office.

1.7.2 Sea and River Defence Division

S&RDD is a junior subdivision of a larger organisation and suffers from inequitable salaries and employment security, inadequate budget, and no authority when dealing with other senior organisations. Given the seriousness of the current state of the sea defences sector, and the critical role it plays in the economy of the country, it is clear that these responsibilities must be handled by an agency operating under a presidential mandate. It is recommended that **S&RDD** be elevated to the status of a single independent autonomous agency attached to the office of the President. Without a ***single agency*** having the prestige and authority to make decisions and implement them, any further assistance to the sea defences sector will simply continue to propagate an ineffective regime.

S&RDD needs a higher proportion of national public expenditures on sea defences due to the critical importance of sea defences to the future of the national economy. The merger of the S&RDD into the WSG of the MPW&C may strengthen the technical abilities of the division and provide improved employment conditions for employees. On the other hand, it may weaken its performance by dissipating the allocated budget among other competing departments.

1.7.3 Regional and Neighbourhood Democratic Councils

The co-ordination of the existing dual decision-making process (i.e. RDC or MPW&C) is an urgent matter to be resolved in the policy. In order to ensure adequate project implementation, the policy should include institutional arrangements and allocation of responsibilities to clarify the respective roles and hence achieve efficiency and effectiveness in S&RD public investment.

1.7.4 Link with S&RDD and NDIA

The policy discussion should be used as an opportunity to stress the need for better collaboration between the NDIA and S&RDD (who used to be one unit) and start establishing and formalising this collaboration.

1.7.5 Link with Hydromet

Monitoring and evaluation or early warning and flood prevention data and information is provided by Hydromet. A closer relationship and clear sharing of responsibilities between S&RDD and Hydromet should be realised in order to state clearly what actions are to be taken on the information passed from Hydromet to S&RDD.

1.7.6 Link with Civil Defence Commission

The Commission is responsible for emergency response, but not early warning or disaster preparedness. A closer relationship should be formed between Civil Defence Commission, S&RDD and Hydromet to crystallise the use of information from FEWERS.

1.7.7 Link with the GFC

The GFC wants mangroves to be taken up in the Guyana Protected Area System. Mangroves could be declared public land and be put under the direct management of GFC as it is the overall co-ordinating and implementing agency for the National Mangrove Management Plan. At the moment, mangroves can still be private lands, which prevent the Forestry Commission from enforcing their protection. However, being public lands does not guarantee their sustainable development because appropriate sources of funding still would have to be created. If mangroves are to become an integral part of the sea defence system, the link with and role of the Guyana Forestry Commission must be established in the policy.

1.7.8 Link with NCC and NCU

The need for more institutional, technical and financial support of the Committee is consistently stressed by many. The policy should link with the NCU for adequate flood monitoring and early warning, and for improving the downscaling capacity of climate models for better addressing the needs of Guyana.

1.7.9 Link with EPA and other Agencies

EPA acts as facilitator in ICZM. Sea level rise adaptation measures should be incorporated into Integrated Coastal Zone Management (ICZM) and the National Development Strategy. In order to develop a rational coastal zone management plan it will be essential to involve Land and Survey Commission in the production of regional land use plans, which can then be implemented at district level, where proof of land tenure will be most important. Co-ordination with the Central Housing and Planning Authority is also needed to avoid inconsistencies. Environmental considerations should be integrated at every stage of decision-making processes. Environmental issues should be woven as a core factor into all actions identified in the sea and river defence sector policy.

The **EPA** is responsible for coordinating ICZM - Integrated Coastal Zone Management, and ICZM - Integrated Shore Zone Management. It is not clear why two committees are needed for one overlapping area, but this is immaterial as both are ineffective. It is recommended that this coordinating function be taken away from EPA and vested with the “New Board”.

1.8 Sea Defences

1.8.1 Alternatives

In the Draft Sector Policy Framework, a strong emphasis is put under Policy Aim I and II on the enhancement of the economic efficiency of flood and coastal defence expenditures, i.e. budgetary transparency, integration, monitoring and tracking. Also under Policy Aim II, two avenues of research are introduced :

- To develop knowledge on ***alternative solutions*** (i.e. redesign, mangroves, etc.) which provide effective flood defence functions and protect or enhance environmental resources, and on their performance in order to build confidence in their use
- To investigate the extent to which ***preventive solutions*** could be developed and adopted in the field of sea and river defence in order to limit the build up of vulnerability and damage potential

The creation of a policy research centre is presented as a first step towards the adoption of a preventive instead of corrective approach. Whilst this approach is supported it is contended that there is much useful information already available, and consolidation of this information may give useful guidance without having to wait for the outcome of a possibly lengthy research program.

There is an urgent need to establish strong and effective leadership and coherence between the various entities i.e. MPW&C, WSG, SDB, S&RDD, NDIA, Hydromet et al. The policy should be used as an ***opportunity*** to establish and formalise cross-sectoral cooperation and implementation.

The Policy Framework does not make sufficient provisions for feedback and integration of public interest groups concerns and expectations for protection from flooding. More public consultation is ***advocated***. This can be used as a platform for tackling the residents' reluctance to evacuate in the event of an imminent flood.

1.8.2 Mangroves

The importance of mangroves as highly productive ecosystems supporting highly diversified food chains and nursery grounds for numerous species, many of them of commercial value, and exploited for a variety of uses by local communities, justifies that their protection and restoration be fully included in the policy.

Moreover, mangroves constitute an integral part of the coastal protection and their maintenance is less costly than that of artificial defences. The rationale for including mangroves, as natural sea defences in the policy, should therefore very strongly be elaborated both from the institutional and technical point of view.

Sea defence policies will have a far-reaching impact on the environment and ecosystems. The decision to protect a particular area determines whether significant local or national habitats are lost or gained. Emphasis is put under Policy Aim II on the importance of the relationship of coastal ecosystems to community livelihoods. This should be given more prominence in the policy.

The policy suggests that Guyana's mangroves could be used as a field laboratory in order to learn more about mangrove ecology and stewardship, conduct research on the economic value, and test new approaches to alternative flood protection. This avenue could also be followed to gather understanding of the economic value of the impact of the defence system as well as on the value of ecosystem services on community livelihoods. This suggestion is ***not*** supported. The economic value of mangroves is well documented internationally. Local research would probably not make a major contribution to knowledge of the subject, and although such local knowledge may be ***desirable***, the funds could be put to better use elsewhere. What is ***essential*** is that the local communities be ***educated*** as to the long term benefits of mangroves to the communities themselves, that communities are ***persuaded*** not to cut mangroves for fuel or tanning materials, and even that the communities themselves participate in the protection of the mangroves.

1.8.3 Inland Watersheds

Damage to coastal ecosystems does not only result from wave and storm action, or human activities in the coastal zone, but also from various activities carried out further inland. The policy suggests research on how upstream deforestation and other forms of vegetation clearance are responsible for escalating sediment loads in rivers, estuaries and coastal waters, which choke coastal and marine ecosystems. This is supported as it may alleviate the burden of regular clearing of weeds and sediments in the drainage canals.

1.9 Conclusion

Guyana will need to establish and maintain a number of management mechanisms for integrated adaptation planning and management to become a reality. These mechanisms cannot all be developed simultaneously and in almost all instances substantial human, technical, and financial resources will be required to establish and maintain the policy, legal, institutional and operational structures that are necessary to successfully deal with the country's vulnerability to sea level rise. Underlying all of these is the need for institutional reform supported by political will at the highest level.

2 Scope of the SEA

2.1 Background

The coast of Guyana stretches between the deltas of the Amazon and Orinoco over a total length of about 400km from the Waini River to the Corentyne River. Guyana has a low-lying coastal plain, which is a narrow strip of fertile land about 40km in width. This strip has the highest population density and the greatest level of economic development of the country. Of the total population of 772,000, nearly 90% live in the coastal area and about 30% live in the immediate vicinity of sea defences. Protective sea defences have been constructed from colonial days. At the moment, a complex system based on concrete seawalls, some which are several decades old, earthen embankments, shifting sand dunes and indigenous mangroves protects the coastal zone against turbulent sea conditions. They are intended to prevent loss of land from erosion, stop saline intrusion and flooding, and protect communities along the coastal plain and riparian areas.

The country Poverty Reduction Strategy Paper (PRSP) states that *"the objectives set for the sea defence programme are to reduce breaches, build local capacity to do maintenance and rehabilitation works and increase community participation in the inspection and protection of the sea defence system"*. Also the Millennium Development Goals, National Development Strategy 2001-2010, and Public Sector Investment Program 2005-2009 recall that the Government of Guyana places a high priority on the construction, rehabilitation and maintenance of sea defences. Safe and secure sea defences are indeed essential to the growth of the national economy and to the improvement of the Human Development Index (HDI). However, lack of public investments and the absence of a clearly defined sector policy have for long prevented the authorities and agencies responsible for the sea and river defences from reaching their operational objectives.

2.2 Sea Defence Programs

EDF is the major contributor to sea defence programmes. However, since 1990 several donors including IDB, IDA, USAID and CDB have provided over US$ 40 million for the reconstruction of critical sections of the sea defences. The Inter-American Development Bank had proposed a five-year plan to resolve the problems associated with the maintenance and administration of sea defences. The plan emphasised both environmental and technical aspects in the following recommendations:

- promote environmentally sound land-use decisions as a basis for sustainable development of the coastal zone;
- build national capacity for integrated coastal zone management by improving the institutional and technical capacity for coastal zone management.

2.3 EDF Support

Development co-operation between Guyana and the European Commission was effected under successive Lomé Conventions (i.e. Lomé I through Lomé IV) and continued under the Cotonou Agreement through the related National Indicative Programmes (NIP). Starting with Lomé IV and the 7th EDF, the fund has made significant contributions to the funding of mainly rehabilitation works, supply of materials and institutional strengthening of the Sea and River Defence Division (S&RDD).

The Financing Agreement for the interventions funded under the 7th EDF between the European Commission and the Government of Guyana was signed in 1994 and physical works were completed in 1999. Simultaneously with the completion of the 7th EDF interventions, an appraisal study under the 8th EDF identified approximately 5km of sea defences in two designated regions (Region 2 and 3) for reconstruction. The study also outlined the need for a separate programme, which should address the implementation of institutional strengthening measures through the development of a Shore Zone Management System (SZMS).

The overall objective of the 8th EDF (1995-2000) was to enable the country to generate income in a sustainable way. There were two focal sectors for EC-funded actions: economic and social infrastructure, of which 85-90% of the total was for sea defences, water and transport, and private sector development. These were the same sectors of concentration as those of the 6th and 7th EDF. The Financing Agreement for the 8th EDF Sea Defences Programme was signed in March 2000 with the corresponding interventions to be completed by December 2008. The programme included institutional capacity building through the development of a SZMS consisting of data collection, modelling, database management and training. However, the system is not fully utilised due to the inability of the Division to retain the qualified staff necessary to manage the database and carry out the sea defences monitoring and maintenance programme.

Other weaknesses identified are the institutional status and the organisational structure of the Sea and River Defence Division (S&RDD). A recent Monitoring Mission from the European Commission has concluded that the rate of progress currently being experienced with the Programme is undesirable and that management needs to be more proactive. Towards this end, funds have been provided under the contingency component of the Financial Agreement for the appointment of a Technical Assistant to the S&RDD. The Technical Assistance services were delivered for a period of 8 months that ended in November 2007.

The overall objective of the 9th EDF (2002-2007) was the reduction of poverty and the promotion of sustainable development. This again included sea defences and coastal management. The 9th EDF CSP and NIP (EC, 2002) maintained the EC/Guyana emphasis on infrastructure and support to poverty reduction as central to sustainable development. For the 9th EDF, a pre-feasibility study identified the need for further interventions in policy and Shore Zone Management System (SZMS) development, strengthening of the management procedures, investment in maintenance and medium-term rehabilitation, and continuation of works in reconstruction of critical segments of the sea wall.

A feasibility study completed in August 2006 formed the basis of the 9th EDF Sea Defences Programme. It identified locations for maintenance and reconstruction works, appraised existing policy elements, developed the SZMS interventions (including a mangrove pilot programme), analysed the existing institutional set-up and concluded on a framework for institutional strengthening. The 9th EDF programme also provided for the reconstruction of 1,400m of coastline and rehabilitation/maintenance of another 20km. A specific target of the 9th EDF programme is the capacity development within the Sea Defence administration in order to prepare for final hand-over of responsibility for the maintenance of this crucial infrastructure from the EC to the national authorities.

The 10th EDF will provide Sector Budget support to sea defences. Under the 10th EDF CSP and the respective NIP, the Government of Guyana (GoG) and the European Commission (EC) have jointly identified the support to Sea Defences as a final hand-over intervention with 14.8 million Euro allocated to *"Economic and Social Infrastructure contribution to GoG's sector policy on coastal management"*. The proposed action will support GoG's increasing emphasis on a combination of points:

- prioritising the investments needed to upgrade critical sea defence structures and locations, and
- supporting preventive maintenance programmes, a strategy that has already been emphasised under the 9th EDF NIP.

The 10th EDF sector budget support evolved out of project support with the objective to support Guyana's Sea Defence Sector Policy. It was acknowledged that the sector policy is fragmented although elements already exist. Technical Assistance, funded from 8th EDF contingencies, was procured to assist the GoG in drafting a Sea Defence Sector Policy Framework and this mission was carried out in Guyana from April to August 2008.

It is stipulated that a strong sector policy and capable institutional set up is a prerequisite to implementation of the 10th EDF support to the Sea Defence sector programme.

2.4 Objective of the SEA

The Strategic Environmental Assessment (SEA) will complement and guide the policy development process. The scope of the SEA Study was agreed upon with the European Commission and the Government of Guyana on the basis of the results of an earlier Scoping Phase. The SEA focuses on the sea defence policy in terms of the construction and maintenance, legislation and institutions, social acceptance and sustainability, and also takes a wider view of coastal land use planning and management. The parties agreed that the SEA Study should include:

- An environmental baseline study
- The identification and assessment of the potential environmental impacts of alternatives
- An analysis of Pressure, State and Response (PSR) performance indicators
- An assessment of the institutional capacities to tackle environmental challenges
- Conclusions and recommendations for the Sea Defence Sector Programme and Budget Support.

The objective of the Strategic Environmental Assessment (SEA) is to describe, identify, and assess the likely significant impacts and implications for the environment of the implementation of the Sea Defence Sector Programme funded under the 8th EDF.

It also aims at identifying opportunities to enhance the programme resulting from a better understanding of environmental interactions. The SEA provides decision-makers from the EC, other donors and the Government of Guyana, with relevant and meaningful information, both qualitative and quantitative, for assessing environmental challenges and impacts from the implementation of the envisaged Sea Defence Sector Programme.

It also helps shaping the associated Sector Budget Support Policy under the 10th EDF. Existing policy documents, laws, strategy papers, profiles and studies have been reviewed and it is expected that the conclusions of the SEA Study will in turn influence the further development and formulation of the Sea and River Defence Sector Policy Framework. This information should ensure that environmental concerns are integrated in the decision-making and implementation processes in the most appropriate manner.

The study may also influence the development of Poverty Reduction Strategic Paper II, or Integrated Coastal Zone Management in Guyana.

3 Background

3.1 Sector Programme Justification and Purpose

The coastal zone is of strategic importance to the country's economy because nearly 90% of the population live there, which is only possible due to the existence of a network of sea and river defences that protect the coastal area from sea and river flooding. Most of the agricultural activity of Guyana takes place in the low-lying coastal plains which are about 1.4m below sea level. Until the mid-1970s sea defences and drainage and irrigation works accounted for most of Guyana's capital expenditure. However, during the 1980s the country's economy went into rapid decline and as a result less financial resources were allocated for maintenance and repairs, resulting in the deteriorated state of the country's sea and river defences. The last 10 years have seen an increasing deterioration of this network, an increase in flood-related damage and losses, and there is now concern that climate change will increase the risk of such losses in the near future.

Guyana is classified by the United Nations as a *continental small island developing state* (SIDS) and is recognised as one of the most vulnerable in the world to the adverse impacts of climate change (UNEP 2003). Climate change impacts could affect the whole of Guyana but the coastal plain, where approximately 90% of the population lives and which lies between 0.5 to 1m below mean sea level, will suffer the greatest effects.

In the past, disconnected funding led to fragmentary project implementation but since the late 1990s donors have tried to coordinate the use of resources. The importance of the sea and river defences of Guyana compels a sector wide approach that extends beyond the engineering issues. The implementation of a sector wide approach to the protection, rehabilitation or establishment of mangroves, dikes, seawalls, sluices and comprehensive budgeting, surveillance and planning of the sea and river defences is considered essential. By preventing damage and further loss, a dependable system of sea and river defences will be created that provides the security needed for the further development of the coastal plains, and hence of the whole country.

Unfortunately, the institutions that have links with sea and river defences or are in charge of carrying out the maintenance works, are not provided with a defined policy, are institutionally weak and have insufficient budgetary means for executing their tasks. The institutions that should create a policy for the sector themselves lack definition concerning their scope and responsibilities, and are not accomplishing their goals. Consequently, there is no planned sector strategy and maintenance work does not proceed in a programmed manner but is carried out in ad hoc fashion.

Yet, national policy objectives on sea and river defences have been expressed in a number of occasions such as in the Poverty Reduction Strategy Paper, Millennium Development Goals, National Development Strategy 2001-2010, and Public Sector Investment Programme 2005-2009.

Hence, with the assistance of the European Commission, the Government of Guyana is preparing a Sea Defence Sector Policy Framework to be funded under the 8th EDF. The S&RD Sector Policy Framework is intended to enhance the sector through a more efficient use of the services delivered by the different institutions involved, by delivering a comprehensive administrative and strategic management reform of the sector, and by strengthening the links between policies and public expenditure. It aims at improving planning, implementation, monitoring and evaluation systems.

This policy will be implemented under a Sea Defence Sector Programme (SDSP) and will benefit from EC Sector Policy Support Programme (SPSP) and budget support under the 10th EDF. The purpose of the Sea Defence Sector Programme is to :

- Rationalise the legal boundaries of areas affected by the sea and river defence network
- Align all relevant but often fragmented and dispersed policies and laws within the sector policy
- Consolidate the jurisdiction of institutions related to sea defence
- Define an institutional framework and level of participation of institutions
- Establish linkages among institutions and administrative bodies to avoid overlapping functions
- Establish a financial forecast and donors list for the sea defence sector

The overall objective of the project will be the *"improvement of living conditions in the coastal zone, stimulation of economic growth and reduction of poverty"*. An initial Draft Sector Policy Framework was prepared in September 2008.

3.2 Main Components of Existing Sea and River Defences

3.2.1 The "Three Pillars"

The three pillars of the Sea and River Defence Sector that ensures the continued existence of activity in the coastal zone are the **sea defence system**, the **drainage and irrigation system**, and the upland water reservoirs, also known as **water conservancies**. These three pillars have interconnected relationships, and failure of any one could have significant, and in fact catastrophic, consequences for the whole coastal zone.

3.2.2 Priorities

Much of the land now in use in the coastal zone lies below the mean high tide level. The priorities listed by the S&RDD for the conservation of the coastal zone are to:

- Ensure the integrity of the sea walls
- Ensure the integrity of the conservancy dams
- Ensure that water can be discharged into the sea quickly and efficiently
- Ensure that water within the populated areas can be pumped away

Such priorities are meant to ensure effective coastal zone management but are in fact limited to maintenance and functioning of infrastructure. There are many other aspects that should be considered including the role of mangroves as natural defences or the impact of taking beach sand for construction purposes.

3.2.3 Sea and River Defences

The coastal plain of Guyana lies about 1m below mean high water spring tide level and must be protected against potential flooding. According to national inventories (1972 and 1997), the current types of sea defences found along an estimated 366km of the coast of Guyana include :

- Concrete seawalls usually 1 to 2m high for a total length of about 80km
- Residual mangrove forests with protective earthen embankments or gabions of about 135km
- Natural mangrove forest and sandbanks for a total length of about 135km
- Rock *rip-rap*, 30 to 70 years old, along approximately 16km

More recent estimations for the whole coast of Guyana over 425km :

- 100km of concrete seawalls
- 170km of earthen embankments of which 50km are in critical condition with no mangrove left and in urgent need of rehabilitation;
- 130km of natural mangroves said to be eroding rapidly.

Mangroves form an integral part of the coastal protection. The residual seafront mangrove has in most locations regressed significantly. The remaining coast protected by sandbars and mangrove forests (Western coastline) is in acceptable condition.

Although the description above gives details of individual types of defences, in reality they are often mixed together and intermingled. (Figure 3-1 Mixed sea defences) This can be by design, for example where earthen slopes have been constructed behind mangroves so taking advantage of the natural wave protection provided by the mangroves, or in response to the natural conditions, for example where a stretch of concrete sea wall is constructed between stands of mangroves. (Figure 3-2) In fact, in some instances concrete sea walls, and rip rap, have been constructed in front of mangrove (Figure 3-3), presumably to halt beach foreshore erosion, which is strongly evident in many locations.(Figure 3-4)

Figure 3-1 Mixed sea defences

Mixed sea defences. Concreted paving slabs protecting toe, and concrete embrasure. Behind are mangroves which were protected by concrete wall which is now in disrepair.

Figure 3-2 Mangroves and seawalls

Evidence of sea wall having been constructed through previous stands of mangroves. The mangroves behind the seawall are flourishing. (in background). The mangroves in front of the sea wall have almost been eradicated.

Figure 3-3 Mixed defences

Mixed defences. The concrete sea wall has been constructed in front of the mangroves. Accretion has taken place in front to the sea wall.

Figure 3-4 Foreshore Erosion

Example of Foreshore Erosion. The sluice gate would originally have been on the line of shoreline. Note the mixed protection: rocks in the foreground, concreted paving to the right and mangroves in the distance.

In some locations the height of the sea wall can appear quite low. (Figure 3-5) It should be noted the sea defences are not designed to prevent complete overtopping of wave action. Sea walls are intended to reflect back incoming waves, hence the curved nature of the wall. Rip rap slopes rely on the wave energy being dissipated as the waves run up the slopes. The current sea defences are designed to limit overtopping to 20 litres / second / metre of wall, although a lower figure of 2 litres / second / metre of wall is recommended to avoid damage to the crest and back slopes. (Mott MacDonald 2006)

Figure 3-5 Sluice gate, mangroves and sea wall

Note low height of sea wall.

The drainage vanes and sluices built into the sea defence structures allow for the evacuation of water at times of heavy rain but they only function at low tide. Since the 1970s the network of dams, canals and sluices has fallen into disrepair, causing the system to be overloaded during heavy rains. Owing to the lack of adequate maintenance in the recent decades, the current state of the defences has thus become critical. An estimated 50km of the existing embankment protection badly need rehabilitation.

Transported sediments have a fine composition and so groynes are not effective as sediment traps. Also the clay and fine sediments require that embankments with sea walls must have a gentle slope in order to avoid lateral shear failure, and vertical settlement over time. The shallow *rip-rap* slope appears to be the design best suited to the poor subsoil characteristics of the coast of Guyana.

3.2.4 Drainage and Irrigation

The Drainage and Irrigation System (D&I) was first developed in the 17th century by major sugar estate owners. During the Dutch colonial period, the coastal zone consisted of a low-lying system of marine and river deposits, which formed an extensive network of tidal areas. The reclaimed land, consisting of irrigated polders drawing water from the back swamps, was protected by an intricate network of seawalls, dykes and drainage structures, and includes the 19th century East Demerara Water Conservancy (EDWC) system. The agrarian economy of the coastal region is still highly dependent on the coastal D&I system that, among other benefits, allows for biannual harvests of rice and sugarcane.

The operation of the system has not changed drastically since the original construction. It is essentially based on gravity flow supplemented with pumps. Secondary drains do not connect directly to the sea but to a facade drainage canal that runs parallel to the coastline and drains into the sea through sluice gates. During high tide, the drainage of surplus water into the sea is impossible through the sluices. Heavy rains together with high tides impede the drainage of the flooded areas, triggering the overflow of drainage waters.

Figure 3-6 Hope sluice gate and siphon (Demerara/Mahaica, Region 4)

The efficient operation of the system and drainage of the whole area depends on regular maintenance and on the efficient management of the facade canal. Canals require weeding and clearing at least three times a year to prevent vegetation growth and silting up resulting in the slowing down or blocking of the gravity flow. Over the past fifteen years, neglect of essential maintenance to the D&I infrastructure has led to the current situation of a system that no longer operates at full capacity. Some sections are totally derelict, blocked or have disappeared to accommodate development.

3.2.5 Water Conservancies

Conservancies were built to store water from upland rivers in a reservoir that could provide water for irrigation as well as drinking water. For example, in the 19th century the East Demerara Water Conservancy (EDWC) system was erected on a wetland, and consists of a major dam to the North, East and West collecting water from the uplands in the South. The level in EDWC is in the order of 2m above the level of the polders outside the dam. The conservancy provides water to GuySuCo as well as to MMA rice farmers. Any failure of the dams would cause a catastrophic release of water.

The local coastal zone is an area of reclaimed land situated between the water storage system and the protective seawall, and dissected by drainage and irrigation canals. These canals link up to the East Demerara Water Conservancy (EDWC) that provides regional agricultural lands and urban areas with irrigation and drinking water. During times of heavy rainfall this system functions as a regional drainage and flood control mechanism, removing the excess water away from the adjacent populated areas.

Here also, the excess water can only be released in the major rivers by gravity at low tide. If the biannual seasonal heavy rains occur in combination with high tides, the gravity functioning of the drainage system is impeded, only pumps can remove water, and the risk of overflow and flooding increases. The maintenance of the conservancies is a critical issue and the focus of donor support.

The conservancy dams were constructed some 150 years ago, and recent flooding demonstrated the shortcomings of the existing drainage system. The additional stress on the system imposed by potential sea level rise raises concerns about the possible collapse of the EDWC. Numerous inspections carried out by the Task Force for Infrastructure Recovery (TFIR) and the United Nations Disaster Assessment and Coordination team (UNDAC) have concluded that the EDWC dam is in poor structural condition. The dam currently has little or no freeboard during floods and has insufficient capacity during droughts. Limited overtopping did indeed occur during the floods of 2005 and 2006 but thanks to the vigilance and efforts of the staff fortunately did not result in a major breach.

The comparison of the flood level with a crest survey undertaken by the Land and Survey Commission suggests that up to 10 percent of the length of the dam were slightly overtopped in 2005. Critical works can provide a temporary respite from the risk of catastrophic failure of the system but a serious effort has to be made to tackle operation and management deficiencies.
Alternatively, the forecasted drying trend of the climate will increase the reliance on the water storage capacity during dry seasons. To meet these needs, the water levels of the conservancies would have to be maintained as high as possible in order to support agriculture and settlements. This increases the importance of effective water level management within the whole system, placing an even greater emphasis on rapid response to water level change within the system to meet water demands as well as safety requirements.

3.2.6 Sea Defences Programs

EDF is the major contributor to the funding of sea defences programs. However, since 1990 several donors including IDB, IDA, USAID and CDB have provided over US$ 40 million for the reconstruction of critical sections of the sea defences. The majority of funds are spent emergency works. The EDF is the major line of funding for sea defences, while World Bank has focused its interventions on the water conservancies. In spite of these efforts deterioration is occurring as rapidly as repairs are made. On average, in spite of ad hoc remedial works, approximately 40km of sea defences require reconstruction, and another 20km are in urgent need of maintenance and rehabilitation, at any one time.

The Inter-American Development Bank had proposed a Five Year Plan to resolve the problems associated with the maintenance and administration of sea defences. The plan includes the following recommendations:

- Promote environmentally sound land use decisions as a basis for sustainable development of the coastal zone
- Build a national capacity for integrated coastal zone management by improving the institutional and technical capacity for coastal zone management.

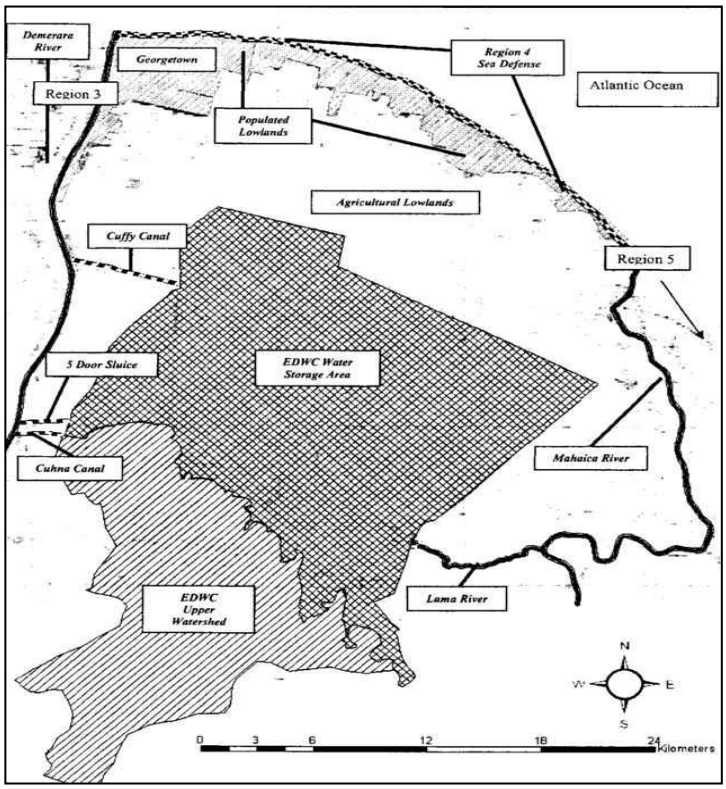
3.2.7 Drainage and Irrigation Programs

The Inter-American Development Bank (IDB, 2004) plays a major role in the drainage and irrigation sector through its Agricultural Support Services Programme (ASSP). On the basis of feasibility studies conducted in 2003/2004, the bank has launched a Drainage & Irrigation Loan for the rehabilitation of agricultural areas in Region 3, 4 and 6. The loan was later restructured and currently amounts to a total of US$ 17.5 million. Disbursements are to be engaged over a period of 5 to 6 years.

The primary objective of the ASSP is to raise rural income by increasing the efficiency of agricultural production in the coastal plains by timely availability of irrigation and improved drainage. More specifically, the programme aims at (i) rehabilitating the drainage and irrigation system, (ii) giving farmers and the WUA the capacity to manage and operate the system, (iii) supporting rice seed research and production, and (iv) promoting agricultural diversification. Hence, the programme addresses issues such as land tenure, farmer participation, fee collection and management, and the role of the WUA.

The programme is expected to rehabilitate approximately 400km of primary channels, 800km of secondary channels, 400km of service roads, 3 pumping stations and 1,200 sluice gates and other water control infrastructures.

3.2.8 Conservancy Programs



The objective of the World Bank Conservancy Adaptation Project (WBCAP) is to reduce the vulnerability to catastrophic flooding in the low-lying coastal area of Guyana that is threatened currently. This objective will be achieved through :

- Strengthening GoG and donor understanding of the EDWC system and coastal plain drainage regimes while identifying key drainage regimes for follow-up interventions
- Implementing infrastructure investments aimed at increasing the drainage capacity of the EDWC
- Strengthening institutional capacity of the GoG to manage water levels in the EDWC and to guide interventions aimed at reducing Guyana's vulnerability to floods

The project will be directed by a Steering Committee formed through an inter-agency agreement between the participating members and chaired by the Permanent Secretary of the Ministry of Agriculture. The committee will consist of senior representatives from the following agencies: the National Drainage and Irrigation Authority, the River and Sea Defence Division of the Ministry of Public Works and Communications, the Land and Survey Commission, the Civil Defence Commission, the Ministry of Finance; the Environmental Protection Agency, and Hydromet. Donors will act as observers to the committee.

Figure 3-7 The East Demerara Water Conservancy (Region 4)

At project completion, the GoG will be in possession of a master plan for future upgrading of the EDWC. Possible interventions for at least 10 key drainage regimes will be identified and presented to the donor community, and the drainage relief capacity of the EDWC to the Demerara River will be increased by at least 35% by reopening and widening the Demerara outlet. The total budget is US$ 3.8 million.

The IDB Drainage & Irrigation Loan will impact the operation of the Boerasirie Conservancy in Region 3, and East Demerara Water Conservancy in Region 4, as several of the areas to be rehabilitated are linked to these conservancies. The project aims at better flood control by developing operating rules for the conservancies.

3.3 Environmental Policy, Legislative and Planning Framework

3.3.1 Environmental Policy and Plans

3.3.1.1 National Development Strategy

Chapter 40 of the National Development Strategy 2001-2010 drafted in 1996 lists suggestions for Water Management and Flood Control Policies. The overall objectives of the National Development Strategy (NDS) are to:

- Attain the highest rates of economic growth possible
- Eliminate poverty in Guyana
- Achieve geographical unity
- Attain an equitable geographical distribution of economic activity
- Diversify the economy

The NDS defines the principal objective of sea defences as *"…to ensure that the assets, productivity and livelihood of those Guyanese who inhabit the coastal belt are protected from the ravages of the Atlantic Ocean"*. This acknowledges that sea defences are a critical component in the protection of the coastal zone.

3.3.1.2 National Climate Change Policy

Guyana signed the United Nations Framework Convention on Climate Change (UNFCCC) at the Rio Earth Summit in June 1992, ratified the Convention in November 1994 and acceded to the Kyoto Protocol in August 2003.
Guyana published a Climate Change Action Plan 21 in 2001, and a National Climate Change Adaptation Policy and Implementation Strategy for Coastal and Low-lying Areas in 2002. Guyana released an Initial National Communication in Response to its Commitments to the UNFCCC also in 2002; the Second National Communication is currently under preparation.

Guyana maintains an ongoing participation in the UNFCCC meetings as well as in the IPCC, and attended the Conference of the Parties (COP13) in Bali in 2007. Guyana has collaborated with regional programmes and institutes on climate change policy and adaptation strategies. These include the Alliance of Small Island States (AOSIS), the network of Small Island Developing States (SIDS), the Caribbean Planning for Adaptation to Climate Change (CPACC) project, the Mainstreaming Adaptation to Climate Change (MACC) project, the Rainforest Coalition, and the Caribbean Community Climate Change Centre (CCCCC).

3.3.1.3 Integrated Coastal Zone Management Action Plan

The most comprehensive document on sea and river defences is the Integrated Coastal Zone Management Action Plan. It was approved by the Cabinet in May 2001 and is intended to guide stakeholders involved in Integrated Coastal Zone Management (ICZM). The Action Plan provides technical information on natural resources, mangrove management, hydrological and climate data, aerial photographic coverage, infrastructure monitoring, surveys and the legal and institutional set up.

3.3.1.4 National Mangrove Management Action Plan

The Government of Guyana recognises the importance of healthy mangrove belts for the protection of the coastline against wave action. It acknowledges that *"the best coastal protection you can have in Guyana is a long sloping foreshore, leading to mangroves and a small earthen dam behind that"* (FAO, 1994). It is recognised that mangroves need to be protected, as they are considered a valuable element in the sea and river defence system. There is no specific legislation but there are relevant clauses in four acts, i.e. the Environmental Protection Act, the Sea Defence Act, the Fisheries Act and the Forests Act. The Government of Guyana adopted a National Mangrove Management Action Plan in November 2001, with the following objectives and sub-objectives.

General objectives:

- To conserve the mangrove resource for maximum benefit to humans involving preservation in some instances, sustainable product harvesting in others and restoration in still other instances
- To minimise those non-sustainable or conversion activities that lead to destruction of the resource

The sub-objectives are:

- To establish the administrative capacity for the management of mangroves in Guyana
- To promote the sustainable management of the mangrove forest
- To obtain local community support for the management of mangroves
- To support research and development of Guyana's mangrove forest
- To increase public awareness and education on the benefits of the mangrove forests

The plan recognises mangrove forests as an important coastal and riparian ecosystem that reduces the damage caused to defence structures by absorbing wave action, provides habitats for marine and terrestrial life forms, and gives useful products to the population. The Guyana Forestry Commission acts as the overall co-ordinating and implementing body for the National Mangrove Management Plan.

3.3.2 Legislative Framework

The sector is governed by four main legislations, two of direct relevance and two of related concern. These are : the Sea Defense Act CAP 64:01; the Sea Defense Act CAP 64:02; the Environmental Protection Act CAP 20:05 and the Drainage and Irrigation Act May 2004 respectively. There is also other legislation including Land and Survey Commission Act 1999, Water and Sewerage Act 2002, and the Guyana Forestry Commission Act (CAP 67:01). These regulations and their relevant institutions are shown in Table 3-1 below. A full description of the regulations is given in ANNEX 1 Legislation.

Legislation	Institution	Responsibilities
Sea Defence Act (CAP 64:01)	MPW&C	• Issue regulations for the protection of the foreshore; • Approve works proposed by the SDB.
	S&RDD	• Act as the actual implementation agency for all works - inspection, maintenance and construction; • Make cost estimates and plans; • Reports to MPW&C and to SDB.
Sea Defence Act (CAP 64:02)	SDB	Establishes SDB: • In charge of care, maintenance, management and construction of S&RD within 8 Sea Defence Districts; • Carry out planning and cost estimates; • Enforce regulation on offences and penalties; • Propose new regulation and formulate policy; • Supervise S&RDD.
Drainage and Irrigation Act (CAP 64:03 and Act 10 of 2004)	NDIA	Establishes NDIA: • Management, operation, maintenance, control and financing of the drainage, irrigation and flood control system and works; • Harmonise activities of water users;

		• Consultation and collaboration among SDB, the Conservancy Boards and NDIA is required by the Act. • The Act also provides for the creation of WUA.
Environmental Protection Act (CAP 20:05)	EPA	Establishes the EPA: • Puts EPA in charge of EIA; • Puts EPA in charge of co-ordinating the ICZM programme to address all aspects of coastal zone management.
Land & Survey Commission Act (1999)	LSC	Establishes the LSC: • Regulate public land management and access to land; • Advise on survey and mapping and on land policies; • Issue land titles and leases; • Obliged to co-ordinates with other relevant agencies.
Water and Sewerage Act (2002)	NWC	Establishes NWC: • Supervise water use and water resources; • Creates Guyana Water Inc. (drinking water supply).
	HD	Establishes the role of the Hydrometeorological Services: • Monitor climate change and water resources; • Collect hydrology and oceanographic data; • Provide information to other agencies.
Guyana Forestry Commission Act (CAP 67:01)	GFC	Establishes the GFC: • Implement the National Forest Policy; • Administer and manage forest resources (including a mangrove management plan); • Emphasise conservation, protection and sustainable uses.
Subsidiary to Ministry of Housing and Water	CHPA	• Produce guidelines on coastal land use planning
Aligned under Kyoto Protocol	NCU/NCC	• Address climate change issues in all aspects; • Link with UNFCCC and IPCC.

Table 3-1 S&RD Sector Legislation, Institutions and their Responsibilities.

3.3.3 Planning Institutions

3.3.3.1 Ministry of Public Works and Communications (MPW&C)

Under the Sea Defence Act (CAP 64:01), the Ministry of Public Works and Communications (MPW&C) has the regulatory powers and is entitled to enact regulations for the protection of the foreshore. These regulations are subjected to an affirmative resolution of the National Assembly. The ministry also approves the sea defence construction and maintenance works that are proposed by the Sea Defence Board. The consultant is not aware of any regulation to date, which would have been enacted by the MPW&C or the previous ministry in charge of the construction and maintenance of the sea defence structures. The two main governmental agencies acting under the authority of the MPW&C in the Sea and River Defence Sector are:

a) The Sea Defence Board (SDB), and
b) The Sea and River Defence Division (S&RDD).

Although there are no specific provisions under the current applicable legislation that are setting out the operational mode between these two institutions, the S&RDD is the actual implementation agency that carries out the sea and river defences maintenance and construction works.

3.3.3.1.1 Sea Defence Board (SDB)

The Sea Defence Board (SDB) was created in 1933 with a mandate for the *"care, maintenance, management and construction of the Sea Defences of Guyana"*. The SDB is an advisory body of the Ministry of Public Works and Communications and is required to advise on the planning and cost estimates of new

sea defences, as well as to formulate policies for sea defence, and submit these to the Minister for approval. The Minister appointed the 18 members of the current Board but the SDB has no direct funds, no permanent office nor independent secretariat, and although it is its duty to supervise the S&RDD, the SDB actually depends on S&RDD facilities.

The Board is expected to use the Draft Sector Policy Framework as a basis for the preparation of strategic master plans that will define the implementation and funding requirements of future sea defences.

3.3.3.1.2 Sea and River Defence Division (S&RDD)

The Sea and River Defence Division (S&RDD) was transferred in 1996 from the Ministry of Agriculture to the Ministry of Public Works & Communications. It can be seen as the engineering unit of the MPW&C for the sea defence sector. The main function of the Division is to carry out the construction, rehabilitation and maintenance of sea and river defences. The Division could also be seen as the implementing agency for the SDB but, as funds are made available through the national budget, the Division actually is part of the Ministry.

The present Sea and River Defence Division was formed in 1996 when responsibilities for sea defences were transferred from the Hydraulics Division in the Ministry of Agriculture to the Ministry of Public Works and Communications. Prior to this transfer the Division comprised the Project Execution and the Emergency Works units. The Division reports through MPW&C, and also reports to the Sea Defence Board, but this is a merely a courtesy as the Board has no effective control over S&RDD.

The Division is represented in most major national Water Control Agencies and is expected to play a significant role in such entities. These include the National Drainage and Irrigation Authority (NDIA), East Demerara Water Conservancy (EDWC), Mahaica-Mahaicony-Abary (MMA) Agricultural Development Authority, Boerasirie Commission, the Water Council and the National Cane Farming Committee.

In addition the Division is represented on the Integrated Coastal Zone Management Committee, co-ordinated by the Environmental Protection Agency (EPA), and on the National Climate Committee (NCC).

3.3.3.1.3 Works Services Group (WSG)

The Works Services Group (WSG) was formed by amalgamating a number of individual project implementation units which had been set up to manage donor funded roads and bridges projects. It is in charge of the construction and maintenance of the public infrastructure works.
In view of strengthening the technical capacity of S&RDD, it was suggested to merge the Division with the Work Services Group. Such a merger would mean that S&RDD staff would benefit from the better salaries and conditions of service enjoyed by WSG personnel. However, this would also place an additional burden on the management of the WSG. As the strengthening of S&RDD is one of the conditions for the launch of the 10th EDF, the merging with WSG is a plausible option. The first steps have already been made in this direction and the restructuring of the sea defence operational unit is under way, although it still needs Cabinet approval to be fully effective.

3.3.3.1.4 Transport and Harbours Department

The Transport and Harbours Department is responsible for rivers, ports and the harbour, and provides services to S&RDD at a cost. The Hydrographic Office of the Department carries out hydrographic surveys, dredging operations in navigation channels, and offers pilot services.

3.3.3.1.5 Maritime Administration Department

The Maritime Administration Department regulates shipping and ferry services.

3.3.3.2 Ministry of Agriculture (MoA)

Initially, the National Irrigation and Drainage Authority (NDIA) and the Sea and River Defence Division (S&RDD) were placed under the common authority of the Ministry of Agriculture (MoA) within the Hydraulic Division. As the successive amendments to the Drainage and Irrigation Act (Act 10 of 2004) conferred a large autonomy to the NDIA since 2001, irrigation and drainage activities were withdrawn from the authority of the Hydraulic Division. The Ministry of Agriculture still approves the construction, acquisition and maintenance of new irrigation and drainage works as proposed by the NDIA together with the relevant specifications, plans and cost estimates.

3.3.3.2.1 National Drainage and Irrigation Authority (NDIA)

The National Drainage and Irrigation Authority (NDIA) was established in 2004 as the successor of the National Drainage and Irrigation Board (NDIB). The Authority is the regulatory and co-ordinating agency responsible for the operation, maintenance, control and management of the drainage, irrigation and flood control systems in agricultural areas, and for effectively harmonising activities that enhance agricultural production. Members include regional administrations, water users associations and the Rice Producers Association.

A formal link remains between the National Drainage and Irrigation Authority and the Sea Defence Board because the Drainage and Irrigation Act requires them to consult and collaborate on all activities involving the management of sea and river defences.

3.3.3.2.2 Hydrometeorological Services (Hydromet)

The functions of the Hydrometeorological Services (Hydromet) are set out in the Sewerage and Water Act. In relation to the Sea and River Defence sector the tasks consist of monitoring climate change and water resources, collecting hydrology and oceanographic data as well as providing information to other agencies on sea surface temperatures, waves and ocean currents.

The Department operates the National Meteorological Stations Network (NMSN) and the National Hydrological Stations Network (NHSN). By collecting, processing, archiving, retrieving and analysing the data from the NMSN and the NHSN, the department can provide information to agencies that are planning agricultural projects or maintaining the sea defences. It also analyses the western hemispheric lower and upper atmospheric weather data, and ensures their availability for the necessary forecasts. In addition to its regular duties the service collects information on long-term climate trends, water flows and tides. Its main role is to monitor and collect data on the atmosphere, water, and climate, to identify changes and provide early warning of potential effects of climate change.

Previously attempts were made to strengthen the capacity of the office, notably through the World Bank financed 1998 El Niño Emergency Assistance Project. Under this project, 9 weather stations were installed and located throughout the country. Similar efforts have also been made by other donor agencies.

3.3.3.2.3 National Climate Unit (NCU) & National Climate Committee (NCC)

In April 2007 the National Climate Unit (NCU) was created under the Ministry of Agriculture as the National Focal Point for Climate Change for Guyana. The Mission of the Unit is *"to facilitate the development in Guyana of a sound knowledge base of the realities of Climate Change, and the identification and implementation of appropriate mechanisms and actions for effective response"*. In addition, the National Climate Committee (NCC) has been established in light of the growing need for actions to be taken nationally to address the potential impacts of climate change. The NCC consists of 26 representatives from key sectors in the country and was developed as a co-ordinated and inclusive approach to Guyana's response to climate change. The committee is responsible for developing cross-sectoral contributions to national policies and actions on matters relating to climate change. The NCC includes participants from the following agencies:

Environmental Protection Agency	Ministry of Finance
Hydrometeorological Services	Ministry of Housing and Water
Institute of Applied Science and Technology	Ministry of Health and Labour
Guyana Forestry Commission	Ministry of Agriculture
Guyana Manufacturers Association	Ministry of Foreign Affairs
Private Sector Commission	University of Guyana
Guyana Energy Agency	Civil Defence Commission
Guyana Natural Resources Agency	Guyana National Bureau of Standards
Ministry of Trade, Tourism and Industry	Office of the President

The Terms of Reference of the NCC are :

- Advise the relevant Ministers on developments and the need for policies and regulations in areas of climate change related activities
- Make recommendations to the Adviser to the President on Science, Technology, Energy and Environment on national measures to address issues related to several climate-related conventions and associated protocols
- Promote technical, scientific, technological and financial co-operation among Institutions/ Organisations with responsibility for climate change related activities
- Monitor and evaluate the implementation of action programmes related to the national obligations under the climate-related conventions and associated protocols
- Oversee the country's activities for the Inter-governmental Panel on Climate Change (IPCC)

3.3.3.3 Environmental Protection Agency (EPA)

The EPA is the institution that co-ordinates environmental management and provides for the management, conservation, protection and improvement of the environment, the prevention or control of pollution, and the assessment of the impacts of economic development activities on the environment. It also approves environmental impact assessment reports for any construction, including sea defence works.

One important function of the EPA is to *"co-ordinate an integrated coastal zone management programme"*. The Agency has formed a Coastal Zone Management Unit and established an **Integrated Coastal Zone Management Committee (ICZMC)**. In terms of coastal zone management the EPA restricts its role to the co-ordination of efforts, as the implementation should be carried out under the direction of the member agencies represented on the ICZMC. The ICZMC must ensure that the applications submitted for coastal developments have been examined by the relevant agency under the provision of the Environmental Protection Act before giving its consent to any development.

The responsibilities of the ICZMC are :

- Co-ordinate the activities of the various sectoral agencies that have involvement in the management of coastal resources
- Recommend policies for the identification, monitoring, utilisation and management of resources within the coastal zone
- Perform an advisory function on issues of concern to coastal zone management
- Advise the EPA on priorities for research, management and monitoring of activities within the coastal zone
- Advise the EPA on strategies, plans and programs relating to coastal zone management
- Participate as necessary in training activities for coastal zone management

The **Integrated Shore Zone Management Committee (ISZMC)** set up by the Environmental Protection Agency (EPA) brings together all 23 major stakeholders with an interest in the foreshore. Members of the committee are representatives from the institutions with an interest in the development and protection of the coastal zone. They are drawn from the following agencies :

- Central Housing and Planning Authority
- Conservation International
- Environmental Protection Agency
- Fisheries Department
- Guyana Water Inc.
- Guyana Natural Resources Agency
- Guyana Forestry Commission
- Hydrographic Office - Transport & Harbours Department
- Hydrometeorological Services
- Land and Survey Commission, Ministry of Agriculture
- National Drainage and Irrigation Authority, Ministry of Agriculture
- Sea and River Defence Division
- University of Guyana

3.3.3.3.1 Natural Resources and Environment Advisory Committee (NREAC)

The Natural Resources and Environment Advisory Committee (NREAC) is a high-level committee comprising directors of natural resource institutions, for example, forestry, mining, water, agriculture, land use, and energy, together with the Environmental Protection Agency which provides the secretariat. This committee meets on an ad hoc basis to examine any environmental and resource policy prior to its submission to the Cabinet for approval.

3.3.3.4 Land and Survey Commission (LSC)

The Guyana Land and Survey Commission is a statutory body, which advises the government on land policies. The commission is responsible for the survey and mapping of the land and water resources of Guyana, the issuance of land titles and leases for all purposes, excluding forestry and mining, and the administration of public lands. It also provides land-based information to a broad range of public and private sectors, and co-ordinates with other agencies concerned with land-based resource management with the objective of ensuring orderly and sustainable occupancy and use of lands. The commission established in 1984 that :

- Georgetown was approximately six feet below the High Water Mark of the tide;
- The gradient of the coastland is approximately half inch to the mile;
- Major breaches of sea defences would result in major loss of lives in the City;
- Any evacuation from Georgetown would be by boats.

A National Land Use Policy is in existence and provides the policy context for all land uses, including conservation land uses.

3.3.3.5 Guyana Forestry Commission (GFC)

The Guyana Forestry Commission is responsible for implementing the National Forest Policy prepared in 1997. The Commission develops and monitors standards for forest sector operations, develops and implements forest protection and conservation strategies, oversees forest research and provides support and guidance to forest education and training.

With regard to sea and river defences, the Commission has developed a National Mangrove Management Action Plan that was adopted by the Cabinet in 2002 and a draft Mangrove Policy. The Commission wishes that mangroves be declared public land and put under its direct management.

3.3.3.6 Central Housing and Planning Authority (CHPA)

The Central Housing and Planning Authority under the Ministry of Housing and Water is responsible for physical planning and housing development. The Authority keeps a close liaison with statutory authorities, including the Sea and River Defence Board, for the supply and maintenance of certain essential urban services. According to the Ministry of Housing and Water the CHPA is producing guidelines on coastal zone land use planning.

3.3.3.7 Guyana Geology and Mines Commission (GGMC)

The role of the Guyana Geology and Mines Commission (GGMC) is the promotion of mineral resources development, the provision of technical assistance and advice to mining, mineral processing, mineral resources utilisation and marketing, mineral exploration and research. The Commission supervises the enforcement of the terms of attribution of Mining Licenses. The GGMC has responsibilities linked to the Sea Defence Sector such as the quarrying of rock and other materials used for seawall and *rip-rap* construction.

3.3.3.8 Civil Defence Commission

The Civil Defence Commission has a particular and important relationship to the S&RD Sector, as it is responsible for early warning, disaster preparedness and emergency response to floods, including the relevant data collection, processing and management.

3.3.3.9 Office of the President

As mentioned above, several institutions related to the S&RD Sector fall under the authority of the President of Guyana, for example the National Climate Committee (NCC), Natural Resources and Environment Advisory Committee (NREAC), Civil Defence Commission and if necessary the Sea Defence Board (SDB). As well as these agencies many of the other bodies can make recommendations to the Adviser to the President on Science, Technology, Energy and Environment, who is located in the Presidential offices.

4 Approach and Methodology

4.1 General Approach

4.1.1 Scoping Phase

The first step in the SEA Study was the Scoping Phase that ended with the Scoping Report. This report (IBF, 2008b) describes the context and objectives of the sector policy, identifies the key stakeholders and environmental aspects establishing which issues need to be addressed, gives an outline of the scope of the study, required baseline information and methodology, and as well as an initial plan of work. The Scoping Report elaborates on:

- The description of the Sector Policy and Programme, the alternatives under consideration, and suggested variants to the alternatives
- The description of the institutional and legislative framework for the sea defence sector
- The list of environmental policies and objectives
- The list of key stakeholders concerns and opportunities to influence decisions
- Key environmental aspects to be addressed in the SEA and the extent to which social impacts should be addressed
- The scope of the required environmental baseline
- The identification of methodologies for impact identification and evaluation to be used in the SEA Study

The Scoping Report concludes on the importance of 3 core tasks:

- Collection of baseline data, identification of alternatives and mitigation measures
- Definition of a set of indicators for future monitoring and evaluation
- Collation of recommendations in consultation with the stakeholders

4.1.2 SEA Phase

For the purpose of establishing the baseline, quantitative and qualitative information was collected. Quantitative information was collected from existing monitoring and research activities while qualitative information mostly was based on stakeholder concerns and expert judgement. Among the sources and forms of information used are :

- Information included in acts and regulations, strategies, plans or programmes, which set the context for the Sector Policy (e.g. the Sea Defence Act or the Coastal Zone Management Plan)
- Government Agencies (e.g. the S&RDD) or consulting firms having worked in the area and published studies and reports, etc. (e.g. the Draft Sector Policy Framework Technical Assistance), who were able to provide environmental data as well as technical advice and information
- Other stakeholders, including donors (e.g. the IDB drainage and irrigation or WB conservancy projects), representative bodies and members of the public (e.g. the Guyanese Citizens Initiative), who have a wealth of knowledge and understanding relevant to the sector and policy

The fact finding and data collection also involved field trips and formal engagement of stakeholders in a series of semi-structured interviews.

The contacts with the stakeholders and the Consultants contracted for the development of the Draft Sector Policy Framework led to the distinction of three broad categories :

- The environmental impacts of sea defences on the environment, sea defences being taken in a broader sense, i.e. not limited to engineered or hard structures
- The impacts of the environment on the sea defences
- The impacts specifically linked to the implementation of the Draft Sector Policy Framework

The Draft Sector Policy Framework was analysed in order to extract a clear list of individual activities. To these activities, a list of impacts and corresponding indicators was attached. Impacts were considered in terms of probability, magnitude, reversibility, synergism and duration. Possible specific ***mitigation and optimisation measures*** and ***performance indicators*** were suggested for the establishment of a monitoring system. The analysis of policy implementation ***alternatives*** was also carried out on this basis.

An assessment of the ***institutional and technical capacities*** to address the identified challenges, and general considerations and recommendation on broader ***mitigation and optimisation measures*** especially in relation to climate change complete the study.

General ***conclusions*** and specific ***recommendations*** are made for each topic area. These can serve as input to the further development of the sector policy, or the Sector Programme.

4.1.3 The Severity Matrix

Many methods and techniques are commonly used in the field of EIA and SEA in order to predict and evaluate environmental impacts. For the purpose of this study, one of the most familiar methods of evaluation of impacts, the ***Severity Matrix***, has been used. Impacts of the sea defences on the environment, and of the environment on the sea defences were rated within a Severity Matrix. The method involves subjective ranking but has the merit of providing an objective framework for a consistent ranking of impacts that increases the reliability of the overall assessment process. Two sets of standard characteristics are used, significance and likelihood. Full details of the severity matrix assessment method are given in ANNEX 11 Methodology.

4.1.4 PSR - Framework

The SEA Study uses the ***PSR-Framework*** (Pressure – State - Response) used by the European Environment Agency in its reporting activities that was built on the basis of the OECD model. In a systems approach, social and economic developments exert Pressure on the environment and, as a consequence, the State of the environment, e.g. the level of biological diversity, changes. This leads to Impacts on communities and ecosystems that may elicit a societal Response that feeds back on the driving forces or on the State directly, through adaptation or curative action. From the policy point of view, there is a need for clear and specific information on:

(i) ***Driving forces*** and
(ii) The resulting environmental ***Pressures***, on
(iii) The ***State*** of the Environment and
(iv) The ***Impacts*** resulting from changes in environmental quality and on
(v) The societal ***Response*** to these changes in the environment.

Performance indicators are relevant to the sea defence policy as well as to the whole sector, as different agencies or institutions are accountable for the changes in environmental pressures or states, and can usefully be integrated into the EC Sector Policy Support Programme. The use of a determined set of indicators over time allows for monitoring the state of the environment from a general perspective, as well as for strategic planning. These are given in the assessment.

4.1.5 Stakeholder Engagement

The Scoping Report established a methodology for engagement of potential stakeholders from the sector or working in ICZM in order to encourage large involvement and ownership. The list of stakeholders relevant to the further elaboration of the sector policy is given in Table 15-1 IN ANNEX 2 Stakeholders .

The team ensured appropriate stakeholder engagement by organising a series of one-to-one semi-structured interviews adopting a qualitative approach to cover all major issues and to gather information from all stakeholders. A total of 55 officials and representatives from 33 stakeholders were successfully contacted between 23 April and 26 September 2008. (Details are given in ANNEX 2 Stakeholders)

The stakeholders were interviewed regarding their perception of the potential impacts and risks from implementing the Sea Defence Sector Programme, giving each stakeholder an opportunity to state personal concerns and ideas as well as to identify possible needs. Obviously, there was no unanimous agreement on all aspects but a large consensus emerged about the most fundamental concerns and a deeper appreciation could be gained of all positions.

Stakeholders in general showed a more holistic perception of the environment and a broad perception of the issues linked to the sector. Stakeholders of the S&RD Sector emphasised two main objectives: the protection against flooding and sustainable development.

The contents and progress of the SEA Study were discussed during a mid-term review with the S&RDD personnel on 15 and 20 October. The draft-SEA Study was circulated amongst stakeholders on 31 October in order to enable them to react on the text, and a validation workshop was organised on 12 November to solicit and share views. A technical presentation to the ECD, Government of Guyana and stakeholders was held in Georgetown on 21 November 2008. The presentation focused on the practical use of the draft report and the outcome of the discussions was taken into account in the finalisation of the study.

4.2 Geographical or Environmental Mapping Units

4.2.1 The Coastal Zone

The coastal plain of Guyana has very peculiar physical characteristics as it constitutes a narrow strip of land stretching 425km between the borders of Venezuela and Suriname, lies below sea level and is subjected to flooding and erosion. Hence, were it not for the extensive seawalls constructed over the past centuries, the coastal zone would be regularly inundated. The developed portion between the Pomeroon and Corentyne rivers is approximately 270km in length and the width of the stretch of cultivable lands increases from about 10 to 25km from Essequibo to Berbice. The coastal zone is of strategic importance to Guyana because it represents the location of almost all the economic and social development of the country. Although its surface area represents approximately 5% of the country's total area, the coastal zone is home to the majority of the population (approximately 90% or 675,000 people), including the capital, Georgetown and most of its townships located along the coast. It supports most of the agriculture and fishing, is the main transport pathway, is the location for industry and commerce, has a network of irrigation channels for water supply, and represents the main opportunity for economic growth. The country's major crops of rice, sugarcane and coconut are cultivated in the coastal zone.

The coastal lowlands are protected from the intrusion of seawater by mangroves, dikes, sluices and seawalls built over the past two centuries. Together with an extensive drainage, irrigation and flood control network, the sea defences make the coast habitable and cultivable. Without this hydraulic system, cultivation and settlement would have to be located much farther inland. However, the present rates of sea level rise associated with global climate change pose a significant threat to this coastal area and to the country’s economy. Recent flooding events (e.g. January 2005) have demonstrated the increased vulnerability of the drainage system and the shortcomings of the current infrastructure.

Due to the importance, and vulnerability of this narrow coastal strip, this area receives the most focus in the report.

4.2.2 The Major Geographical Units

The SEA Study considers the whole coastal area from a holistic approach. The baseline covers geographical units such as the coastal and estuarine waters, the inter-tidal zone and supra-tidal coastal lands, the wetlands and back swamps up to the coastal watersheds.

For obvious reasons, the whole length of the shoreline must be considered. Any decision on sea defences infrastructure maintenance or change would imply taking into account the local/regional sediment budget, nearshore hydrodynamics, position of remaining mangroves, next to the actual data on existing sea defences or the regional meteorological data.

The issue of flooding in the coastal plains makes it necessary to consider the existing drainage and irrigation network, the water conservancies, and their upland catchment areas. All back swamps and coastal marshes, where they still exist, would automatically be considered within this area, especially for their role as water regulator, or value in terms of biological diversity.

The complete coastal watersheds are considered for specific issues such as the impact of hinterland development, deforestation and clearing on the overall water balance and sediment load of the country’s major rivers. This is needed to understand the relationship between inland rainfall and the total indigenous freshwater and sediment input to the coastal zone especially in view of the potential impact of changing climate patterns. Simple models can satisfactorily handle inputs limited to a limited set of observation points for rainfall and river flow. This would be required for implementation of water management in the context of Integrated River Basin Management.

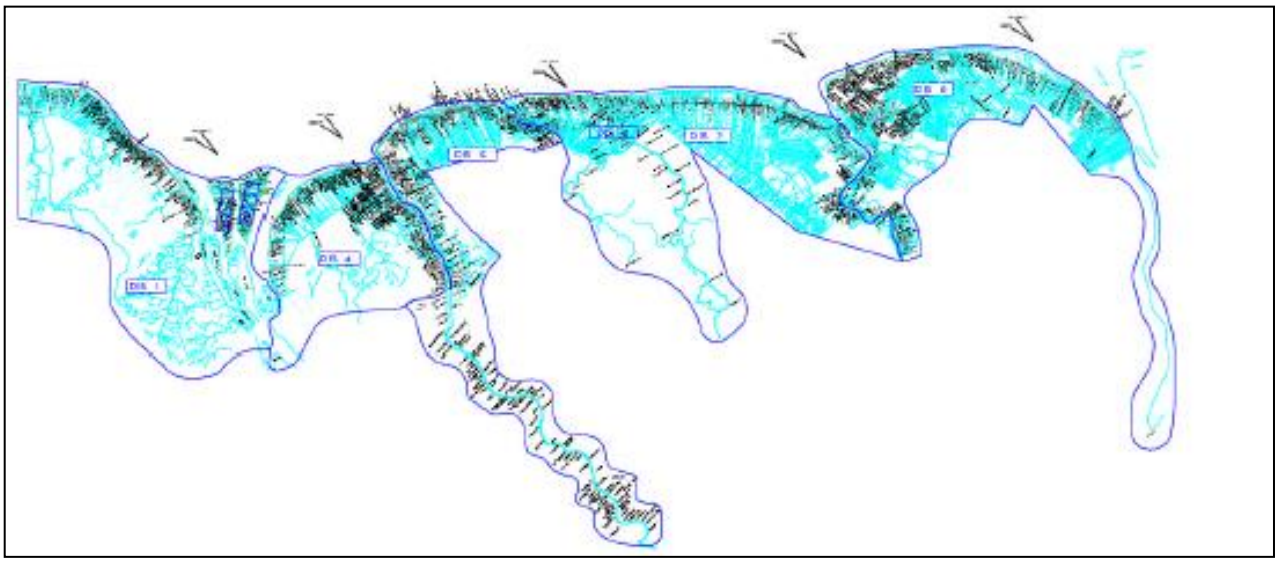


Figure 4-1 The 8 Sea Defence Districts (CAP 64:02, VI)

Although the study areas are chosen based on geographic characteristics, the actual implementation of decisions will follow the legal boundaries of the Sea Defence Districts as defined in the Sea Defence Act.

4.3 Assumptions, Uncertainties, Opportunities and Constraints

4.3.1 Timing of Sector Policy

For the sake of the SEA Study the ***assumption*** was made that the Sector Policy will not be implemented in its totality, but rather than by Policy Aim, and any particular donor could choose to fund either one or more of the Policy Aims. It was also assumed that, out of the 53 identified Activities within the S&RD Draft Sector Policy Framework, one indicator could be used to monitor several activities, as several of the activities are intended to achieve a common goal.

A major ***uncertainty*** in the study was that edition of the Sea and River Defence Draft Sector Policy Framework document was not finalised. However this is also an ***opportunity*** as it allows for the Sector Policy Framework to evolve as new stakeholder concerns surface, and ideas gain acceptance or are rejected.

The ***major constraint*** affecting the SEA is that any recommended actions must be ***no regret options***. An action where the benefits exceed the costs can be considered no-regrets, but in order to choose the most cost effective action, it may be necessary to try certain activities, accept failure and discard them. The acceptance of a possible failure means the Sector Policy can be changed, but it would be prudent not to commit to an action that may prove a costly failure. Therefore selected actions must be chosen cautiously.

There are budget and staffing issues that impose a ***constraint*** on the institutional development in the Sector Program. Disparities in salaries and ineffectual committees are but two examples and these issues will need to be addressed promptly.

4.3.2 Available Data Coverage

In Guyana, data are generally scarce and not up to date. Also, the data that have been collected often have not been processed. Only raw data are mostly available, although with significant gaps. For example, there does not seem to be any report analysing rainfall data for Guyana. The Hydrometeorological Services collect water flow data for the main rivers, but there are no annual reports or analysis available. Recent initiatives to build databases that would be accessible through a web site (e.g. 4SHORE) suffer from limited data collection, input or extraction, little use and no reporting capacity. It appears that data availability, collection analysis and interpretation, as well as the national capacity for modelling and monitoring climate change in relation to sea defences, constitutes a ***constraint***.

4.3.3 Data Needs

There are severe limitations in the availability of data on environmental baseline information including climate change. The aspects of climate change that are most relevant to Guyana's sea defences fall into three key areas :

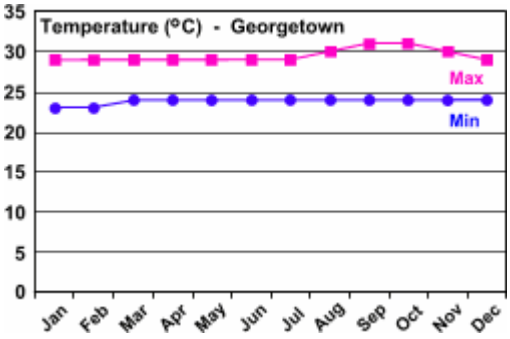
- Sea Level Rise
- Changing Weather Patterns
- Increasing Temperatures

In order to successfully mainstream response to climate change into Guyana's sea defence policy it is necessary that a combined and cross-sectoral approach is adopted for the collection of baseline information in relation to these three areas. Absence of this approach will impose a ***constraint*** on the development of the sector Program as initiatives will become compartmentalised, rather than cross-sectoral.

5 Environmental Baseline Study

5.1 General Climate

Guyana is located in the Equatorial Trough Zone (ETZ) and its weather and climate are influenced primarily by seasonal shifts of the ETZ and its associated rain-bands called the Inter Tropical Convergence Zone (ITCZ). Secondary influences on the climate originate in the Pacific. Formation of El Niño and La Niña can disturb the normal position of the ITCZ and thus result in higher or lower than normal rainfall at specific locations. The El Niño/La Niña events are primarily responsible for inter-annual variation in rainfall.



Temperature ranges between 16°C and 34°C. Lower values can be experienced at higher elevations. Along the coast, temperatures rarely rise above 31°C or fall below 22°C (Figure 5-1), due to the stabilising effect of the ocean and the Northeast Trade Winds (Hydromet). The highest temperature occurs during the September-November period. The lowest temperature occurs in the January-March period.

Figure 5-1 Minimum and maximum average monthly temperature for Georgetown (Hydromet).

5.2 Rainfall

Rainfall ranges from over 3,000mm in the forested region, to about 1,600mm in the savannah region, and averages about 2,300mm along the coast (Hydromet).

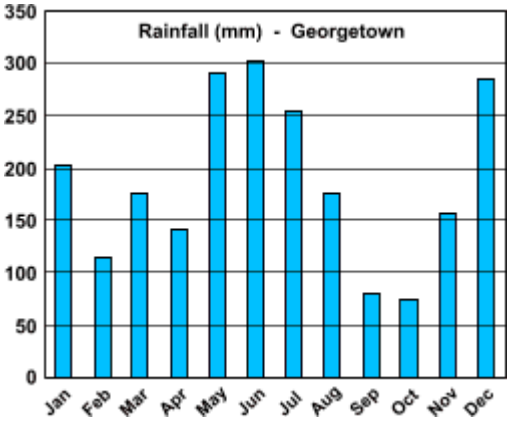


Figure 5-2 Average monthly rainfall for Georgetown (Hydromet)

The year is normally divided into four seasons: First Dry Season (February-April), First Wet Season (April-July), Second Dry Season (July-November) and Second Wet Season (November-January). There are basically two climatic provinces determined by their respective average annual rainfall, as shown in **Error! Reference source not found.**.

There are no reports analysing rainfall data in Guyana. However, an EIA report prepared for IDB by Trow International reviews daily precipitation data for the period January 1998 to December 2002, for the Botanical Gardens. For the period of record, the maximum monthly and daily rainfalls were respectively 565 and 334mm. The maximum monthly and daily rainfall occurred in January 2000 and in August 2002, respectively. The highest rainfall was recorded during the months of May to July and November to January. The months of February-March and September-October are the months of lowest rainfall.

Extreme rainfall events can also occur. In January 2005, 1,033mm of rainfall were recorded. A review of data from 1983 indicates that this represented about twice the highest monthly rainfall in the period i.e. 565mm in January 2000. Further, the 5-days total in January 2005 is 590 mm, exceeding the monthly figure of January 2000.

5.3 Wind

The wind climate along the coast of Guyana can be characterised as very moderate. Winds blow primarily from the Northeast and East (sector 15°N to 105°N). Wind speeds are usually the highest in March and the lowest in July. The average of the higher wind speeds is 7.7 knots. The average of the lower wind speeds is 4.8 knots (Trow, 2005). A wind speed of 8.9m/s, Beaufort class 4, is exceeded only 13% of the time (DHV, 2008). The coast of Guyana lies significantly South of the path of Caribbean hurricanes so the country has never experienced such events.

5.4 Watersheds

The Guyana Basin lies between the Orinoco Basin to the Northwest and West (Venezuela) and the Amazon Basin to the South (the Brazilian-Guyanese political border being on the watershed line parting the waters between the two basins). The Guyana Basin is limited to the east by the Corentyne River, which also forms the political border with Suriname.

Figure 5-3 The main rivers of the Guyana Basin (Administrative Map of Guyana)

The basin counts six main watersheds, each one being drained by one or several main rivers. To the Northwest, and encompassing a part of Venezuela that is not included in the Orinoco Basin, is the Waini-Pomeroon Basin. The Waini River mouth forms the Shell Beach area in Region 1, while the Pomeroon River is in Region 2. Further to the East, the Essequibo River (Figure 5-4) is the central feature of Region 3 and Guyana's main watershed. Just West of Georgetown and constituting the limit between Region 3 and 4 is the Demerara River. In Region 5, the watershed (known as the MMA area) includes three shorter rivers: the Mahaica, the Mahaiconi and the Abary River. Two other watersheds are drained by the Berbice River (along the limit between Region 5 and 6) and by the Corentyne River on the border with Suriname.

Figure 5-4 The Essequibo River at approximately 150km from the coast

With a water flow reaching 4,000m^3/s, the Essequibo River is by far Guyana's largest river. One of its tributaries, the Potaro River, features the highest waterfall in the world (Kaieteur Falls) with a single drop of 226m.

Based on the period 1977 to 2003, the average volume of river and overland flow in the country was 241km^3/yr (WRI, 2003c). To this must be added the volume of ground water recharge (103km^3/yr). This would yield a total of 344km^3/yr of freshwater input. However, there is an estimated 103km^3/yr that will not reach the coast to be deducted from that total, and some 1.5km^3/yr must further be deducted to account for water withdrawal for human use. This leaves a total amount of freshwater input (including ground water) into the coastal zone area of 239.5km^3/yr.

Given the extremely flat nature of the northern part of the country, major rivers have a tidal regime over great distances and are therefore very much susceptible to saltwater intrusion. For example, brackish water has been known to penetrate into the Mahaica River for more than 60km during dry season.

Water withdrawal is mainly for irrigation purposes. Hence, the agricultural sector accounts for 98% of all withdrawals (withdrawal year 1992) while the industry and domestic users each account for about 1% of the total (Figure 5-5).

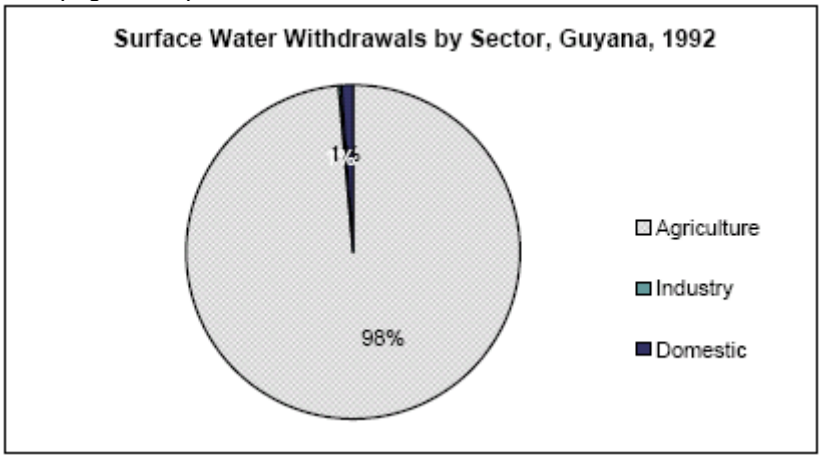


Figure 5-5 Surface water withdrawals by sector in Guyana in 1992 (WRI 2003c)

The Hydrometeorological Services collect water flow data for the main rivers. However, there are no annual reports, or analytical reports over longer periods, available for review. As only raw data with significant gaps, is available, the establishment of trends is very difficult.

5.5 Coastal Currents

Longshore currents are oriented toward the Northwest. In the past, regular hydrographic surveys were carried out along the coast of Guyana, but unfortunately this programme was stopped more than 20 years ago.

A more recent programme was undertaken to build the Shore Zone Management System database that would also be made accessible through a web site (4SHORE). Under that programme, some measurements of coastal currents were performed, though along a rather limited portion of the coast. Unfortunately, the 4SHORE system currently has limited capacity for summary data extraction and reporting, while its GIS interface is not optimised to query the 4SHORE database graphically.

However, as reported (Mott MacDonald 2006), coastal currents are only a minor environmental factor not playing any significant role in the context of sea defences, as coastal currents mainly exert an influence on the longshore circulation of mud banks.

5.6 Wave Patterns

Due to the presence of an extensive shallow foreshore, nearshore wave height normally is very low. Hence, independently from the offshore wave conditions, the maximum wave height directly in front of the shoreline is entirely determined by the local water depth. According to DHV (2008) the significant wave height (Hs) can be calculated as a fixed factor of the local water depth (d) at the coast, and gives the following results:

Hs = 0.35 * d for the Essequibo Coast and West Demerara Coast
Hs = 0.40 * d for the East Demerara Coast up to the Corentyne Coast

These results show that for half a meter of water depth, the waves that reach the shore would have a significant height of 17.5 to 20cm. Because of the long foreshore, waves are diffracted before reaching the shore and therefore are reaching the coast almost perpendicularly, with a mean period of 8s and a peak period of 10s.

5.7 Sedimentation

The coast of Guyana has a highly dynamic sedimentation pattern of shifting erosion and accretion. The sediment balance and budget is dominated by the primary influence of the Amazon River, even though this river reaches the ocean on the Brazilian coast at about 1,000km to the South of Guyana. It is generally considered that about 20% of the one billion tons per year of Amazon transported sediments reach the coast of Guyana. Given the long distance, only the finest fraction of the sediment load travels that far, being deposited in the form of large mud banks which migrate from Southeast to Northwest along the coast (Augustinus, 1999).

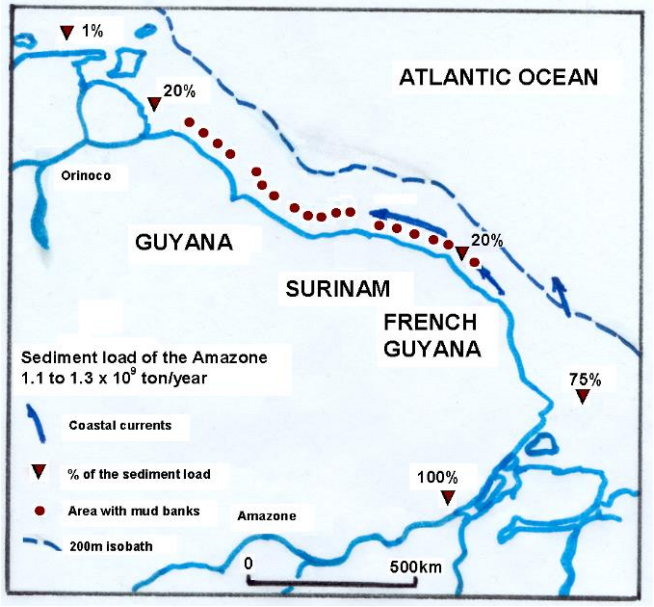


Figure 5-6 Amazon dominated sediment budget (after Augustinus, 1999)

Where longer mud banks are present the foreshore will be high. At locations in between, or near shorter mud banks, the seaward going wave action undertow will be stronger and the foreshore will be eroded. It is estimated (Augustinus 1999) that a westward displacement occurs of about 1.5km per year. For a given point on the coast, the complete erosion / accretion process will repeat with a return cycle of about 30 years. This can result in serious erosion events affecting very short lengths of the coast followed by a longer period of accretion. The Guyanese rivers also contribute part of their sand loads to the sedimentation regime which can locally cause the formation of sandy beaches.

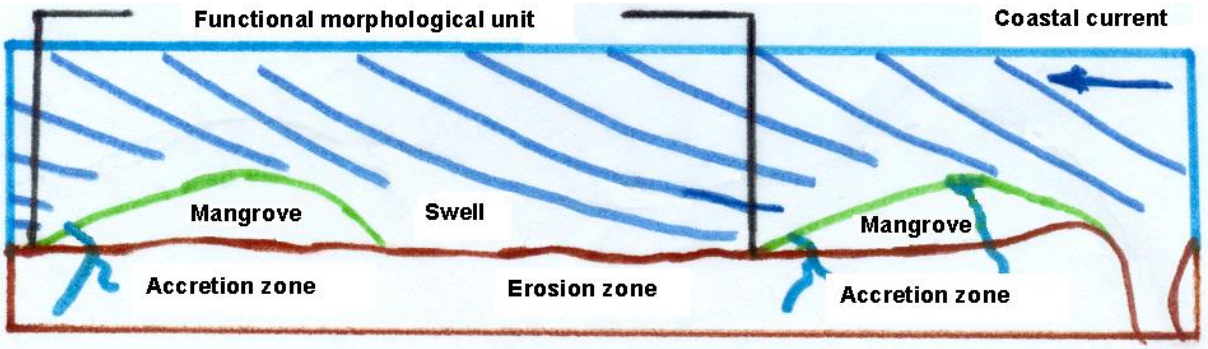


Figure 5-7 The accretion/erosion cycle along the coast of Guyana (after Augustinus, 1999)

5.8 Sea Level Rise

Tide-gauge records for the period 1951 to 1979 indicate a mean relative sea level rise in Guyana in excess of 10mm per year. This rate of increase is approximately 2 to 5 times faster than the estimated global average of 2 to 4mm per year. (Douglas, 1995 and Smith et al., 1999) This suggests that a compounding factor maybe operating on Guyana's coast, i.e. not only is the sea level rising but also the land level is sinking. One hypothesis (World Bank, 2007) is that the mainland, i.e. the Guyana Shield, is affected by subsidence. Due to the compounded effect of subsidence, sea level rise values differ quite strongly from the average global estimates of 2 to 4mm per year in the first half of the 21st century, and of 3 to 6mm per year in the second half.

5.9 Biodiversity

No formal ecological classification system has ever been applied to Guyana, and therefore no formal bio-geographical classification exists of the country's territory (Atkins 2006). However, the Agriculture and Land department (AGL) at FAO does provide a rudimentary classification, by which Guyana's coastal area lies within the *tropical moist deciduous forest* ecological zone, as illustrated in Figure 5-8 below.

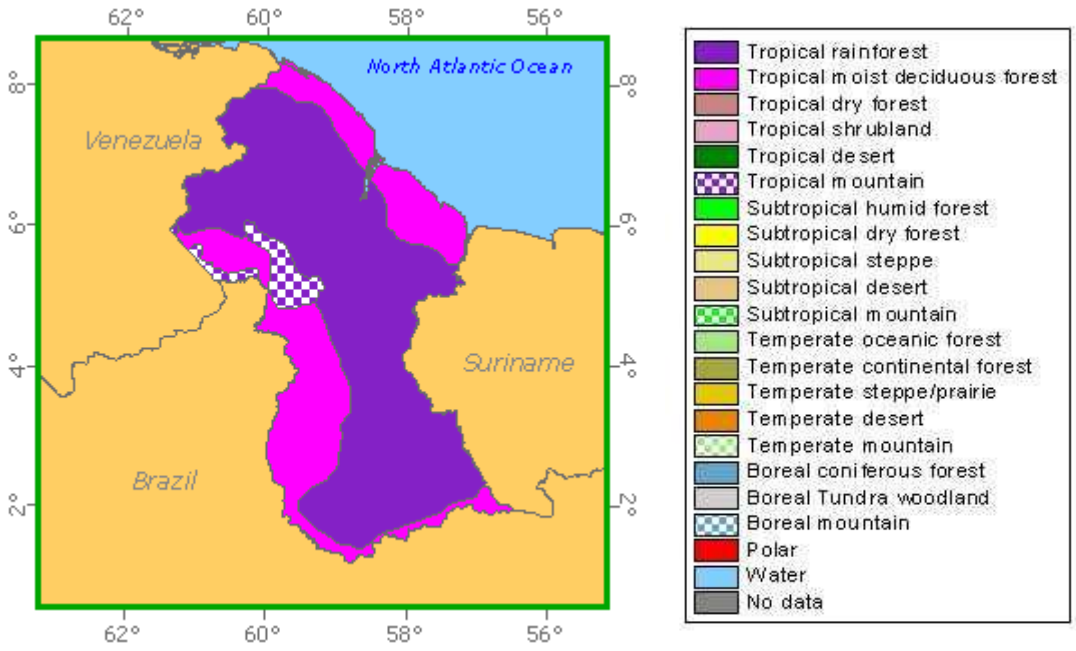


Figure 5-8 Ecological zones of Guyana (FAO/AGL)

Aside from a few fairly well preserved mangrove stands the coastal zone of Guyana has been significantly modified by human action. The population of Guyana is concentrated in urbanised areas such as Region 3, 4 and 6 as occurs between Parika on the Essequibo River and the Mahaica River. The original habitat of mangroves backed by swamps and wetlands has almost completely disappeared from these regions.

Rich and varied forests cover most of the country (Figure 5-9) and host more than thirty animal species listed on the IUCN Red List of endangered species. Some of these species, such as the leatherback turtle, are coastal species found in mangrove areas.

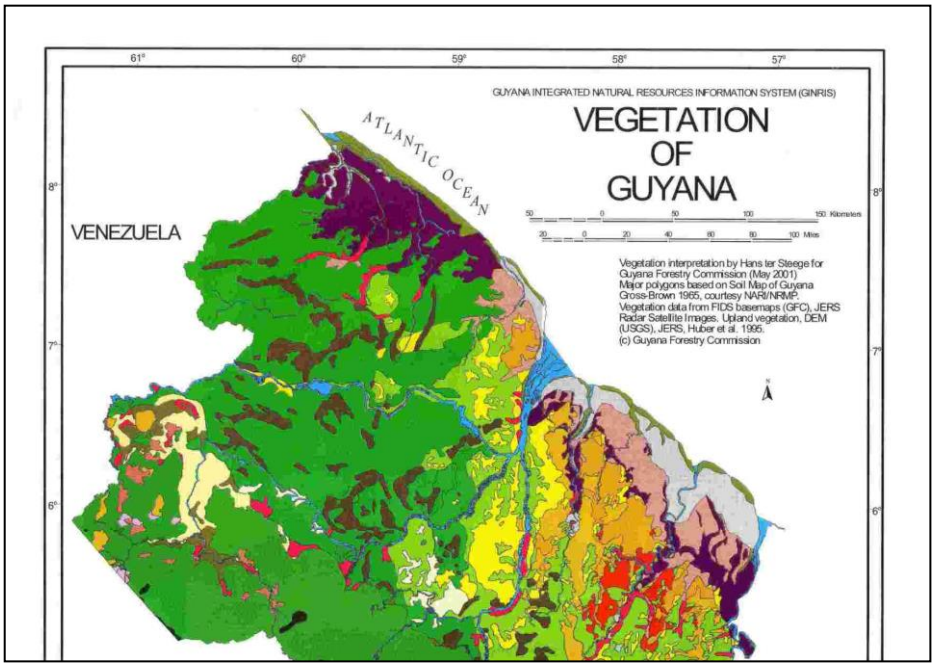
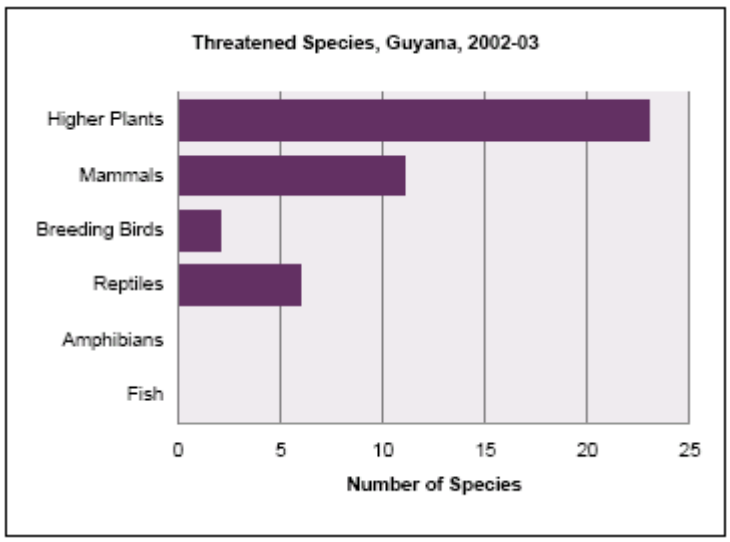


Figure 5-9 The vegetation of Guyana (GFC, 2001)

Between the forests of the interior and the coastal belt are conservancies. These are artificial systems used for drainage and water storage established on the site of a natural wetland. The system includes a reservoir fronted by an earthen dam, drainage channels used to release excess water from the reservoir, and a network of canals used to provide drinking and irrigation water. Further inland, a network of natural creeks and man-made smaller channels supports the system.



Although conservancies have been in place for 150 years, benefit from total protection as access is strictly restricted, and are considered a natural area (WB, 2007), no scientific studies or biological diversity inventory has ever been conducted in the conservancies. They reputedly host several species listed on the IUCN Red List of endangered species, such as the caiman, the giant otter, the harpy eagle, or even the jaguar. There are 42 species of mammals, birds, reptiles and plants that fall under the category of endangered or threatened species in Guyana (see Figure 5-10).

Figure 5-10 Threatened species recorded in Guyana (WRI, 2003a)

5.10 Marine Environment

Guyana's coastline is 432km long, and the Exclusive Economic Zone (EEZ) encompasses 138,240km^2. The average width of the continental shelf is 112.6km. The extent of the shelf is wider in the East and narrower in the Northwest, giving a total shelf area of 48,665km^2.

Guyana's marine environment lies within the area bounded by the Orinoco and Amazon rivers, and during the rainy season it is greatly influenced by the important sediment load and fresh water discharge from these two huge rivers, as well as from its own large rivers Essequibo, Demerara and Berbice. The fresh water affects the salinity, while the sediments (and nutrients) create a series of shifting sandbars and mudflats that cover the shelf out to about the 40m isobath. Sand gradually becomes dominant beyond this depth and is replaced by coral at about 100m depth (Figure 5-11).

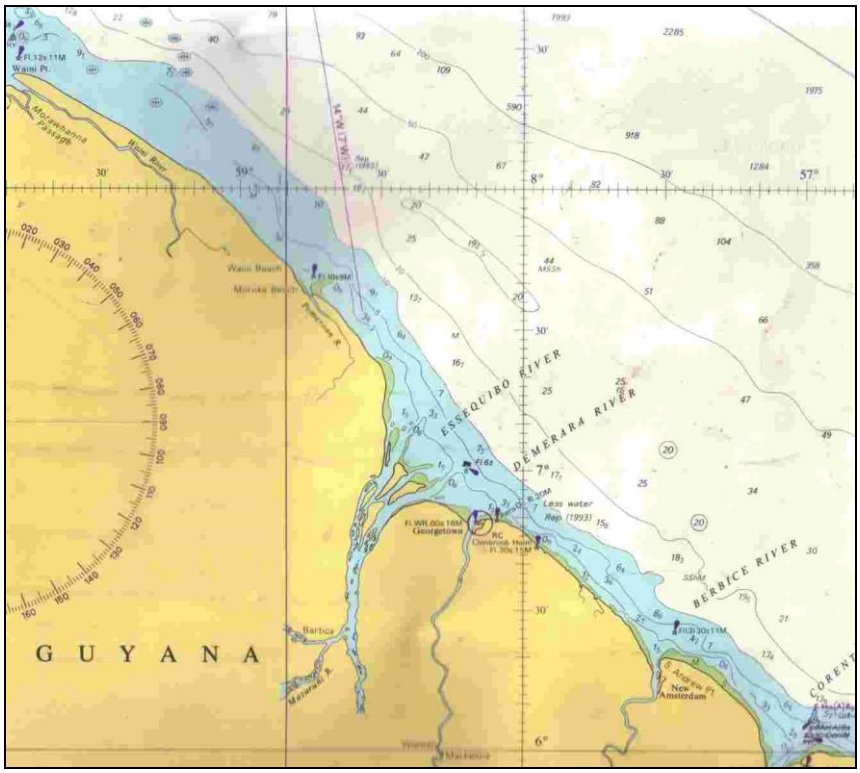


Figure 5-11 Bathymetric map of Guyana

The mud supports a rich invertebrate fauna that nourishes a variety of demersal species. Where the mangrove belt is present, primary production by phytoplankton is particularly high, sustaining rich populations of both demersal and pelagic fish species, shrimps and crabs that use the mangrove forest as feeding grounds, breeding or nursery grounds.

There is a limited amount of harvesting, especially of crab, in the intertidal and shallow sub-tidal areas along the coast, without use of vessels. The main crab species taken are the blue-back or blue sheriga (*Callinectes bocourti*), the bunderi (*Cardiosoma guanhami*) and the red sheriga (*Portunus rufiremus*).

Over the inner shelf, cool water does not reach as far inshore as further East e.g. off Suriname, probably because of the bottom configuration. The same holds when comparing with the waters off the coast of Venezuela, which enjoy a strong upwelling area in front of the Orinoco River. As a consequence, Guyana's marine life is poorer. This is illustrated by surveys (Annex 1, Map 4.2, FAO, 1988a).

Demersal fish families include catfish, croakers, snappers, grunts and groupers mainly, while pelagic fish families include sardines, anchovies, carangids, scombrids and barracudas. The few and restricted areas over the mid-shelf with somewhat higher densities show a mixture of anchovies, sardines and horse mackerels with predators: Spanish mackerels, barracudas and hairtails (FAO, 1988a). Artisanal fishermen mainly exploit finfish and also the whitebelly shrimp (*Nematopalaemon schmitti*), along with the seabob (*Xyphopenaeus kroyeri*) also exploited by the industrial fishery. The most common fish, shrimp, prawn and crab species are given in Table 5-1 below.

Table 5-1 : The most common fish, shrimp, prawn and crab species (after Geer, 2004)

Common Name	Scientific Name
Banga Mary	*Macrodon ancylodon*
Butterfish	*Nebris microps*
Bashaw	*Micropogonias furnieri*
Bonito	*Euthynnus alletteratus*
Black-tip Shark	*Carcharhinus limbatus*
Blue-back or Blue Sheriga Crab	*Callinectes bocourti*
Bunderi	*Cardiosoma guanhami*
Catfish	*Arius proops, Bagre bagre*
Cavalli	*Caranx hippos*

Cuffum	*Megalops atlanticus*
Freshwater Pacu	*Colossoma macropomum*
Giant Malaysian Freshwater Prawn	*Macrobrachium rosenbergii*
Gill Backer	*Arius parkeri*
Grey Snapper	*Cynoscion acoupa*
Grouper	*Epinephelus spp.*
Hassar	*Hoplosternum littorale*
Kingfish	*Scomberomorus cavalla*
Lane Snapper	*Lutjanus synagris*
Lobster	*Panulirus spp.*
Lukunani	*Chicla ocelaris*
Marlin	*Makaira spp. or Tetrapturus spp.*
Mozambique Tilapia	*Oreochromis mossambica*
Mullet	*Mugil curema*
Nile Tilapia	*Oreochromis nilotica*
Prawn	*Farfantepenaeus (Penaeus) brasiliensis*, *F. notialis*, *F. schmitti* and *F. subtilis*.
Queriman	*Mugil brasiliensis*
Red Sheriga	*Portunus rufiremus*
Red Snapper	*Lutjanus purpureus*
Sailfish	*Istiophorus albicans*
Seabob	*Xiphopenaeus kroyeri*
Shark	*Carcharhinus porosus, Rhizoprionodon porosus*
Silver Bashaw	*Plagioscion spp.*
Snook	*Centropomus undecimales*
Spanish Mackerel	*Scomberomorus brasiliensis*
Swamp Shrimp	*Mesopenaeus tropicales*
Trout	*Cynoscion virescens*
Vermillion Snapper	*Lutjanus spp.*
White Belly Shrimp	*Nematopalaemon schmitti*

Shrimp and prawns are the main target of the industrial fisheries. Four species of prawns (*Penaeus brasiliensis*, *P. notialis*, *P.* (*Litopenaeus*) *schmitti* and *P. subtilis*) and one species of shrimp (the seabob, *Xyphopenaeus kroyeri*) are currently exploited.

There has been a steady decline in prawn total landings and a dramatic increase in seabob total landings, particularly in the late 1990s. Prawn catches went from a high 4,240 tonnes in 1984 to only 1,086 tonnes in 2004. Seabob catches went through a peak of 25,158 tonnes in 2001, from an initial 222 tonnes in 1984, but were down to only 11,422 tonnes three years later, i.e. 2004 (FAO 2006). The consensus seems to be that the prawn resource has been overfished and that the seabob resource has reached its maximum sustainable level (Geer, 2004). It is also possible that the decrease in mangrove area available for feeding, breeding or nursing has had a negative effect on these species.

5.11 Mangrove Habitats

Mangroves are present along most of the coastline of Guyana, but mainly along the coast of Region 1, 2 and 5, as well as along the banks of most main rivers. Elsewhere they only form small isolated pockets. Fifteen years ago, their total area was estimated at more than 80,000ha (GAHEF, 1992). Thriving in highly dynamic sedimentary environments, mangroves fulfil a variety of functions, stabilising sedimentation processes along the coastline and acting as a natural barrier against wave action, storms and flooding. Moreover, as they support a highly diversified heterotrophic food chain, they form highly productive ecosystems that can export energy and matter to adjacent, comparatively poorer communities. Mangroves are offering breeding and nursery grounds to marine life (invertebrates, crustaceans, and fish) as well as nesting opportunities to a variety of birds and other animals including small mammals. Mangrove uses include for example wood for timber and fuel for local communities, the extraction of tannins or the gleaning of various species of seafood.

Figure 5-12 Seafront mangrove in West Demerara, Region 3

Natural defences such as mangroves are effective against wave energy but can suffer in the process. They are also vulnerable to littoral drift, accretion and erosion. Sand mining for construction and building along the seashore can also have an impact. The current coastal evolution of a repeated cycle of erosion and accretion of mudbanks described above means an erosion phase would never last long enough to wipe out completely the mangrove belt and expose the shore.

Originally, the mangrove belt was wide enough to sustain erosion periods and would have fully recovered before the next cycle could come. This was however giving the seafront mangrove a sinusoidal aspect (Figure 5-7). This is confirmed by early accounts of the coast of Guyana describing it completely fringed by a continuous mangrove belt. It would seem that a minimum width of 200m is necessary to maintain this equilibrium (Howard, personal communication). Due to mangrove clearings and the cutting-off of fresh water supply by sea defences, this condition gradually disappeared from most parts of the coast, allowing coastal erosion cycles to wipe out the mangrove belt (this analysis is corroborated by Hussain, 1990). In ANNEX 6 Map The continuous mangrove belt of Guyana in 1787 a map from 1787 shows the continuous mangrove belt fringing the coast from the Berbice River (near the current Suriname border) to the Orinoco River (in Venezuela). Only the major river estuaries interrupt the belt.

Guyana counts a limited number of mangrove species. Traditionally, three species were recorded: *Avicennia germinans* or black mangrove (the dominant species, Figure 5-13), *Rhizophora mangle* (red mangrove, Figure 5-14) and *Laguncularia racemosa* (white mangrove).

Figure 5-13 Black mangrove

Figure 5-14 Red mangrove

The distribution of mangrove species in Guyana follows a pattern that differs from what is usually found around the Caribbean (Pastakia, 1991). The development of mangrove in the Caribbean follows a pattern of pioneering shore colonisation by *Rhizophora spp*. With increasing stabilisation, *Avicennia spp*. invade and dominate the *Rhizophora* with a higher, denser canopy, and with *Laguncularia spp*. forming the main part of the higher, inward areas of the forest.

In Guyana, there is no evidence that pioneering *Rhizophora spp*. have been present along parts of the coast (Pastakia, 1991), which is totally dominated by *Avicennia* (together with *Laguncularia racemosa* in some localised areas). *Avicennia germinans* occurs extensively on the exposed mudflats outside the sea defence, mixed with *Rhizophora mangle* and other species inland and in sheltered areas. *Rhizophora mangle* does not normally occur in abundance in areas exposed directly to the ocean and is found in sheltered areas such as rivers and canals banks, and around islands not directly exposed to the sea (Hussain, 1990).

Important accompanying species are:

- *Spartina brasiliensis*, a grass that first colonises newly formed land in the coastal area (particularly if the sedimentation is very rapid, Lindeman, 1953);
- *Batis maritima*, a major shrub that associates with *Avicennia germinans* and the plant *Philoxorus aggrigatus;*
- *Sporobolus virgincus,* or crab grass, is found on higher ground behind *Avicennia germinans* (Hussain, 1990, and Pastakia, 1991).

Another mangrove species can be found at the back of the mangrove belt, *Conocarpus erectus*, usually considered to be a mangrove-associate rather than a true mangrove species (Tomlinson, 1986). A palm forest (Lindeman, 1953, and Figure 5-15) often occupies the back of the mangrove belt.

Figure 5-15 Palm forest at the back of the mangrove (Region 5)

The mangrove forest hosts a number of animal species, many of which are vulnerable or endangered species, or have a high commercial value.

The sand banks and shoal areas, especially at the mouth of the major estuaries, are major spawning areas for the shrimp *Xyphopaeneus kroyeri*, while the mangrove forest itself is a major spawning ground for the high commercial value species *Paeneus subtilis* and *P. brasiliensis*.

Within the mudflats, a number of crabs are found, particularly fiddler crabs, *Uca rapax*, *U. vocator* and *U. maraconai* (Spaans & Baal, 1990). Apart from the crab-eating racoon (*Procyon cancrivorous*), very few large animals (reptiles or mammals) are found within the mangrove forest, although nothing is known of the Waini region, the most natural mangrove forest remaining in Guyana. The shell beach that migrates along this part

of the Guyana coast is known to be the nesting ground of a number of marine turtles: *Chelonia mydas* (the green turtle), *Dermochelys coriacea* (the leatherback), and possibly *Lepidochelys olivacea* (the Olive-Ridley turtle) and *Eretmochelys imbricata* (the hawksbill).

Other large mammals, reptile or fish are found within the estuaries (although not necessarily dependent on the mangrove areas) include the manatee (*Tricherus manatus*), the caiman (*Caiman crocodylus*) or the arapaima (Lindeman, 1953), the largest freshwater fish in the world, believed to be an endangered species.

The avifauna is rich within the mangrove forest and the inland lagoons. The water fauna includes various herons and egrets, including the great blue heron (*Butorides virescens*), the white-necked heron (*Ardea cocoi*), the night herons *Nycticorax spp*., the common egret (*Egretta alba*), the snowy egret (*Egretta thula*), the scarlet ibis (*Eudocimus ruber*) and the glossy ibis (*Plegadis falcinellus*). Carnivorous birds include the snail kite (*Rostrhamus sociabilis*) and the turkey vulture (*Cathartes aura*). Although not identified, woodpeckers and owls have been seen within the mangrove forest (Pastakia, 1991). Lagoons could also possibly be wintering areas for migratory birds.

6 Projection of Environmental Trends

6.1 Rainfall

According to Guyana's National Vulnerability Assessment to Sea Level Rise, there has been a tendency since 1960 for lower than average rainfall, as well as an increase in intensity of rainfall events, based on the A-O GCM model of the Canadian Climate Centre. This dryer trend, together with an increased intensity of rainfall events, is confirmed by estimates from climate models developed by the United Kingdom's Meteorological Office's Hadley Centre. The Hydrometeorological Services conducted some monitoring of levels of precipitation and changing weather patterns in the past, and volunteers currently also conduct some monitoring. There is no comprehensive ongoing monitoring or measurement of changing weather patterns and levels of precipitation by the Hydrometeorological Services or any other department, so projections are difficult to make. However, the trend in rainfall patterns indicates that extreme events are likely to become even more pronounced.

The mean annual temperature and rainfall trends are more likely to vary spatially as well as seasonally with larger water deficits in southern Guyana. For example, in the medium-term, for a doubling of CO_2 concentration (ppm) in the atmosphere scenario, an increase in excess of 1.5°C (instead of the 1.2°C of the synopsis) is expected in southern Guyana in the Second Dry Season (August to October). Rainfall is expected to decrease by 12mm per month or higher instead of the average 10mm per month of the synopsis in the First Wet Season and Second Dry Season (May to October). In the latter part of the 21st century, with a tripling of CO_2 concentration (ppm) in the atmosphere scenario, temperature and rainfall would also show a stronger variation in the southern part of the country. Evaporation and water deficit also show regional and seasonal variability.

Estimates obtained with other climate models support the prediction that Guyana will experience a general drying trend. Guyana may be amongst the most affected countries in the world, with average precipitation decreasing by roughly 1mm per day by 2050. El Niño Southern Oscillation events are known to have severely affected Guyana especially in the last decade of the 20th century.

6.2 Coastal Erosion

Currently, there appears to be no meaningful database on coastal erosion due to climate change as there are not sufficient mapping and GIS resource available for the coastal zone. Hence, distinguishing between normal erosion cycles and events that are specifically due to climate change is impossible.

The full length of the shoreline must be considered for the baseline acquisition and trend projection. A full-fledged coastal evolution timeline should be established to study and quantify recent coastal trends and fluctuations as well as the spatial variability associated with seasonal, annual and short-term environmental forcing.

6.3 Saltwater Intrusion

Since the floods in 2005 the non-governmental organisation, the Guyanese Citizens Initiative, has carried out considerable work on assessing coastal communities' access to safe water. From these studies, it appears that saltwater intrusion is already taking place. However, there is currently no accurate assessment of the extent to which saltwater has intruded into the coastal freshwater aquifers of Guyana and if there is a correlation with sea level rise. The monitoring of seawater intrusion is necessary to determine and predict future groundwater decline.

6.4 Soil Salinity

Linked to the observed intrusion of saltwater is the increasing salinity level of soils in the coastal zone. Salinity is a measure of the concentration of soluble salts in the soil. Sodium chloride is the most common salt. Other salts include bicarbonates, sulphates and carbonates of calcium, potassium and magnesium. Some of these are useful and used in fertilisers but a too high concentration can also damage plant health and reduce crop yields. So far it appears that there is a lack of comprehensive, ongoing measuring and monitoring programme of soil salinity in the coastal strip of Guyana. If a trend in increasing seawater intrusion is detected then it is likely that soil salinity will also increase.

6.5 Coastal ecosystems degradation

Coastal ecosystems such as mangroves are likely to evolve and adapt to sea level rise already in the medium-term. On the other hand, some ecosystems or species will possibly suffer from changes that could even have severely detrimental effects. So far there is no meaningful data or monitoring of ecosystems

adaptation to sea level rise in Guyana, and it is important that comprehensive data be compiled on the state of coastal ecosystems and on the impacts of sea level rise on these ecosystems. As adaptation to sea level rise will be a long tem effect, establishing the current baseline should be a priority.

Among coastal ecosystems, mangroves are an integral part of the coastal defence system, representing a soft system engineering option in the range of sea defence strategies available to Guyana. Their effectiveness as a sea defence is well known but their functionality and resilience to the impacts of climate change and especially sea level rise are not.

Increasing salinity due to intrusion of saltwater in groundwater and soils, could lead to irreversible damage to ecosystems, including mangroves. There is insufficient knowledge on how increased temperatures combined with changes in freshwater inflow can adversely impact on biological diversity. Baseline data collection and monitoring should include temperature (sea surface, atmospheric) and salinity levels (water, sediment, and soil). Unfortunately, there is a lack of usable environmental baseline information on the impacts of climate change on biological diversity in the marine and terrestrial coastal zone of Guyana. In addition, there appears to be a general lack of technical capacity to monitor losses and changes in biological diversity in the coastal zone. There also is a concern that particular structures used as sea defences, e.g. the use of submerged structures such as groynes, may have an adverse effect on ecological habitats and species due to an alteration of sediment deposition patterns.

For changes over time, and trends, to be established, monitoring of the increase or decrease of mangrove cover should start as soon as possible.

6.6 Agricultural Stress

Guyana's agrarian economy, contributing more than 35% to the national gross domestic product (GDP), is highly dependent on adequate and effective sea defences, and coastal drainage and irrigation system. The agricultural sector is generally recognised as having a significant role in nutrient cycles and carbon fixation and being highly susceptible to climate change. A greater level of environmental baseline information is required to establish impacts of climate change on agriculture and establish trends. The agricultural sector will be affected dramatically by saltwater intrusion, increased water demand from crop transpiration and greater respiration losses as a consequence of higher temperatures and decreased diurnal temperature range leading to decreased yields from agriculture. The greatest yield losses are likely to be experienced in two main staples, sugarcane and rice. Hence, Guyana's agricultural sector, which is mainly located in the coastal strip, has recently adopted a policy of diversification.

Analyses carried out on the basis of changes in climate variables for the agricultural sector, predict that yield losses will affect sugarcane and rice. These losses would be triggered by increased water demands from crop transpiration and greater respiration losses as a consequence of higher temperatures. There may be changes also in yield quality due to a decreased diurnal temperature range resulting in, for example, decreased sucrose content. There also is uncertainty in assessing the effect of fertiliser and pesticide use on crop yields as a result of the increase in temperature. An adjustment of the levels of application may be an effective stabilising response in extreme years. Nevertheless, spatial shifts may have to be considered as climate change takes effect. There may be the need for a substantial switch of crops or species of crops in particular areas. In addition, changes in farm profitability can be expected to affect non-agricultural sectors of the economy. Studies would have to examine the possible advantages of increased CO2 concentration and the effects of increased temperature, rainfall and evaporation on the major crops in Guyana.

6.7 Forestry

It is expected that CO_2-induced climate change can impact on the forestry sector in a similar way than in agriculture. Based on the Holdridge classification and the classical climate scenarios, the possibility of change in the sector shows that :

- With a doubling CO_2 concentration, the forests in Southern Guyana may be affected with the *shrub savannah* spreading southward to replace the *tall evergreen forest*; and
- With a tripling CO_2 concentration, the same areas can be affected but also the Northwest may be affected by a similar change to *shrub savannah*.

However, if the dry seasons get drier, this may impose severe constraints on forest growth and may be critical in determining species response to increasing levels of CO_2.

6.8 Vector- and water-borne diseases

Typical water-borne diseases will proliferate due to the increased frequency of flooding events.

6.9 Extreme Events

Flooding and storm surges are two of the most devastating events expected in Guyana, although hurricanes are not experienced. An early warning system that could help in protection from storm surge has recently been put in place for the Caribbean through the introduction of a Radar Project. The extent to which this system is effective is yet to be fully proven.

6.10 Sea Level Rise

The level of the sea does not rise by the same amount everywhere. The earth rotation, local coastline morphology, general oceanic circulation and currents, vertical movements of the earth crust, tidal patterns and variation in seawater density, for example, have an influence on the magnitude of sea level rise at a given point on the globe. Regular measurement and monitoring is required in order to properly establish the baseline for sea level rise in Guyana but there appears to be no meaningful data and currently there is no ongoing monitoring or measurement of sea levels by the Hydrometeorological Services or any other department. Sea level rise baseline data collection should be a first priority in terms of impact mitigation.

Particularly relevant to Guyana is the possible effect on sea level rise related to the alleged subsidence of the Guyana Shield.

Modelling conducted to predict climate change for Guyana's Initial National Communication in Response to its Commitments to the UNFCCC (2000) and National Vulnerability Assessment to Sea Level Rise (2002) established the net change in sea level from 1951 to 2005 at 1.8 feet (i.e. approximately 55cm). Sea level is projected to rise in Guyana by about another 40 cm (1.3 feet) by the end of the twenty-first century. Moreover, if the contribution from melting land ice is also considered, then the rise could reach about 60cm (nearly 2 feet).

The impacts of climate change on the sea defence system and coastal plain of Guyana are predicted to be extreme, resulting in breaching and overtopping of the sea defences as well as in failure of the drainage and irrigation system. A combination of sea level rise, change in precipitation pattern and intensity, increase in temperature and variations in wave action due to extreme events threatens the already degrading sea defences.

6.11 Land Development

The major issue remains the rapid and uncontrolled development of the coastal zone. The concentration of agriculture and business provides much of the employment. The pressing need for housing development increases the extent of vulnerable settlements in areas that are prone to flooding. Housing schemes are constructed at a fairly rapid rate and the integration of housing plans in the management of the sea defences and drainage system appears to be very limited. Hence, development is actually occurring in areas that were historically designated as flood retention basins and spontaneous development or land invasion also plays a significant role.

6.12 Modelled Trends

In terms of environmental trends linked to climate change, little hard data are available and one must rely on the predictions made by a few general models. For example, models (IPCC, 2007) show that globally, the sea level is expected to rise by 28 to 43cm but studies (Singh, 1997) show that the rate in the Caribbean may be expected to be significantly higher than the globally predicted levels. A brief overview of the expected trends for the various environmental components determined by climate change in Guyana is given below in Table 6-1. Among other sources, Guyana's Initial Communication (2000) and National Vulnerability Assessment to Sea Level Rise (2002) are the most useful reference documents.

Table 6-1 : Synopsis of projection and trends affecting the environmental baseline

Current to short-term	**Medium-term** (doubling of CO_2 concentration in the atmosphere)	**Long-term** (tripling CO_2 concentration in the atmosphere)
Temperature rise		
Records show a 1.0°C rise between 1909 to 1998	The projection is a 1.2°C rise in the period 2020 to 2040	The estimations are a 4.2°C rise in the 2nd half of the 21st century

Sea level rise		
Estimations show a 55cm rise from 1951 to 2005 rate of 10.2mm per year	The projection is a 15 to 30cm rise in the period 2020 to 2040	The projection is a 40 to 60cm rise by the end of the 21st century
Rainfall		
Generally above or about normal annually, prior to 1960	Tendency to below normal rate of 10mm per month annually, since 1960	Tendency to decrease rate of 21mm per month Expected rainfall pattern change: 1. more intense periods of rain 2. longer dry spells
Evaporation		
	Insignificant increase on average less than 3mm per month	Expected increase up to over 12mm per month
Water deficit		
	Insignificant increase on average about 8mm per month	Expected increase up to over 21mm per month
Extreme weather events		
No significant effect of hurricanes (due to near equatorial position)		Expected spin-off of change: Increased winds, storm surges
Flooding		
		Expected worsened situation due to changed weather patterns and frequency / intensity of extreme events
Water balance		
		Expected worsened situation due to changing weather patterns and increased flooding

7 Draft Sector Policy Framework

7.1 Description of the Draft Sector Policy Framework

The Draft Sector Policy Framework comprises 5 Policy Aims, 10 Strategic Objectives and 53 Activities. It is intended that the activities will evolve during the further development of the policy and consultative process. These are shown in Table 7-1. A more comprehensive description of each activity is given in ANNEX 3 Actions under the Draft Sector Policy Framework. This may be consulted for reference, because this constitutes the basis for the identification of impacts and indicators relevant to the implementation of the sector policy.

The vision of the sector is *"to reduce the risk to people and the developed and natural environment from flooding and coastal erosion from the sea and the rivers by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures"*. The sector is built of three major complementary components :

1. The sea defence infrastructure system that protects the coast from the sea
2. The drainage and irrigation infrastructure system that protects from flooding by the rivers
3. The system of Conservancy Dams that retain the water from upland peak-flows

The Draft Sector Policy Framework recognises the importance of :

- The necessity to combine all levels of policy-making, planning, research and action over a wide range of organisations at different levels from local to national
- The necessity to integrate actions in a comprehensive approach linked especially to ICZM, land use planning and catchment management.

The rationale for the Sector Programme is to align and co-ordinate the course of action of several ministries which traditionally lack coherence and direction toward the achievement of a common set of goals, and to harmonise and enhance their policies on sea and river defences.

7.2 Sector Institutional Needs Assessment

In addition to the Draft Policy Framework for the Sea and River Defence Sector (draft report of 29 August 2008) the Institutional Needs Assessment, Sea and River Defence Sector, Guyana: "*Final Report - Assessment of the Present Condition of the S&RD Sector*" (30 June 2008) was reviewed.

The Draft Sector Policy Framework states that *"notwithstanding the substantial engineering efforts to build and maintain the sea and river defence system, some additional economic, social and environmental criteria are demanded beyond the technical rehabilitation of the dams, for a sustainable and efficient management of the sea defence system"*. It also says that *"the Sea Defence Sector Programme will work most effectively when the budget responsibilities of main actions are confined / defined in terms of the area of a single sector ministry"*.

The Institutional Needs Assessment also stresses that *"Guyana's National Development Strategy 2001-2010 states there will be need for an effective, permanent agency to manage maintenance tasks"*. Also, the Needs Assessment states that *"the Minister for MPW&C considers sea defences prices are too high when compared with road works. However, S&RD works are by their nature difficult to implement properly as tides interfere with the works"*.

The Draft Sector Policy Framework document also states that *"ICZM Sector Programs embracing too many ministries have generally proven problematic and have rarely secured sustainable improvements"*. The Needs Assessment insists that *"the main issue is how to ensure a strong link between the existing Integrated Coastal Zone Management processes and the day-to-day regulation by administrative decision-makers"*.

These statements highlight the institutional problems which impose a major constraint on the effectiveness of the Sea and River Defences sector.

Table 7-1 **POLICY FRAMEWORK GLOBAL AIMS AND STRATEGIC OBJECTIVES**		
Policy Aims	**Strategic Objectives (SO)**	**ACTIONS**
I. Sea and River Defence Infrastructure Management	SO1. Maintenance and Investment Plan of Sea and River Defences Infrastructure	1.1. define clear set of Preventive Maintenance targets 1.2. Improve transparency and comprehensiveness of maintenance expenditure in the budget 1.3. Integrate Recurrent and Capital Expenditure 1.4. Infrastructure Investment Plan
II. Information Systems and Research Priorities	SO2- Improving The Knowledge Base Surveillance and Monitoring & Evaluation of Sea and River Defence Infrastructure	2.1. Monitoring the budget 2.2. Establish Surveillance and Inspection Plan of Physical condition of Sea and River Defence Infrastructure 2.3. Create a Monitoring and Evaluation Mechanism for S&RD sector
	SO3 Creating a Research Centre	3.1 Create a policy research UNIT in close collaboration with University for Sea and River Defence m 3.2 GAP analysis of Knowledge Resources 3.3. National Baseline Assessment 3.4. Create and Information and Data Base Network 3.5. Create Data and GIS center for information sharing
	SO4 Public Awareness, Training and & Capacity Building	4.1. Targeted Research Policy 4.2. Create a Training and Capacity Building Program 4.3. Design a Public Awareness campaign on SRD and Mangroves 4.4. Awareness of flood risk among the institutions and the affected communities
	SO5 Assessment of Flood Risk	5.1. Develop a Flood Risk Assessment
	SO 6 Create an Early Warning and Emergency Response System	I.O. 5.1. Develop an Early warning System
III. Strengthening and enforcement of law and Institutional framework	SO 7. Institutional Reform	7.1. Sea and River Defence Board Reactivation through reforms and institutional strengthening 7.2. Share responsibilities for Maintenance costs between S&RDD and local governments
	SO 8. Law Enforcement & Regulation	8.1. Reactivate and assign the Sea and River Defence Board responsibilities as a Law enforcement Unit to work as a supervisory body
IV. Discourage Inappropriate Land Use	SO 9. Land Use Restriction and development planning	9.1. Land Use Planning
V. Sustainable Water Management	SO 10 Water Management and Planning	10.1 Preparation of Water Level Management Plans
		10.2 Reporting system on the impact of sea defence operations on habitats covered by national Biodiversity Action Plans

8 Impact Identification and Evaluation

8.1 Key stakeholder concerns

The major concerns identified were :

- Legal, i.e. conflicting mandates and weak law enforcement
- Institutional, i.e. overlapping responsibilities and lack of human capacity
- Environmental, i.e. appropriate technology, role of mangroves and climate change
- Social, i.e. awareness, safety and public health
- Operational, i.e. maintenance planning and budgetary constraints
- Long-term sustainability, i.e. ILUP and ICZM capacity, poverty alleviation

The specific concerns about the environment, i.e. biological diversity, sediment budget, freshwater balance, meteorological factors, early warning and disaster response, mangrove protection and restoration, land use, and climate change are treated extensively below together with the stakeholder views on impacts and mitigation.

8.1.1 Legal Issues

Officials do generally recognise the existence of comprehensive legislation and regulations but emphasise the general lack of law enforcement, in spite of the considerable powers granted to various agencies, as well as the significant lack of co-ordination between authorities. For example, local authorities allow residential development by issuing building permits without checking on land ownership or the limitations imposed on construction in flood prone areas. In addition uncontrolled spontaneous developments are becoming a significant issue. As a result, houses have been built in land reserves allocated for sea defences, or even alongside and actually in drainage canals. The Sea and River Defence Division complains that it cannot enforce legislation on private land, or over other agencies who have issued a permit.

Guyana's National Vulnerability Assessment to Sea Level Rise (2002) summarises the situation as follows. *"The assessment of the existing environmental land use and building laws indicates that while generally, statutory powers are established in existing legislation to respond to the potential or likely effects of sea level rise, there are some gaps and weaknesses that need to be addressed…. The legislative framework is generally too outdated to offer any significant influence. This is reflected vividly in the inadequacy of fines and penalties, the lack of coordination among agencies, inadequate institutional arrangements, the absence of modern day principles such as the precautionary principle and reliance upon alternative enforcement and compliance methods. More importantly, the legislative process has not kept pace by passing the required implementing legislation. And in the isolated circumstances where regulations were made, they have become rigid and inflexible and their application to the issues presented by sea level rise and climate change is generally inadequate."*

8.1.2 Institutional Issues

According to the S&RDD and NDIA, the number of agencies with intersecting jurisdiction over coastal zone management creates a sense of confusion due to overlapping responsibilities. For example, the responsibility for the construction and maintenance of the sea defences clearly rests with the Sea and River Defence Division but the maintenance and operation of sluice gates, and the drainage of freshwater into the sea is the responsibility of the National Drainage and Irrigation Authority. The stewardship of coastal zone areas falls under the jurisdiction of several agencies so that mangroves, sluice maintenance, fishing activities, cattle grazing, farming on embankments, or the dumping of wastes are all out of the control of the S&RDD.

Agencies face a continuous out-migration of skilled personnel leading to a severe lack of capacity. This is particularly prevalent in the Sea and River Defences Division. The Hydrometeorological Services face the problem of lower wages in comparison with other Caribbean countries. Commonly stated reasons for dissatisfaction are the lower salaries in relation to other governmental agencies, the temporary nature of contracts and unclear conditions of employment, and the fact that project staff leave soon after training for the private sector or abroad.

8.1.3 Ecological Issues

There is considerable debate on which are the best marine structures to be employed as sea defences. A combination of structures seems to be most likely depending on the location, i.e. the existing coastline characteristics, tidal regime and level of risk to be faced. Control of coastal erosion by use of submerged

structures such as groynes is under consideration but their effectiveness has been questioned due to the fine nature of sediments transported in the littoral zone. Changes in sediment deposition patterns may have an adverse effect on ecological habitats and so disturb the existing species distribution and diversity index. Also the changes in freshwater inflows can affect salinity levels which in turn cause alterations to breeding patterns and ecological niches.

The Guyana Forestry Commission has specifically made suggestions to declare mangroves Public Land to be able to enforce sustainable management practices. Pilot projects have been suggested but so far with little success. The commission insists that mangroves should be protected in their own right as a source of high biological diversity and as a natural sea defence. EPA noted that a certain level of degradation of biological diversity has already been observed in mangroves. It deplores that there are no funds for mangrove restoration, though areas have already been identified, and that there is a general lack of financial resources for the implementation of policies on mangrove protection. The Fisheries Department expressed the concern that aquaculture activities are not properly regulated. Feeder-canals are allegedly cut through the mangrove belt and embankments to allow seawater into the aquaculture ponds.

There is broad consensus that climate change including sea level rise poses significant and wide-ranging challenges for Guyana in terms of its national development, the livelihood of its communities and its Sea Defence Policy. Also the general lack of environmental baseline data is perceived as a factor preventing efficient and concerted action.

8.1.4 Social Issues

The concentration of agriculture and business in the coastal zone provides employment, leading to a pressing need for housing development. Housing schemes are constructed at a rapid rate but the integration of housing plans in the management of the sea defences and drainage system appears to be very limited. Development is actually extending the level of vulnerability to flooding.

A Relocation Policy for illegal squatters or vulnerable groups was already suggested 15-20 years ago, but never implemented, as it was thought to be impractical and unpopular. There is a perceived lack of public awareness, education and outreach relating to sea defences, and a need to strengthen the collaboration of the public with the sea defence sector among other regarding land use planning. Also there is genuine concern for the considerable health risk associated with overloading drainage systems as potable water supplies may be contaminated by sanitary waste.

There is strong concern regarding the effects of a failure of sea defences or overtopping on the city infrastructure and on the people depending on that infrastructure. The Georgetown area between the Demerara and Mahaica rivers lies below sea level and there is no provision made for the victims of natural disasters. Early warning systems and disaster response mechanisms are felt to be insufficient to give appropriate warnings of imminent flooding to guarantee the safety of the general public. For example, the early warning radar system implemented with EC funding is thought to be too regional in scope and insufficient for localised flood warnings.

8.1.5 Economic Issues

The emphasis under the 9th EDF (EC Country Strategy paper and National Indicative Programme 2002-2007) *will shift from only rebuilding sea defences to include a programme of sustainable maintenance support*. The Government of Guyana has proposed to allocate more than half of the available 9th EDF sea defence appropriation to preventive maintenance, which is widely believed to be up to 2-3 times more cost effective than the cycle of neglected maintenance, disrepair and subsequent expensive re-construction. A periodic maintenance programme should hence replace the practice of ad hoc emergency repairs, and it is therefore commonly felt that the absence of policy needs to be addressed swiftly. New ways are to be sought as according to the IDB, all access possibilities to concession resources have been exhausted and the Government of Guyana now has to face higher rates for borrowing.

Officials recognise that there is a need for the establishment of a strong, thorough and on-going monitoring and evaluation programme of the status of sea defences. This should include the D&I system, the conservancies with their drainage system, as well as the riverbanks that may be affected by the discharge from the conservancies. The role of preventive maintenance is emphasised through the implementation of a periodic maintenance programme rather than the present ad hoc emergency approach. For example, to avoid unnecessary wastage there is a need to evaluate, reduce and control avoidable environmental and economic losses due to shoreline erosion and flooding. The EPA also expressed the concern that this SEA

Study might be used as an excuse for not performing the needed EIA studies for the works associated with the policy implementation. Another concern from EPA is whether the recommendations made in this SEA Study will be appropriately incorporated into the policy.

There also is a broad concern for budgetary sustainability, as in the past a large proportion of government expenditure was allocated to the sea defences. The availability of means to maintain sea defences in the future is a concern. This concern stems from the merging of the S&RDD into the Ministry of Public Works and Communications. It is felt that this could lead to a loss of transparency and an increased uncertainty regarding the availability of budget, as for example the ministry also covers the building of roads and bridges. Levies have been suggested as a means to collect the needed funds but imposing taxes on vulnerable persons seems inequitable to many stakeholders.

8.1.6 Long-term Sustainability

Several stakeholders perceived the need to promote environmentally sound land use decisions as a basis for sustainable development of the coastal zone. For example, the EPA regrets that the ICZM committee so far has had little impact. However, the Ministry of Housing and Water and its Central Housing and Planning Authority are preparing guidelines for building and construction in the coastal areas. But so far, there is no rational land use plan, hence, no zoning map. This is seen to lead to a negative impact of land use on the coast. For example, sawmills or small ports are known to have deliberately caused damage to the sea defences in order to get access to the river or to the sea.

Also other agencies think that there is an urgent requirement to build national ICZM capacity by improving the institutional and technical capacity for the implementation of coastal zone management strategies. There is a broad concern regarding the general lack of technical capacities and the observed degradation in biological diversity, especially in mangroves.

There is also a general consensus regarding the lack of public awareness, i.e. regarding sea defence integrity and the value of mangroves, in spite of the awareness-building efforts that have been taking place. It is recognised that sustainability cannot be achieved without genuine public awareness but also that the lack of response to public awareness campaigns stems not from disinterest but from the more urgent needs imposed by the high level of poverty.

8.2 Impacts of Sea Defences on the Environment

8.2.1 Sediment budget

Any hard structure developed along a sedimentary coast may affect the balance between the input and output of sediment in a given area i.e. the sediment budget. A negative budget would imply coastal erosion, whereas a positive budget suggests accretion. Both of these imbalances could threaten the sea defences, including mangroves, in that area. However, there is a local contribution of sediment and sand from local rivers and streams. Structures such as sluices and vanes, the drainage and irrigation system and the conservancies are all sediment traps and can have a local impact on the formation of beaches and estuaries

The impact on the sediment budget should thus be investigated through the collation and analysis of existing data on sediments, longshore currents and tides. Seawalls and *rip-rap* likely will not have a significant impact on the sediment budget as most of the sediment along the Guyana Coast originates from the Amazon and is transported from Southeast to Northwest with the longshore current.

The impact of the built structures on the sediment budget is rather localised even though permanent, but the magnitude is moderate to low. Therefore, the overall impact of the sea defences structures on the sediment budget is of ***medium likelihood*** and ***moderate significance***.

The impact of the Sea Defences on the Sediment Budget is classed as ***Moderate Severity***.

8.2.2 Water Balance

Climate change may cause increased rainfall intensity, or droughts, and new conservancies will store more water, all of which could modify the overall water balance in either direction. However, one may reasonably expect that the overall peak flows of freshwater to the coast will increase in intensity. Constructed sea defences, acting as a barrier to free water flow, definitely have an impact on the freshwater balance. The critical point is the working of the sluices and vanes as inadequate drainage can have local or regional effects in times of heavy rain or high tides, and cause flooding. Alternatively, increased drainage to cope with excessive flows can deliver more freshwater quickly to the marine environment and upset the salinity balance with significant effects on coastal ecosystems.

The impact of the built structures on the water balance is rather widespread even though temporary but will become more frequent with climate change. The magnitude of the disturbance will usually be high. Therefore, the overall impact of sea defences structures on the water budget environment is of ***high likelihood*** and ***major significance***.

The impact of the Sea Defences on the Water Budget is classed as ***High Severity***.

8.2.3 Mangroves

Mangroves can be affected in two ways by constructed sea defences. The development of additional seawalls, *rip-rap* areas, conservancies and the location of sluices and gates can exacerbate coastal erosion which affects the root systems of mangroves. Alternatively, the facade canal and sluice system which delivers freshwater to the mangrove stands can be blocked by sea walls, and this could be one of the causes for their observed regression and for the loss of the natural protection that they offer.

Seafront mangroves reduce wave damage to seawalls and embankments but the construction of a new seawall at the back of a mangrove belt does to some extent affect the mangrove by cutting off most of its freshwater supply. This could result in hypersaline soil conditions, which could prevent seeds from hatching. In the medium-term this could lead to the disappearance of the affected mangrove belt.

The impact of the built structures on the mangrove is localised, though permanent, and the magnitude is quite high. Therefore, the overall impact of the sea defences structures on mangroves is of ***medium likelihood*** and ***major significance***.

The impact of the Sea Defences on Mangroves is classed as ***High Severity.***

8.2.4 Biodiversity

Disturbed sedimentation, freshwater imbalance, soil salinity changes and regression of mangrove stands will in the medium-term have negative impacts on the local biodiversity. The impact of the built structures on the biological diversity acts as a compounding factor. Therefore, the overall impact of the sea defences structures on biodiversity is of ***high likelihood*** and a ***major significance***.

The impact of the Sea Defences on Biological Diversity is classed as ***High Severity.***

8.2.5 Fisheries

As result of the impacts on mangroves and biological diversity, it is very likely that the fisheries sector will also be affected. Numerous species of crustacean and fish targeted by the fishing industry depend on mangroves in a variety of ways e.g. feeding grounds, shelter, or nursery grounds. Fisheries may thus indirectly be affected by the construction of sea defences, especially if the overall area of mangroves decreases. A change in biological diversity may have either a positive or negative impact on particular species, as it is the balance between the species that most likely will be affected.

The impact of the built structures on fisheries acts as a compounding factor. Therefore, the overall impact of the sea defences structures on fisheries is of ***high likelihood*** and ***major significance***.

The impact of the Sea Defences on Fisheries is classed as ***High Severity.***

8.2.6 Public Health

The development of a sea defence infrastructure obviously is expected to have a tremendous impact on public health in many aspects. Most impacts would indeed be significant and positive, e.g. reduction of the loss of lives by drowning, waterborne diseases associated to flooding, contamination of drinking water, scarcity of foodstuffs through crop destruction, poor sanitary conditions, damage to households, etc.

The impact of the built structures on public health acts as a compounding **positive** factor. Currently overtopping would have a low likelihood and medium significance. However, this assumes that the drainage system operates correctly and ignores the issue of sea level rise. Therefore, the overall impact of the sea defences structures on public health is of ***medium likelihood*** and ***positive significance***.

The impact of the Sea Defences on public health is classed as ***Beneficial.***

This classification of ***Beneficial*** represents the positive benefit provided by the sea defences assuming they operate effectively. If one considers sea level rise, changing weather patterns and a failing drainage system, which compound current impacts, then the impact of the Sea Defences on public health is classed as **negative** and ***Moderate Severity***.

8.2.7 National Economy

The development of a Sea Defence Sector Policy Framework, with its accompanying maintenance, repair and/or extension works, obviously has a major impact on the national budget. Besides the costs, it is expected to yield economic benefits in many aspects. Most impacts would indeed be significant and positive, due to the expected reduction financial losses due to crop destruction, damage to property, households and the industry, etc.

The impact of the built structures on the national economy is widespread even though temporary in nature, but the magnitude is moderate to high. Therefore, the overall impact of the sea defences structures on the National Economy has a ***medium likelihood*** and ***positive significance***

The impact of the Sea Defences on National Economy is classed as ***Beneficial.***

However, with a failing drainage system unable to cope with changing weather patterns, and the acceleration of sea level rise, overtopping and flooding would have a ***high likelihood*** and ***major significance***. In this case the impact of the Sea Defences on National Economy is classed as High Severity.

8.2.8 Sea Defences Impact Severity Matrix

A preliminary rating of the overall impact of the sea defences on the environment can be given in a severity matrix for the major areas of concern. The matrix shows that the environmental price to pay for some economic benefits is quite high.

The ratings are given for the overall impact of the sea defences on the:

1. Sediment budget
2. Water balance
3. Mangroves
4. Biological diversity
5. Fisheries
6. Public health
7. National economy

6. Public health – with sea level rise, changing weather patterns, failing drainage system
7. National economy - with sea level rise, changing weather patterns, failing drainage system

Note:
6 and *7* represent the positive benefit provided by the infrastructure in optimal conditions, while 6 and 7 represent the current compounded impacts including sea level rise and changing weather patterns with a failing drainage system.

Of particular interest is the impact on mangroves. As mangroves are a natural component of the environment, these negative impacts are indeed largely bound to the presence of built structures. This demonstrates the value of mangroves as natural sea defences.

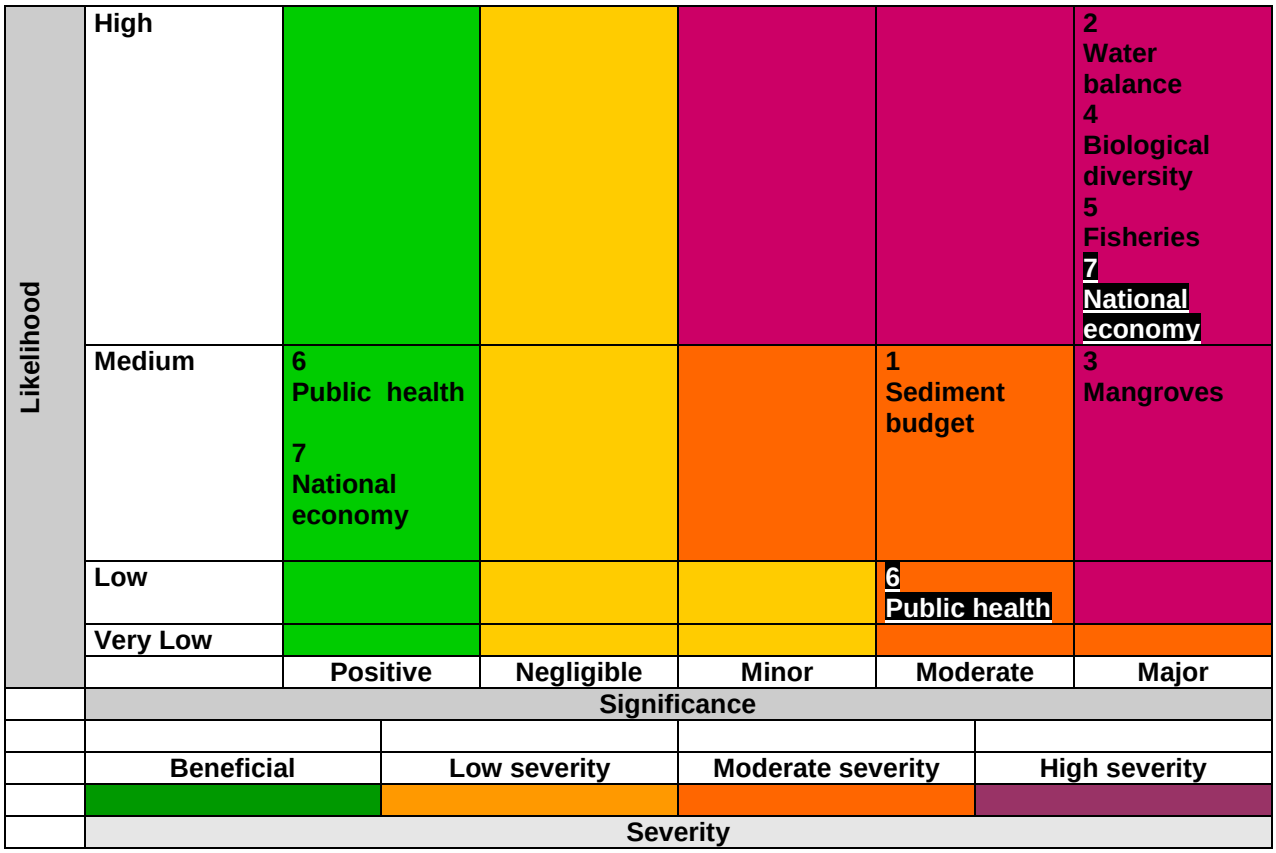


Figure 8-1 Sea Defences Impact on Environment - Severity Matrix

8.3 Impacts of the Environment on Sea Defences

8.3.1 Nearshore hydrodynamics

Climate change causing increased run-off or new conservancies trapping an increased amount of sediment could modify the overall river sediment load. However, it is doubtful that there will be a significant impact on the coastal sediment balance considering the large input from the Amazon. Impacts will probably remain local but river mangroves and estuaries will be affected and the stability of natural defences in these sites should be investigated.

The extent of the impact of nearshore hydrodynamics on the built structures or mangroves is localised, but permanent. The magnitude is moderate to low except during extreme events, which are becoming more frequent with climate change, and increasing in magnitude. Therefore, the overall impact of nearshore hydrodynamics on the sea defences structures has a ***medium likelihood*** and ***moderate significance***

The impact of nearshore hydrodynamics on sea defences is classed as ***Moderate Severity.***

8.3.2 Winds

Depending on their direction and speed, winds may affect sea defences, natural or artificial. Winds generate waves and swells that break on the shore and in the long-term can have a destructive impact on artificial sea defences. Storms can generate devastating waves capable of destroying seafront mangroves. Winds generate geostrophic currents, which can also carry sediment, deposit their load and block infrastructure or trigger and exacerbate coastal erosion. Winds can hence have an impact on both natural and artificial sea defences.

The impact of winds on the built structures or mangroves is rather localised even though permanent, but the magnitude is moderate to low except during extreme events that are becoming more frequent with climate change and increasing in magnitude. Therefore, the overall impact of winds on the sea defences structures has a ***low likelihood*** and ***moderate significance***.
The impact of winds on sea defences is classed as ***Moderate Severity.***

8.3.3 Rainfall

Rainfall determines overland flow and the hydraulic regime of rivers. With climate change the frequency and intensity is likely to change putting an increasing pressure on the water conservancies and drainage system as well as on the peak flow rates that need to be evacuated through the defences i.e. sluices and gates. Inability to cope with peak flows can lead to overtopping and the destruction of these structures.

The impact of rainfall on the built structures or mangroves is rather widespread even though temporary, but the magnitude is moderate to high except during extreme events that are becoming more frequent with climate change with a very high magnitude. Therefore, the overall impact of rainfall on the sea defences structures has a ***high likelihood*** and ***major significance***.

The impact of rainfall on sea defences is classed as ***High Severity.***

8.3.4 Sea Level Rise

There is no meaningful data, and no ongoing monitoring or measurement, of sea levels by Hydromet or any other governemnt department. Hence, very little is known about the actual impacts of sea level rise because so far flooding cannot be directly related to a particular increase in sea level, but to a concurring set of circumstances. Some estimates were made that shoreline retreat could be quite significant ranging from 10 to 150m according to the retained sea level rise scenario. There are also estimates that backwaters could extend from about 5 to 10km upstream for a 1m rise in sea level resulting in severe inundation up to 1 to 5 km from both sides of the rivers, even in higher reaches.

The measure of sea level rise obviously is a pressure indicator linked to the tremendous impact that is very likely to affect the whole coastal zone of Guyana especially in the medium- to long-term. Sea level rise significantly would reduce the affordable freeboard of seawalls (typically 1 or 2m currently). Resulting in higher water tables, an increased frequency, duration and intensity of flooding, sea level rise will affect all components of the environment, communities and the economy of Guyana. For example, a higher water table in built areas would affect the foundations of buildings as well as the sea defence infrastructure. Therefore, the overall impact of sea level rise has a ***high likelihood*** and ***major significance*** (see Climate Change Impact Severity Matrix, section 6.1.3.11).

The impact of sea level rise on sea defences is classed as ***High Severity.***

8.3.5 Saltwater Intrusion

Overtopping, flooding and inadequate operation and maintenance of the drainage system have an impact on the water quality in the coastal zone. However, there is currently no accurate assessment of the extent to which saltwater has intruded into the coastal freshwater aquifers in Guyana as a result of sea level rise. The high level of dependence of residents on coastal aquifers for domestic water supply (allegedly 88%, EPA, 2002) generates a high vulnerability to saltwater intrusion. Most settlements are located within a few tens of kilometres from the coast and within a few hundreds metres from riverbanks, well within the domain of impact by saltwater intrusion. Intrusion or inundation will have a significant impact by infiltration of saline water into pipelines and contamination of aquifers used as source of drinking water, and large numbers of coastal aquifers are already known that experience saltwater intrusion caused both by natural and human-induced processes.

Together with sea level rise and the lower precipitation, lower freshwater input will allow for the migration further upriver of the saltwater front, strongly increasing salinity levels further inland. As the major rivers have a tidal regime over great distances, they are therefore very susceptible to saltwater intrusion. Along the coast, mangroves will receive less freshwater input and are likely to regress.

The measure of salinity is a direct state indicator of the quality of freshwater aquifers that must be monitored in order to assess the impact of seawater intrusion on groundwater quality. The impact is very likely to affect major parts of the coastal zone of Guyana especially in the medium- to long-term and communities will suffer from freshwater shortage. Activities such as freshwater aquaculture are more likely to be affected. Soils, coastal ecosystems and the vast agricultural areas of the coastal plains will also largely be affected as they fall well within the domain of impact by saltwater intrusion. The overall impact of saltwater intrusion has a ***high likelihood*** and ***major significance***.
The impact of saltwater intrusion on sea defences is classed as ***High Severity***

8.3.6 Soil Salinity Increase

Overtopping, flooding and inadequate operation and maintenance of the drainage system also have an impact on soil salinity in the coastal zone. However, there is currently a lack of comprehensive, on-going measuring and monitoring programme of soil salinity. Soil salinity has a major impact on agricultural crops that cannot resist high salinity levels.

The overall impact of increasing soil salinity has a ***medium likelihood*** and ***moderate significance*** for communities.

The impact of increasing soil salinity on sea defences is classed as ***Moderate Severity.***

8.3.7 Coastal Erosion

Coastal erosion affects all sectors including infrastructure, settlements and communities, agriculture, ecosystems and economic development. The fisheries sector is particularly exposed as landing sites and co-operative building are mostly directly exposed, and tourism can suffer from the loss of beaches or damage to seafront resorts. However, there appears to be no meaningful database on the evolution and impacts of coastal erosion. Ancient parts of the sea defences are indeed nowadays in the sea and the mangrove is known to regress in a major part of the coastline but without an appropriate database it is impossible to quantify impacts.

Coastal erosion / accretion is known to be a cyclical process. The contribution from the Amazon to the sediment load is not likely to decrease in the near future. In the long-term it does not seem that coastal erosion will be changing dramatically as increased flooding does not imply any additional erosion. Impacts are likely to remain localised, temporary and rather infrequent. The overall impact is rated as having a ***minor significance*** and a ***low likelihood***. However, a single event may locally seem catastrophic.

The impact of coastal erosion on sea defences is classed as ***Low Severity.***

8.3.8 Coastal Ecosystems Degradation

The degradation of coastal ecosystems can mean the loss of species and biological diversity, the regressing resilience of the system to change, or in the longer term the complete destruction of the system. However there appears to be no meaningful database on the impacts of climate change on ecosystems in Guyana. Damage to coastal ecosystems will affect fragile nursery areas in mangroves and swamps with a significant impact on stock and fishing grounds. Locations that are strongly affected may loose their value for tourism.

Given the renewed interest for mangroves, as part of the sea defence system, a better knowledge of their current state and resilience to climate change induced impacts would be very important to the database. For example, it is known that an increased salinity can prevent mangrove seeds from hatching while mangroves are also known to be under normal circumstances a valuable reservoir of biological diversity.

The impacts to ecosystems such as mangroves can soon take a regional dimension and become quite irreversible. So the impact is of ***major significance*** even if of ***low likelihood***.

The impact of coastal ecosystems degradation on sea defences is classed as ***High Severity.***

8.3.9 Changing Precipitation Levels

The impacts of changing weather patterns and precipitation levels will mainly affect the agricultural sector as well as the environment and biological diversity. Yet, little is known of the potential impacts, as there appears to be no meaningful database on the impacts of climate change in this respect. For example, lower precipitation causing a lower water level in rivers will allow for the migration further upriver of the saltwater front as well as for the intrusion of saline water into groundwater and aquifers.

A database of climate change induced impacts on agricultural production and the status of ecosystems still needs to be established. Attention should be given to the possibility of alternating periods of drought and water-logging. The impact of climate change on water supply is not very clear. Decreasing rainfall and increasing evaporation can lead to lower water levels in the rivers but extreme rainstorm events can create flood conditions especially during cold phase ENSO events. The demand for water is expected to increase with increasing temperatures and the relative value of water for alternative uses would change as priorities are determined on the basis of urgency or needs.

The effects of changing weather patterns on agriculture can be summarised as follows :

- Increased irregularity in water availability with temporary overflows and periods of drought;
- Increased variability of the soil moisture contents with a possible incidence on agricultural pests.

The impacts on the agricultural sector will be seasonal but extensive with regular losses in production, those on coastal ecosystems will be more difficult to assess but still have a regional dimension. So the overall impact is of ***major significance*** even if ***low likelihood*** in the medium-term. In the long-term one could expect the high likelihood but by then effective mitigation measures could have been taken.

The impact of changing weather patterns and precipitation levels on sea defences is classed as ***High Severity.***

8.3.10 Extreme Events

The changing weather patterns and precipitation levels will mainly cause an increased frequency and intensity of storms and flash floods but so far there appears to be no meaningful database on the impacts in this respect. However, as shown by the flood event of January 2005, the overall impact on the communities and the economy is known to be catastrophic, especially when two incidents combine i.e. flood and storm surge.

Overtopping and inundation of parts of the coastal zone will have a major impact on agriculture, human settlements and tourism. Infrastructure, i.e. sea defences, buildings, roads, bridges and dams will be destabilised through the repeated periods of inundation. Water resources and fisheries will also be affected.

Tourism will suffer from damage or loss of national landmarks, e.g. ancient administrative buildings, from the disturbed infrastructure and communications, and possible damage or devastation of specific facilities and locations e.g. resorts, beaches.

The impacts of the catastrophic event, i.e. before, during and after, on communities and on most sectors of the economy are of ***major significance,*** being huge and widespread. The increased frequency makes the overall impact of ***highest likelihood*** in the long-term.

The impact of extreme events on sea defences is classed as ***High Severity.***

8.3.11 Impact of Environment on Sea Defences Severity Matrix

The severity ratings are given in Figure 8-2 for the overall impact of:

1 Nearshore hydrodynamics;
2 Winds;
3 Rainfall;
4 Sea level rise and overtopping;
5 Saltwater intrusion contaminating freshwater aquifers;
6 Soil salinity increase;
7 Coastal erosion;
8 Coastal ecosystems degradation;
9 Changing precipitation levels;
10 Extreme events;

The matrix shows that the price of “wear and tear”, that is effects of waves, wind and rain is quite high. The matrix also shows that the price to pay for maintaining economic development in the coastal zone is high.

Likelihood						
	High					3 Rainfall 4 Sea level rise and over topping 5 Saltwater intrusion into freshwater aquifers 10 Extreme events
	Medium				1 Nearshore hydrodynamics 2 Winds 6 Soil salinity increase	8 Coastal ecosystems degradation 9 Changing precipitation levels
	Low			7 Coastal erosion		
	Very Low					
		Positive	Negligible	Minor	Moderate	Major
	Significance					
	Beneficial		Low severity		Moderate severity	High severity
	Severity					

Figure 8-2 Impact of Environment on Sea Defences - Severity Matrix

As shown by the impact severity matrix, Guyana is undoubtedly very susceptible to environmental factors including climate change and sea level rise. The entire fabric of the Guyanese society, i.e. population, agriculture, industry and infrastructure is vulnerable to a slight increase in sea level, rainfall intensity, saltwater intrusion or drought.

The most exposed area is the coastal zone protected by the artificial and natural sea defences. If relocation is not considered a valid option, the potential socio-economic impacts likely to affect the population are the loss of land and natural resources, loss of businesses and sources of income, loss of social amenities, and increased incidence of water-borne diseases.

The cost incurred by damage prevention measures such as the upgrading of the sea defences and drainage systems to withstand sea level rise is likely to be very high. However, if these measures are not taken, in the long-term, relocation will be inevitable as a result of increased inundation and flooding.

Other impacts from climate change are not as directly relevant to the sea and river defence sector. For example, the energy sector will also be affected in terms of increased demand for cooling and a possibly decreased potential for hydropower. Depending on the river basin, changing weather patterns will induce a shift in seasons and river discharge affecting water supply and storage at hydropower sites.

8.4 Impacts of Draft Sector Policy Framework (i.e. policy analysis)

The overall impacts of the S&RD on the environment and of the environment on the S&RD have been discussed above. The relation of the Draft Sector Policy Framework to these concerns and issues is obviously of concern particularly where it relates issues raised by the stakeholders. A comprehensive description of these aspects for each activity in by the Draft Sector Policy Framework is given in ANNEX 4 Impacts of Actions under Draft Sector Policy Framework on Sea Defences. This will be useful as input to the prioritisation of activities when the donor areas of interest will be known. This is likely to be a major task for the Technical Assistance foreseen under the capacity building and institutional strengthening of the sea defence sector.

9 Analysis of Alternatives

9.1 Policy Timing Alternatives

The Draft Sector Policy Framework can be evaluated as a whole but it is extremely unlikely, or even desirable that time, should pass until the Policy can be implemented in its entirety. Certain actions should be implemented immediately. Also different donors may offer to fund programs to attain Policy Aims or Strategic Objectives separately.

The Policy aims are :

- Policy Aim I (Strategic Objective 1) lays the accent on the routine and preventive maintenance of the S&RD, i.e. targets, strategy and objectives, and on the need for an integrated, i.e. recurrent and capital expenditure, investment plan.
- Policy Aim II covers S&RD budget, physical condition and policy monitoring (SO2); the creation of a research and GIS centre, and of a networked knowledge base (SO3); training, awareness and capacity building (SO4); a flood risk assessment (SO5); and the establishment of a FEWERS (SO 6).
- Policy Aim III (Strategic Objective 7 and 8) focuses on institutional reform strengthening the position of the Sea Defence Board and of its link to local governments, with empowerment to law enforcement.
- Policy Aim IV (Strategic Objective 9) puts emphasis on restrictions that should discourage inappropriate land use and development planning.
- Policy Aim V (Strategic Objective 10) specifically considers water level management planning, the issue of sea level rise assessment, monitoring and prevention, and the impact of S&RD operations on natural habitats.

One may also assess the impact of the *"Do Nothing"* or *"Business as usual"* alternative where the future without implementation of the policy will be envisioned.

Do Nothing

The *"Do Nothing"* or *"Business as usual"* scenario will lead in the long term to catastrophic failure of the sea defences structures, have a major impact on the economy of the country, exacerbate unplanned development and lead to social discontent. This scenario is considered ***unacceptable***.

Short Term

The major benefits are obtained for the planned operational changes. They flow from the setting up of genuine infrastructure budgeting, preventive maintenance, capital investment planning, and policy monitoring and evaluation. Institutional reform is necessary. The current institutional arrangement is weak and cannot achieve progress. This is a priority action.

A program can be started to raise ***awareness*** on the dangers of inappropriate land use and lack of coordinated development planning. The measurement of local sea level rise can be initiated. This will add credibility to suggested mitigation measures and give "ownership" to the issue, rather than relying on secondary information from model predictions.

For the sea defence sector to function it requires the providing of operational tools, whereby lessons learned can be a **basis** for later research. Full research can come later. It is not necessary to have perfect knowledge before decisions can be taken. In fact skilful decision makers make good decisions based on incomplete information. This stage is considered ***essential***.

Medium Term

Other benefits are the development of networking, awareness and identifying knowledge gaps and starting-up specific operational research. Training and capacity building of departments should progress to stop loss of qualified staff. Having raised awareness on the risks inherent in lack of coordinated development planning, inappropriate land use should now be actively ***discouraged***. Water level management planning can commence as a long term undertaking.

The upgrading of the knowledge base and awareness, the understanding of the value of ecosystems for livelihoods, and the design of new alternative or preventive measures are all useful actions. This stage is considered ***desirable.***

Long Term
Coordinated and comprehensive development planning should be ratified to the extent that inappropriate land use can now be ***Prohibited.***

There is a lot of emphasis in the Policy on research. This emphasis is considered wrong. The problems facing the sea defences sector are well known – it is the implementation of solutions that is problematic. Redressing the lack of targeted research and awareness regarding linkages between ecosystem conservation and community livelihoods is desirable in the long term, given the critical nature of more pressing issues is, it is considered ***optional.***

The priorities and recommended phases for implementation are shown below in Table 9-1. The table presents actions as Essential, Desirable and Optional. It is assumed the GoG will agree that if actions are essential then they should be implemented immediately. In terms of prioritisation, non-essential items can be deferred. Of course essential actions may continue through the medium and long term, and having addressed the most pressing concerns it may be revealed that actions previously considered "Optional" may now be revealed to be Essential. This is the reason for the Policy needing to be flexible and subject to constant review and change.

Policy Aim	**To be implemented in Short Term**	**To be implemented in Medium Term**	**To be implemented in Long Term**
Timeline	< 1 Year	>1 Year < 5 Year	> 5 Year
Evaluation	*Essential*	*Desirable*	*Optional / Uncertain*
Business as Usual – Do Nothing Scenario	Budget for Capital program consumed by emergency works. D&I maintenance works struggle to cope. Conservancies operate at full capacity. Mangroves diminish. Shore line recedes. Illegal encroachment continues. Flooding continues	Further sea defences fail. Budget for Capital program restricted by lack of donor confidence. D&I maintenance program curtailed. Conservancies start to fail. Mangroves diminish. Shore line recedes. Illegal encroachment leads to conflicts. Flooding becomes severe.	Sea defences fail. Donor support withdrawn from capital program. D&I maintenance program curtailed. Conservancies fail. Mangroves diminish further. Shore line recedes. Illegal encroachment saturate coastal zone. Flooding regularly severe.
Policy Aim I	SO 1 S&RD targets, strategy and objectives for routine and preventive maintenance. Integrated capital investment and recurrent expenditure plan free from major change by MoF.	Continue	Continue
Policy Aim II	SO 2 Improve knowledge base but accept decisions can be made despite lack of complete data	M&E of S&RD budget, physical condition and policy	Continue
	SO 3 Creation of a research centre – waiting for research results should not be used as an excuse for lack of action	Having established baselines, define useful research objectives, not academic. Be pragmatic, publishing is not a worthy objective.	Establish operational research and GIS centre, networked knowledge base

	SO 4 Training, awareness and capacity building. In short term consider *ex gratia* payments to staff to retain them.	Implement.	Continue.
	SO 5 Flood Risk Assessment In short to medium term rely on local historical knowledge.	Check predictions are substantiated by and match historical trends	Continue
	SO6 Create a Flood Early Warning and Emergency Response System (FEWERS) **IF** civil defence response system is realistic and viable.	If civil defence response system is non viable cancel development of FEWERS.	Concentrate on flood avoidance rather than flood warning.
Policy Aim III	S O 7 & 8 Institutional reform; strengthening Sea Defence Board; strengthen link to local governments; with law enforcement powers. Consider creating new board with presidential mandate.	Continue	Continue
Policy Aim IV	SO 9 Raise ***awareness*** of dangers of inappropriate land use and development planning.	SO 9 ***Discourage*** inappropriate land use and development planning.	SO 9 ***Prohibit*** inappropriate land use and development planning.
Policy Aim V	SO 10 Water level Mgmt. ***Planning***.	***Implement & Manage***	Take heed of Lessons Learned and if necessary ***Modify***.

Table 9-1 Timeline of Policy Options

9.2 Alternative Infrastructure Design

Guyana's sea defences have evolved over time, in response to the successive extensions of the settled areas and to the changing perceptions of the nature of the threat from the sea. Today it is understood that the design of the defences has to take into account the following factors :

- As coastal plains are about 1m below mean high water spring tides, any development along the coast must be protected against flooding during high tides;
- Sea defence infrastructures must be resistant to incoming wave action, especially during high (spring) tides, and as earthen embankments would erode, either their seaward face must be adequately protected (e.g. *rip-rap*) or other types of infrastructures, e.g. concrete or sheets piling walls, should be built.
- The use of *rip-rap* armouring is considered the most appropriate and desired design option (Mott MacDonald, 2006). *Rip-rap* is sturdy, almost maintenance-free and prevents possible slipping due to poor subsoil conditions. However, it requires a significant budgetary effort.
- An engineering approach aiming at dramatically increasing the width and height of the sea walls (i.e. by building major seafront dikes) could be attempted in most locations as the required space is available but in most cases the subsoil would not be able to support the weight of such constructions. Also the financial cost would be prohibitive even with funding support from several donors.
- Sea defences must be built taking into account the existence of an erosion/accretion cycle of 30 years involving the lateral displacement of mud banks, and therefore anchored below erosion or scour level in order to avoid undermining by the seaward tow;

- Groynes are not effective under the conditions prevailing in Guyana, i.e. due to the fine nature of the foreshore materials, but may be useful along the estuaries where sand is present;
- Embankments should have gentle slopes to prevent the earth from sliding (Mott MacDonald, 2006);
- Heavy structures are likely to experience excessive settlement over time (Mott MacDonald, 2006).

However, any option for action must be thoroughly evaluated for its cost and submitted to a detailed budget analysis in order to determine whether the plan indeed is realistic and financially bearable. Complementary options should preferably be considered next to the classic infrastructure building approach.

Alternative infrastructure development would include the further extension of the existing sea defences. This could include extending the length and/or height of seawalls, extending *rip-rap* areas, but also restoring the mangrove areas, extending the area of the conservancies, or expanding the secondary drainage network. The drainage network and conservancies should be examined as a whole to determine whether the current design actually is the most appropriate.

Modification or adaptation options of the existing sea defences would also fall in this category. For example, sluice gates could be moved a short way inland (e.g. about 100 m) in order to protect them from coastal erosion and from wave action, therefore increasing significantly their life expectation.

Other technical alternatives can be proposed that would include establishing a second line of defence, seaward (against storms) and/or inland (against heavy rainfalls). Seaward it could be constituted of submerged groynes, in order to widen mudflats in front of the seawall and provide a better terrain for mangrove colonisation. Inland it could be constituted of a network of small hill reservoirs (or alternatively larger dams on the main rivers), that could be filled in case of heavy rainfall. These options are however capital intensive and not suited to the local situation.

The control of coastal erosion and restoration of beaches by use of submerged longshore groynes artificially stabilising the coast, reducing the slope and therefore extending the width of the coastal mudflats has been proposed to widen mudflats in front of the seawalls and provide a better terrain for mangrove colonisation. However, there is a concern that these particular structures may have an adverse effect on ecological habitats and so disturb the existing species distribution and diversity index due to an alteration of sediment deposition patterns. The matter remains to be studied but the fact is that given the rather fine nature of the transported sediments, groynes are not quite suitable as sediment traps along the coast of Guyana. Hence, although the technique is under consideration, its effectiveness has been questioned.

9.3 Alternative Maintenance Design

Maintenance would first consist of maintaining and repairing the existing seawalls and *rip-rap* areas, protecting mangroves, where they still exist, against further degradation, and repairing and maintaining the drainage and irrigation network in relation to the existing conservancies. Appropriate maintenance would already make a significant difference in terms of protection from the ocean and inland flooding although it does not constitute a solution to the impacts of climate change.

Maintenance fees are acceptable but not properly enforced in the agricultural sector. Water User Association should be empowered and able to efficiently manage the collected moneys. Funding remains an issue in other areas where no fees can be levied e.g. for the maintenance of seafront mangroves. The idea of a sea defences maintenance tax is known to be unpopular with all agencies and is considered impractical.

In various countries flood protection levies are calculated per habitant, owner, beneficiary, proportional to the economic value of the protected property, etc., collected by water boards and contribute to the funding of the works. Alternative approaches to the issue of maintenance, especially of natural sea defences, must be considered in terms of acceptance and willingness to pay. Institutional and cultural aspects need first to be fully understood and properly addressed.

9.4 Alternative Development

Obviously, there is no single response to the problems but the solution may be a combination of measures. This includes alternative infrastructure design and maintenance as well as the development of measures regarding the institutional, legal, social, and financial aspects of coastal zone management. The coupling to the drainage and irrigation network and to the water conservancies is a first option but other aspects can also be considered.

The drainage network could be modified in several places so that the main rivers, as opposed to the drains towards the sea and the facade canal, will actually evacuate the excess water. An efficient monitoring and forecasting system could also be developed (gathering data on wind, rainfall, tides and water level in the water conservancies), allowing for an optimum management of water flows and drainage capacity. It will be essential to link ongoing conservancy projects with drainage and irrigation development plans and sea defences design and construction programmes, to ensure consistency of design standards as well as an integrated approach to the flooding and climate change driven issues. The IDB and WB are rightfully considering a combined approach of the water conservancies and drainage and irrigation system.

From the observation of settlements it becomes obvious that older housing was ***adapted*** to flooding, i.e. built on stilts with practically no ground floor. However, due to recent population growth, housing shortage, economic issues, etc., people started to fill the spaces between the stilts to build walls and create rooms at ground floor level. Although land use is regulated at national level, in relation to coastal zone development it is not enforced. Hence, many housing construction schemes are currently taking place in inappropriate areas.

Given the threat posed by climate change, the most logical alternative is to ***retreat***, which implies the relocation of vulnerable populations. The setbacks banning new constructions within a certain distance from the shore (e.g. 100m or 200ft as recommended by the EPA) are insufficient and not enforced by local land use planning agencies. The Ministry of Housing and Water issues guidelines on coastal setbacks. New legislation could be introduced requiring people to be relocated but this does not seem to be a popular option. Indeed, wherever implemented in the world, relocation schemes are known generally to be a failure.

Local government, public services, utilities, etc. should be the first to stop building in flood prone areas. Incentives can be created to encourage people to move to other areas. For example, the new settlement should benefit from priority access to utilities and equipment (such as water, electricity and telephone networks, housing, commerce and services), public services (administrations, schools, health services, etc), amenities and work opportunities to avoid the trouble and expense of commuting towards the previous place of residence. History has shown that people can move if there is an incentive but that forced migration most often fails. This must be at the basis of a relocation policy. For example, if EU and IDB implement a new set of criteria for issuing loans for the construction of housing schemes, a conditionality could be that new development should be located outside flood prone areas.

10 Mitigation or Optimising Measures

10.1 Mitigation of impacts of the Sea Defences on the Environment

10.1.1 Sediment Budget

The control of coastal erosion and restoration of beaches by use of submerged longshore groynes artificially stabilising the coast, reducing the slope and therefore extending the width of the coastal mudflats has been proposed. The matter remains to be studied but the fact is that given the rather fine nature of the transported sediments, groynes are not appropriate as sediment traps along the coast of Guyana. The mitigation of the impact of built structures on the sediment budget would be localised.

10.1.2 Water Balance

The critical point is the working of the sluices and vanes. Mitigation measures comprise improvement, maintenance and operation of the drainage system. The installation of more powerful pumps is an option to cope with excessive freshwater flows but will impact on the salinity balance. More pumping stations will help distribute the freshwater input more evenly, and lower the impact on the mangroves and marine environment. This option requires considerably more funding. The mitigation of the impact of built structures on the water balance is possible but the financial burden will be a limiting factor.

10.1.3 Mangroves

The implementation of the sector policy would normally prevent the construction of additional seawalls or *rip-rap* close to mangrove areas, which instead would become part of the sea defence system. The construction of a new seawall at the rear of a mangrove belt encourages the natural functions of the mangrove if established at a sufficient distance. Allsopp (personal communication) recommends a setback of 200m. For the conditions of Guyana, a few kilometres would be preferred. The seawalls were in fact built much too close to the edge of the seafront mangrove preventing them from playing their natural protective role. In some case they were built in front of the mangroves so negating their benefits.

10.1.4 Biodiversity

The use of submerged longshore groynes to widen mudflats in front of the seawalls and provide a better terrain for mangrove colonisation is disputed. There is a concern that these particular structures may have an adverse effect on ecological habitats and so disturb the existing species distribution and diversity index due to an alteration of sediment deposition patterns. The matter remains to be resolved.

10.1.5 Fisheries

As for biological diversity, direct relationships and causal chains are difficult to establish for impacts on the fisheries sector. Obviously the extent of the remaining mangrove is a measure of the impact but replanting mangrove on mudflats will mostly not constitute the solution. The reason is that the condition of the whole ecosystem is determinant of the wellbeing of crustacean and fish populations that are depending on the mangrove for feeding, shelter, or as nursery. Here also, research must identify indicator species and data collected for monitoring. Again, it will be very difficult to design specific mitigation measures, and the impact of the built structures on the fisheries sector remains of major significance

10.1.6 Public Health

The issue in terms of public health is that the sea defences may fail to fulfil their role because of climate change and sea level rise. Most benefits would indeed be lost, e.g. increasing loss of lives by drowning, waterborne diseases associated to flooding, contamination of drinking water, scarcity of foodstuffs through crop destruction, poor sanitary conditions, damage to households, etc. A projection in the future would thus yield many negative impacts. Maintaining the integrity and performance of the sea defences remains a key mitigation measure.

10.1.7 National Economy

The issue in the development of a Sea Defence Sector Policy Framework obviously is the tremendous cost associated with its implementation. Besides the costs, the policy is expected to yield economic benefits in many aspects. A variety of indicators can be used and the relevant baseline economic data should be collected to evaluate the overall benefit to the national economy. An Extended Cost/Benefit Analysis (i.e. including externalities, damage, etc.) would have to confirm whether the benefits are indeed much greater than the costs of investment, maintenance and operation.

Mitigation measures must be taken indirectly in other sectors, i.e. for drainage and irrigation, conservancies or sea defences to avoid indirect impacts on the economy.

10.2 Mitigation of impacts of the environment on the sea defences

10.2.1 Nearshore Hydrodynamics

The mitigation of impacts of nearshore hydrodynamics on the stability of built infrastructure, its long-term functionality or destruction as a result of coastal erosion is not likely to be considered for older structures. For new infrastructure, the impact of longshore currents, subsoil condition, tides and wave climate should be evaluated prior to construction. Modelling is a useful tool to test and assess the validity of potential mitigation measures. The impact of nearshore hydrodynamics on the built structures or mangroves could increase during extreme events that are becoming more frequent with climate change.

Nearshore hydrodynamics are meant to enable the control of coastal erosion and restoration of beaches by use of submerged longshore groynes. The approach is meant to widen mudflats in front of the seawalls and provide a better terrain for mangrove colonisation but although the technique is under consideration, its effectiveness has been questioned due to the quality of sediment transport in the littoral zone. Little can be done indeed about the changing sediment loads of the major rivers due to changing weather patterns.

10.2.2 Winds

The impacts of changing climatic patterns are not likely to be fully mitigated and will increase with time. More destructive events are likely to take place in the future with serious impact on artificial as well as natural sea defences.

The impact of winds on the built structures or mangroves could increase during extreme events and become more frequent. Mitigation measures are unlikely to be feasible.

10.2.3 Rainfall

Capacity increase and new dimensioning standards will be needed to mitigate the impacts of changing weather patterns and especially the frequency and intensity of rainfall. Both storage and drainage are to be considered for improvement. Also new peak flow rates will need to be taken into consideration. The lack of baseline data will unfortunately impair the quick response to the need to review the dimensioning of failing infrastructures. A limiting issue is the cost of such investments.

10.2.4 Sea Level Rise

As there appears to be no meaningful data and no ongoing monitoring or measurement of sea levels by the Hydrometeorological Services or any other department, the first mitigation measure will be the establishment of a structured regime of ongoing measurement and monitoring incorporating hydro-meteorological surveys along the coastline. Therefore, the lack of financial and technical capacity must be overcome.

The primary action points are thus the measurement and monitoring of sea level rise (i.e. relative and absolute level) in order to support sound decision-making in the nearest possible future, the integration of these concerns in the sector policy, and the mobilisation of the needed budgetary allocation. Practical technical mitigation measures will only be usefully considered when reliable data will be available on the impact of sea level rise on the parameters of flooding. Whatever the decisions implemented at the level of Guyana, the pressure of sea level rise will remain identical and it is only wise at this stage to consider that the long-term overall impact will remain unchanged even though some mitigation measures may start to be implemented.

10.2.5 Saltwater Intrusion

As there is currently no accurate assessment of the extent to which saltwater has intruded into the coastal freshwater aquifers as a result of sea level rise, the monitoring of seawater intrusion will be crucial to determine and predict groundwater decline. This will be the first step toward the design of measures to mitigate the impact of saltwater intrusion.

The primary action points are thus the measurement and monitoring of saltwater intrusion in order to support sound decision-making in the nearest possible future and the integration of these concerns in the sector policy. Practical technical mitigation measures will only be usefully considered when the issue of flooding is satisfactorily under control. However, tapping new sources of freshwater supply can easily be organised if solutions are found so that the cost of transportation can be covered. Hence in the long-term the issue of freshwater availability could be resolved and the negative impact will be limited.

10.2.6 Soil Salinity Increase

As there is a lack of a comprehensive, ongoing measuring and monitoring programme of soil salinity there is little known about the impact on communities. The first step would be to install a measuring and monitoring programme. The impacts at the level of communities e.g. salt damage to housing and homestead gardens

are likely to be more localised and less spectacular than flooding. Because most often simple corrective practices could be implemented on an ad hoc basis, it is likely that the population will not perceive the overall impact as so important. However the impact on other large scale stakeholders e.g. agriculture will not be mitigated.

10.2.7 Coastal Erosion

Coastal erosion in theory affects all sectors but in the absence of a meaningful database on the evolution and impacts of coastal erosion due to climate change in Guyana, there is no quantified estimate of the impact. A robust and regular monitoring system will be required as part of the sea defence policy.

A genuine coastal database and monitoring system would support land use planning for coastal communities, reviewing shoreline stabilisation projects and S&RDD maintenance and operation strategic objectives. A detailed understanding and predictive capability spanning could be fully integrated into the sea defence policy, acknowledging that the protection of the sea defences politically is a must.

10.2.8 Coastal Ecosystems Degradation

Mitigation measures that will prevent and reverse further degradation of ecosystems are not simple to conceive or implement. The complexity of relationships and systems is such that well-meant interventions do not always have the expected results. Additional research should thus provide insights in how to enhance the inherent resilience factors of ecosystems. In the case of mangroves, the research should also aim at finding means to assist their position as an important tool in the sea defence system.

10.2.9 Changing Precipitation Levels

The mitigation of changing weather patterns by increased irrigation or diversification of crops will take place in the agricultural sector, especially in situations of seasonal drought. Water-logging periods will be more difficult to deal with in the coastal zone as drainage already is a longstanding issue. Lack of precise knowledge of the impacts on ecosystems will delay the implementation of practical mitigation measures with regard to this aspect of climate change.

To start with, the lack of technical capacity and budgetary allocation for genuine measuring and monitoring of weather patterns should receive full attention. In order to cope with the lack of financial and technical support, public awareness of the importance of monitoring these aspects of climate change should be raised and volunteers could be trained to cover some aspects of the data collection, e.g. rainfall measurements. This could in the long-term provide for an effective and comprehensive monitoring system for precipitation levels and possibly for some other weather parameters.

The mitigation of impacts on the agricultural sector will only partially be possible e.g. drought periods could be easily overcome, wet periods would cause additional pressure.

10.2.10 Extreme Events

The first step towards the mitigation of severe climate change impacts linked to the increased frequency and intensity of extreme events is the installation of an effective early warning system. A more comprehensive and therefore more anticipatory approach to storm surge should be taken. For example, a network of marine hydro-meteorological stations gathering data on sea surface temperature, wave action, ocean currents, wind speed, tides and sea level would greatly assist in disaster preparedness. The prediction and forecasting of floods and storm surges, and the likelihood of combined events must be integral part of the early warning system. The further integration of extreme climate change impacts such as floods and storm surges in the sector policy is required.

One Strategic Objective (SO6) of the Draft Sector Policy Framework is to have a Flood Early Warning and Emergency Response System (FEWERS) in place to give timely forewarning of the likelihood of flooding in order to save lives and property. It is meant to enable people to take effective action in order to minimise risk and damage.

Notwithstanding the agreed need for more data for predicting flooding, it should be noted that the FEWERS alone will not prevent flooding, but will alert residents to a forthcoming danger. However, as floods have occurred on the coastal strip for centuries this seems somewhat unnecessary. Even with prior warning, residents are reluctant to leave their homes. Flood warnings are desirable, but pointless without a realistic emergency evacuation plan which has the full consent, approval and participation of local residents and community leaders. The FEWERS scheme alone, without a realistic workable evacuation plan, is not a cost effective plan.

A European Development Fund project is assisting the Hydrometeorological Services with weather forecasting. This Regional Weather Radar Warning System project, also known as the CMO Radar Project is a six-year initiative that commenced with the signing of a financing agreement in October 2003. It is aimed at improving the level of detail available for early warning systems relating to extreme weather conditions in the Caribbean region and could help in the prediction and mitigation of the impacts from storm surges. However, the effectiveness of the system has yet to be proven.

Prediction and forecasting should thus be given a high priority but the education of the general public and officials must also be done in order to enable an effective response in case of extreme event. This requires a continuous effort starting in at the level of elementary schools.

Whatever the mitigation measures, the magnitude of future catastrophic events will remain an unknown and the impact on communities and the economy are hard to foresee in the long-term.

10.2.11 Strategic Planning

Strategic planning is essential for addressing adaptation options. The capacity to identify options as well as the capacity to respond to the observed or predicted impacts should be put in place. Disaster-prevention agencies such as the Civil Defence Commission, the military, non-governmental organisations and local communities must be prepared to respond effectively to abrupt and prolonged adverse conditions. It is also recommended that response options be considered in terms of short-term (5-year time span), medium-term (20-year horizon) and long-term (beyond the century).

10.2.12 No-regrets Options

No-regrets options are those that deliver benefits that exceed the costs, whatever the extent of climate change. Hence, in climate change issues, these should always be implemented where they exist as an option. For instance, where weather-related problems are already experienced, then cost-effective actions that effectively deal with these problems are no-regret options. No-regret options are particularly suitable for the near-term as they can deliver obvious and immediate benefits, and can provide experience on which to build for further adaptations in the longer term.

11 Environmental PSR Indicators

11.1 Uncertainties

The Draft Sector Policy Framework includes a financial forecast and estimate of donor support to the sector (not reproduced in this SEA). The most pressing uncertainties are :

- ***Are the S&RD M&O expenditures timely realised?*** The progress in percent of the monetary value of the planned expenditures on a yearly basis can be used as an indicator
- ***Is the S&RD Investment Plan properly realised?*** The progress in percent of the monetary value of the planned the planned investments on a yearly basis can be used as indicator;
- ***Is the SPSP economically successful and therefore justifiable?*** If the total monetary value of damages and losses avoided is less than the expenditure than the program is economically sustainable.

The most pressing questions that could be monitored in relation to the implementation of the future Sector Policy will be :

- ***What is the current condition of the S&RD system?*** The focus here is on the maintenance and operation of the built infrastructure. The length (km) of infrastructure in poor or critical condition in respect of the total length (%) of the defences can be used as indicator. The same approach can also be applied although with a lower level of accuracy to natural defences

- ***What is the evolution of coastal ecosystems?*** The focus here is broader than on natural defences. The state of the environmental quality in the coastal zone can be measured by the extent (ha) of coastal ecosystems e.g. mangroves that are still unaffected by degradation, erosion etc. and expressed in relation to their extent (%) in previous years. Accurate data is currently missing and previous reports (Mott MacDonalds 2006) suggest the use of Ikonos satellite imagery. Until such detailed data is available, estimates based on visual ground inspections will have to suffice. However the absence of comprehensive data does not mean that monitoring cannot commence.

- ***What is the dynamic regime of the coastline?*** The critical parameters are the length of coastline affected by erosion (km) and the distance of coastal retreat (m) observed on a yearly basis and in relation to the full length of the coastline (%). This can be used as indicator of coastal change

- ***What is the status of sea level rise?*** The mean sea level (m) can be monitored in critical locations of the coast. This will follow the actual rate of sea level rise and evaluate whether the plans made and the measures taken are appropriate or should be adapted

- ***What is the status of precipitation patterns?*** More than the actual yearly rainfall (mm), the most important parameter that should be monitored is the number of consecutive days exceeding a critical level of precipitation intensity (mm/hr), exceedence of which will lead to flooding. The frequency of such events is likely to increase with climate change and several occurrences will be possible within one year. This indicator will follow the actual change in precipitation patterns and to evaluate whether the plans made and the measures taken are indeed appropriate or should be adapted.

The most pressing questions that could readily be monitored to assess the implementation of the future SPSP will be :

- ***What is the progress made toward more appropriate land use in the coastal zone?*** The effectiveness of land use restrictions as measured by the total areas (ha) closed to development, reconverted or adapted to appropriate land use, as a percentage of the coastal zone (%) per year can be used as indicator

- ***What is the performance of the overall system (S&RD, D&I and WC) to prevent floods?*** The annual frequency (#), level (m) and duration (days) of recurrent flooding at selected locations in relation to previous years (%) can be used as an indicator

Appropriate indicators will have to be defined and finalised during the further elaboration of the Sector Policy Framework as well as during the preparation of the Sector Policy Support Programme. Indicators of climate change induced issues are discussed in section 7.3 at the end of this chapter with emphasis on the required monitoring of these parameters.

11.2 Performance Indicators

In spite of the lack of technical details, specifications and background information, it is possible to provide an overview of the relevant performance indicators corresponding to each activity of the Draft Sector Policy Framework from an environmental perspective and within a context (cf. section 7.1) of:

- Drivers / Pressure
- State / Impact
- Response

Performance indicators are meant to give a measure of the realisation of components or activities as well as of the state of the environment following the implementation of the Sea Defence Sector Programme. More than 200 Indicators are listed and a full discussion of these is given in ANNEX 5 **Discussion on Indicators to be used in SEA and Policy Framework** for further reference.

11.2.1 Verifying Indicators

Data collection should be based on Objectively Verifiable Indicators – OVIs. These are simple to measure, easy to understand by a non expert, and lead to clear unambiguous conclusions. The emphasis should not be on ***Impacts*** (*What happened?**)*** but on ***Consequences*** (*So what?**).***

For example, tide gauge readings from the harbour are OVIs. Satellite altimetry is not. Occurrence of heavy rain in times per year, intensity of rain in millimetres, and duration of storm in minutes is an OVI. Changing weather patters based on Climate change models are not. Indicators should be selected which are within the capabilities of the existing agencies to be measured and understood.

11.2.2 Use of Lessons Learned

The emphasis should be placed on how interpreted information will be used. Analysis of data should lead to conclusions and then action. This can be in the short term e.g. an imminent storm or the long term e.g. beach erosion. Actions should also be reviewed after they have been implemented, and if seen to be ineffective, future similar actions should be modified. This feedback can be institutionalised as CAR – Corrective Action reporting. After any major incident an analysis should be made of successes and failures. Any policy decision should be similarly reviewed at least annually. The **Lessons Learned** should be used to guide future actions.

A summary of Activities, Pressure, State, Response and Objectively Verifiable Indicators is given in Table 11-1 below

Table 11-1 Summary of Activities, PSR and Indicators

Policy Aims **I. S&RD Infrastructure Management**						
SO1 Maintenance & Investment Plan of S&RD Infrastructure	**#**	**Activities**	**Main Impacts**	**D Direct I Indirect**	**Short / Medium / Long Term**	**Pressure State Response OVI**
	1.1a	Activity : define a clear and SMART set of preventive maintenance priorities and targets for the S&RDD	Operational : the SMART set is in use.	**D**	**ST**	**Pressure** Need to measure effectiveness of sea defences works. **State** Uncertainty as to whether sector program is achieving any real results **Response** Confused results lead to concern over further budget approvals. **OVI – Achievements of S&RDD** • length (km) of structures restored (Increase) • extent of protected areas (ha) protected from flooding • number of people protected from flooding • monetary value of insurance ($$$) paid out in claims for flooding (Decrease)
			Physical infrastructure is repaired	**I**	**ST**	
			Scaling-up of reduced flooding in adjacent areas, protection of communities, reduction of economic damage and losses, and overall improvement of the coastal environment	**I**	**LT**	
	1.1b	Activity: establish a year-based routine maintenance plan to support maintenance expenditure claims	Operational – Annual Plan	**D**	**ST**	**Pressure** Emergency repairs take precedence over planned preventive maintenance **State** Budget for planned maintenance inadequate **Response** S&RDD want to Insist planned maintenance program is followed: extra contingency budget should be provided for emergency repairs. **OVI – Does S&RDD have realistic targets?** • How much of annual budget (%) is spent on planned expenditure and how much goes to emergency relief. • What % of planned annual routine maintenance is actually achieved. (Target 100%) • How consistent are succeeding annual budget expenditures. Do they vary wildly year to year.
			Operational : clarity of recurrent expenditure leads to 3 and 5 year plans.	**I**	**MT/LT**	

	1.1c	Activity: define a clear cross-sectoral strategy and set of maintenance objectives for WSG/S&RDD and NDIA under SDB	Operational : a working group needs to be set up.	**D**	**ST**	**Pressure** All 3 bodies, WSG, S&RDD and NDIA, have different tasks. Some duties overlap, some duties are ignored by all. **State** Some duties have two agencies attempting to do them. Some duties do not get done. **Response** Cooperation between bodies is sporadic and un predictable. **OVI – Engagement with other Agencies** • Record how many times a year different departments met. (Compared with agenda for planned meetings) • Are agendas of meetings set; are minutes kept and circulated. Do successive meetings check that actions identified in previous meetings have actually been carried out. • Have stated objectives been agreed and tasks allocated to relevant bodies. (Yes/ No) • What % of stated objectives has actually been achieved.
			Operational : a strategy for maintenance needs to be agreed.	**D**	**LT**	
	1.2a	Activity: improve transparency and comprehensiveness of actual maintenance expenditures at all levels of the budget	Operational : unified approach and terminology enabling sector wide approach	**D**	**ST**	**Pressure** Different agencies at national and local level use different approaches and terminology to planning sea defences sector budgets. **State** Confusion results as to who is doing what and when. **Response** All agencies act independently **OVI – Performance against Agreed Budget** • Can a national planned budget be compared with a local prepared budget and give a sensible coherent comparison.
	1.2b	Activity: integrate recurrent (routine maintenance) and capital expenditure for WSG / S&RDD and NDIA under MoF	Operational : financial integration	**D**	**ST**	**Pressure** Plans are made by for WSG, S&RDD and NDIA and then priorities changed by MoF **State** WSG, S&RDD and NDIA have in adequate budget for routine maintenance and capital works. **Response** Targets for planned maintenance and new works are not

						met. **OVI – Is plan of budgeted activities adhered to ?** • How much of requested budget is actually received (%). • How much of planned capital works completed (%). • How much of planned maintenance works completed (%)
	1.2c	Activity: prepare a long-term (10 years) sector wide comprehensive S&RD infrastructure investment plan	Operational : long-term plan	**D**	**ST**	**Pressure** Lack of long term plan means no discipline is enforced on financial planning. **State** It is too easy to change annual plans on an adhoc basis, as it cannot be argued that such changes deviate from 10 year plan. **Response** Departments prepare annual plans which are aggregated to make long term plan. Reverse should apply. A 10 year plan should be broken down into 10 year strategy, two 5 year programs, 3 year objectives and 1 year budget. Plans should be revised every 1, 3, 5 and 10 years. **OVI – Long Term Planning** • Is a 10 year strategy prepared • Is a 5 year program prepared • Have 3 year objectives been set. • Has an annual budget which is consistent with the 3 year objectives been prepared. • Have long term targets been set for achieving reduced flooding in numbers of flood events, and numbers of properties and persons affected. • Have long term targets for reduction of economic damage and losses ($$$).
			Scaling-up of reduced flooding in adjacent areas, protection of communities, reduction of economic damage and losses, and overall improvement of the coastal environment	**I**	**LT**	
II. Information Systems and Research Priorities						
SO2 Improving the knowledge base, Surveillance and M&E of S&RD Infrastructure				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	2.1	Activity: create monitoring and tracking mechanism of budget expenditures of S&RD and D&I	Operational : budget monitoring)	**D**	**ST**	**Pressure** Insufficient tracking of budget expenditure occurs **State**

						It is hard to judge cost-effectiveness of measures implemented and hard to judge "value for money". **Response** Agencies have difficulties justifying need for further funds. **OVI – Establish Performance Trends** • Compare preceding years budgets with quantified targets achieved in terms of kms of sea defences. Are they consistent. Can a "unit price" year by year be calculated for sea defences and what is the variance? If variance is high, costs may be same but budget tracking faulty. If variance is low then budget tracking is efficient.
	2.2	Activity: establish a surveillance inspection plan and database of the condition and status of the S&RD infrastructure	Operational : surveillance database	**D**	**ST**	**Pressure** Capital and remedial works are carried out in a confusing manner **State** Attempts to give a consolidated condition report on the status of sea defences has failed. **Response** Donors tend to pick and choose their areas of intervention. **OVI – Establish Useful Database** • Infrastructure: physical condition – structural integrity and length • Effectiveness of internet accessible database; how many times accessed. • Check with other agencies how many times per month they use the database. If at all.
			Scaling-up of reduced flooding in adjacent areas, protection of communities, reduction of economic damage and losses, and overall improvement of the coastal environment	**I**	**LT**	
	2.3a	Activity: optimise the ecological, biophysical, socio-economic data collection and knowledge base of the S&RD sector	Operational : knowledge base	**D**	**LT**	**Pressure** Lack of reliable regular data **State** Lack of reliable data makes it impossible to establish baselines and trends. **Response** Lack of baselines and trends hinders advising decision makers on correct strategies to follow, and effectiveness of any new polices being trialled. **OVI – Ensure Database is used** • Existence of centralised data base • Availability of data on any chosen subject

						• Number of people that access data base • Number of people that return to data base more than once.
	2.3b	Activity: establish the ecological, biophysical, socio-economic knowledge central clearing house of the S&RD sector	Operational : clearing house	**D**	**LT**	**Pressure** Need to know more baseline data on state of degradation of coastal zone. **State** Insufficient data to make meaningful decisions. **Response** Lack of interpretation of data means data not used **OVI – Make S&RDD a Clearing House of Knowledge** • Existence of reports interpreting data • Availability of analysis on any chosen subject • Number of people that access data base • Number of people that return to data base more than once • Number of people that request specific analysis of data
	2.3c	Activity: create a monitoring and evaluation mechanism and unit for S&RD sector policies	Operational : policy monitoring unit	**D**	**LT**	**Pressure** Need to report on effectiveness S&RD sector policies **State** Lack of knowledge on effectiveness S&RD sector policies **Response** S&RDD does not know which policies are most effective. **OVI – Ensure S&RDD is subjected to M&E** • Establishment of M&E unit • Carry out M&E of S&RD sector policies every 6 months for 3 years and then every year after that. • Check Outcome of policies – ***what*** they achieved. • Check Consequences of policies – ***so what***
SO3 Creating a Research Centre				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	3.1a	Activity: create an S&RD Policy Research Centre or Unit linked to international universities and research	Operational : policy research centre	**D**	**LT**	**Pressure** Need to compare local knowledge with best international practice **State** Ignorance of international best practice **Response** Cannot advise on local policies that may be inconsistent with regional practices

						OVI – Establish credentials and credibility of Policy Unit • Establishment of S&RD Policy Research Centre • Unit linked to international universities and research • Number of staff, projects, programmes, amount of funds ($), level of equipment and facilities
	3.1b	Activity: develop a policy support and evaluation toolbox with EVA, DSS, GIS, vulnerability mapping and spatial planning	Operational : toolbox	**D**	**LT**	**Pressure** Need for more GIS data **State** Lack of reliable GIS data **Response** Unable to support evaluation of policies due to lack of practical tools **OVI – Ensure S&RDD is practical** • Existence of operational toolbox • List of tools • Utilisation by agencies • Comments by agencies of ease of use and practicability of tools
	3.1c	Activity: pursue research on the intrinsic value of coastal ecosystems in view of conservation or development	Operational : knowledge base on ecosystems	**D**	**ST/MT**	**Pressure** Habitats needed for development **State** Ignorance on value of ecosystems **Response** Ecosystems degraded and destroyed as value not appreciated **OVI – Ensure Value of Ecosystem is Appreciated** • Check has economic valuation been made of ecosystems value, resources and functions • Check if areas preserved (ha) is increasing or decreasing
			Ecosystems conservation and community livelihood development	**I**	**LT**	
	3.1d	Activity: perform evaluation of negative impacts of land-based activities in view of mitigation or reversal	D ST mitigation of land-based impacts on physical and biological environment	**D**	**ST**	**Pressure** Need for more land to be developed **State** Inappropriate land use taking place **Response** Attempts to reverse and mitigate against impacts on environment **OVI – Improve Land Use Planning** • Development of policy on land on use planning
			I LT overall benefit to communities and the economy	**I**	**LT**	

						• Implementation of policy • Monitor increase or decrease of land zoned under protection being taken for unsuitable development
	3.1e	Activity: perform evaluation of impacts of intensification of land-based activities in view of mitigation or reversal	Mitigation of land-based impacts on physical and biological environment	**D**	**LT**	**Pressure** Intensification of land used for development **State** Inappropriate land use taking place **Response** Attempts to reverse and mitigate against impacts on environment **OVI – Improve Land Use Planning** • Development of policy on land on use planning • Implementation of policy • Monitor increase or decrease of land zoned under protection being taken for unsuitable development
			Overall benefit to communities and the economy	**I**	**LT**	
	3.2	Activity: perform gap analysis of existing knowledge resources, databases & baseline in view of S&RD operational needs	Operational : identified gaps	**D**	**ST**	**Pressure** Need to have full comprehensive data **State** Gaps exist in current data base **Response** Impossible to reach conclusions on trends **OVI – Gap Analysis** • list identified gaps • Record % of gaps filled per year and subsequently
	3.3	Activity: carry out a comprehensive national coastal baseline assessment	Operational : coastal baseline	**D**	**ST**	**Pressure** Need to have full comprehensive data **State** Gaps exist in current knowledge of coastal baseline data **Response** Cannot plot trends **OVI – Compile all baseline data** • This is a very complex undertaking and does lend itself readily to OVIs. • This should be constructed from other smaller tasks; coastal erosion records, flooding incidents, mangroves monitoring, biodiversity surveys etc
	3.4	Activity: create multilevel information exchange network for S&RD with	Operational : national network	**D**	**ST**	**Pressure** Need to make informed decisions

		database access	Operational : international network	**I**	**LT**	**State** Lack of data to make informed decisions **Response** Decisions not made **OVI – Keep number of parameters manageable** • Existence of information exchange network • Functionality, accessibility, number of hits, • Parameters listed. This should not be too large. Small number of meaningful parameters is better than large number of data sets which are meaningless.
	3.5	Activity: create fully geo-referenced coastal ecosystems archive linking existing databases and GIS facilities	Operational GIS-based reference system	**D**	**LT**	**Pressure** Need to link data to geographical location **State** Lack of GIS facility **Response** Agencies hindered by inability to build up "layered" data sets **OVI – Functional GIS** • Existence of facility • Number of layers established in GIS in addition to base maps. • How many users access GIS • How many projects use GIS in evaluation
	3.6a	Activity: target research policy in an integrated approach to coastal zone research	Operational targeted research	**D**	**ST/MT**	**Pressure** Need for informed decision making **State** Lack of data **Response** No integration of coastal zone management by agencies **OVI – Ensure research areas reflect local priorities** • Research policy established • Priority areas for research reflected in research agenda • Research findings useful to sea defences policy formulation. If of no use, change research priorities • Enforce checks and balances on research funding. • Establish research priorities in terms of short, medium and long term projects, to reflect sector needs.
			I LT overall benefit to physical and biological environment, communities and the economy	**I**	**LT**	
	3.6b	Activity: pursue research on coastal	Locally overall benefits to	**D**	**LT**	**Pressure**

		ecosystems services to conservation and livelihoods	ecosystems conservation and community livelihoods			Need to develop land puts pressure on ecosystems **State** Value of ecosystems not appreciated and ecosystems lost. **Response** Benefits of ecosystems preservation to community needs to be demonstrated **OVI – establish local specific economic values** • Economic valuation of the specific benefits, e.g. fisheries productivity rate, critical distance of natural protections, etc.
	3.6c	Activity: pursue research on the contribution of mangroves to coastal protection	Locally overall benefits to mangroves and community stewardship	**D**	**LT**	**Pressure** Need to develop land puts pressure on mangroves **State** Value of mangroves not appreciated and mangroves lost. **Response** Benefits of mangrove preservation to community needs to be demonstrated **OVI - establish local specific economic values** • Economic valuation of mangroves productivity, critical distance of natural protections, etc.
	3.6d	Activity: pursue research on the resilience and recovery of species and communities in coastal mangroves	Locally conservation of ecosystems – resilience	**D**	**LT**	**Pressure** Need to develop land puts pressure on mangroves **State** Value of mangroves not appreciated and mangroves lost. **Response** Mangrove protection program needs to be more focussed **OVI - establish local specific parameters for behaviour of mangroves** • Critical distance of natural protections • Rate of resilience and recovery of different species and communities
	3.6e	Activity: pursue research on the presence and impact of invasive alien species in coastal ecosystems	Locally conservation of ecosystems - alien invasion	**D**	**LT**	**Pressure** Land development destroys ecosystems **State** Indigenous ecosystems destroyed and invader species move in. **Response** Balance of ecosystem changing and long term impacts unknown

						OVI - establish local specific parameters for response of mangroves • Rate of loss of indigenous species (%, Dominance) • Rate of occurrence of different alien species and communities (Species Diversity, Shannon Wiener Index) • Rate of alteration of natural ecosystems (%, ha)
	3.6f	Activity: pursue research on coastline evolution timeline mapping by RS/GIS	Operational (i.e. coastline evolution base)	**D**	**ST**	**Pressure** Need to understand coastline changes over time and distance **State** Lack of GIS facility to analyse time series data **Response** Agencies hindered by inability to build up "layered" data sets on coastal movements **OVI – Establish trends in coastline evolution** • Existence of facility • Number years of data input in RS/GIS • Time series of erosion/accretion cycle established • How many users access RS/GIS • How many projects use information in evaluation
	3.6g	Activity: pursue research on the impact of hinterland development on coastal erosion and flooding	Operational knowledge : hydrology and water balance, erosion and flooding	**D**	**ST**	**Pressure** Hinterland development holding back sediments and enhancing rain water run off. **State** Increased coastal erosion and flooding **Response** Need to have deeper understanding of impacts of hinterland development on coastal regime **OVI – Improve knowledge of water management** • Water level, peak flows and frequency • Erosion rate • Frequency of flooding • Frequency of de-weeding and de-silting program by D&I
			Adapted physical mitigation measures	**D**	**MT/LT**	
	3.6h	Activity: pursue research on the impact of hinterland deforestation/clearing on sediment	Operational knowledge : hydrology and sediment loads, system choking	**D**	**ST**	**Pressure** Hinterland development causes deforestation **State**

		load or coastal system choking	Adapted physical mitigation measures	**I**	**MT/LT**	Increased rainfall runoff and sediment loads **Response** Need to have deeper understanding of impacts of hinterland development on coastal regime **OVI - Improve knowledge of sediment deposits** • Water level, peak flows and frequency • Upland erosion rate • Sediment loads • Frequency of choking
	3.6i	Activity: pursue research on the valuation of gains or losses from S&RD infrastructure and policy	Operational knowledge : economic valuation of S&RD sector	**D**	**ST**	**Pressure** Need to know cost effectiveness of S&RDD program **State** Insufficient data on cost effectiveness **Response** Hard to judge "best value for money" components of program **OVI – Define "Value" of S&RD activities** • Increase / loss in value of property in flood prone area • Insurance pay outs for flooding • Change in insurance premiums for flood damage • Trend from year to year in estimated damage to property from flooding
	3.6j	Activity: pursue research on the design of alternative solutions [redesign, mangroves, etc.] to S&RD approaches	Operational knowledge : alternative solutions to S&RD	**D**	**ST/MT**	**Pressure** Conventional solutions for sea defences are expensive. Need to seek lower cost but equally effective alternative. **State** Uncertainty over whether alternatives will prove effective **Response** Tendency is to stick to conventional proven solutions and avoid new ideas **OVI – Define limitations of use of mangroves** • Implement pilot mangrove project which has stalled and monitor closely but on a small scale.
			Overall benefit to the physical environment including SD infrastructures, to the ecosystems, communities and the economy	**I**	**LT**	
	3.6k	Activity: pursue research on the design of preventive solutions to S&RD approaches	Operational knowledge : preventive solutions to S&RD	**D**	**ST/MT**	**Pressure** Repair of sea defences is expensive. Preventive maintenance is cheaper.

			Overall benefit to the physical environment including SD infrastructures, to the ecosystems, communities and the economy	**I**	**LT**	**State** Uncertainty over whether preventive measures will prove effective **Response** Tendency is to stick to established reactive approach rather than proactive. **OVI – Establish local data on effective solutions** • Implement pilot projects under controlled conditions
SO4 Public Awareness, Training & Capacity Building				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	4.1a	Activity: target training and capacity building of professionals towards S&RD sector management and ICZM	Operational : S&RD, ICZM capacity	**D**	**ST**	**Pressure** More professional demands on S&RDD staff **State** Capacity and capability of staff inadequate **Response** S&RDD sector managed on a project basis rather than integrated program basis **OVI – Monitor training programs** • Number of training programs • Number of professionals trained • Number of professionals remaining in post for more than 1 year, 3 years, 5 years • Staff turnover • Comparison of staff salary and benefits with private sector
			Overall benefit to the physical environment including SD infrastructures, to the ecosystems including natural defences, to communities and the economy	**I**	**LT**	
	4.1b	Activity: target training and capacity building of planners towards economic valuation of coastal ecosystems	Operational knowledge (i.e. economic valuation capacity)	**D**	**ST**	**Pressure** More professional demands on planning staff **State** Capacity and capability of staff inadequate **Response** Planners make decisions without considering quantified benefit-cost assessments. **OVI – Progress of Planning** • Number of training programs • Number of planners trained • Number of planners trained and remaining on duty • Number of projects including Benefit-Cost assessment in Feasibility study

	4.2a	Activity: enhance awareness of planners and policy makers of integrative landscape approaches	Operational knowledge : landscape approaches	**D**	**ST**	**Pressure** Need to adopt integrated approach to planning coastal defences **State** Lack of awareness of planners and policy makers of integrative landscape approaches **Response** Decisions made on a project basis not programs **OVI – Awareness increase** • Number of projects showing an integrative approach
			Overall benefit to landscapes and to ecosystems	**I**	**LT**	
	4.2b	Activity: enhance general public awareness of the role of ecosystems for livelihoods development	Operational awareness role of ecosystems for livelihoods	**D**	**LT**	**Pressure** Ecosystems undervalued and destroyed by development pressure **State** Ecosystems destroyed by development pressure **Response** Need to educate public in role of ecosystems for livelihoods and benefit to communities **OVI – Public awareness increase** • Number of campaigns • Stakeholders and number of communities reached • Quantification of specific benefits to communities
			Benefit to communities livelihoods	**I**	**LT**	
	4.2c	Activity: enhance general public awareness of the contribution of mangroves to the S&RD system	Operational awareness : mangroves contribution to S&RD	**D**	**LT**	**Pressure** Mangroves undervalued and destroyed by development pressure **State** Mangroves destroyed by development pressure **Response** Need to educate public in role of mangroves for livelihoods and benefit to communities **OVI – Communities appreciate value of mangroves** • Number of campaigns • Stakeholders and number of communities reached • Quantification of specific benefits to communities
	4.2d	Activity: enhance awareness of decision makers and general public of flooding risks and issues	Operational awareness (i.e. flooding risks	**D**	**LT**	**Pressure** Flooding risks ignored under development pressure **State** Flooding risk increased **Response**

						Need to educate public as to flooding risks **OVI – Public agree to participate in flood responses** • Number of campaigns • Stakeholders, decision makers and number of communities reached
SO5 Assessment of Flood Risk				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	5.1	Activity: develop a Flood Risk Assessment with specific recommendations for mitigation	Operational : flood risk assessment			**Pressure** Vulnerability to flooding increasing **State** No flood risk vulnerability mapping available **Response** Development permitted without flood mitigation included **OVI – Flood predictions correct** • Existence of FRA • Validity of the FRA by accuracy of predictions (%)
SO6 Create an Early Warning & Emergency Response System				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	6.1	Activity: design and realisation of a FEWERS in partnership between S&RDD, NDIA and Hydro-meteorological Services	Operational FEWERS	**D**	**ST**	**Pressure** Occurrence of floods increasing **State** Inadequate early warning system **Response** Poor response to flood warnings **OVI – Reduction in loss of life and property** • Existence of FEWERS • Performance, number and accuracy of forewarnings • Reaction time of Civil Defence • Willingness of communities to evacuate
			Overall benefit to the physical environment including SD infrastructures, to the ecosystems including natural defences, to communities and the economy	**I**	**LT**	
III. Strengthening and enforcement of law and Institutional framework						
SO7 Institutional Reform				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	7.1a	Activity: achieve the institutional reform and strengthening of SDB	Operational reform :SDB capacity	**D**	**ST**	**Pressure** Need for clear strong leadership of S&RDD sector **State** No clear leadership given to S&RDD sector

						Response Lack of direction in S&RDD sector **OVI – Effectiveness of SDB** • Establishment of strong leadership body • Body has political support at the highest level • Body has authority to ***demand*** action, not ***request***
	7.1b	Activity: create SDB Steering Committee	Operational reform : SDB Steering Committee	**D**	**ST**	**Pressure** Need for clear strong leadership of S&RDD sector **State** No clear leadership given to S&RDD sector **Response** Lack of direction in S&RDD sector **OVI - Effectiveness of SDB steering committee** • Establishment of strong leadership body • Body has political support at the highest level • Head of committee has Cabinet Status • Committee has authority to ***demand*** action, not ***request***
	7.2	Activity: clarify the link of SDB with local government for adequate regional maintenance co-ordination / costs sharing	Operational reform : linkages	**D**	**ST**	**Pressure** Need for clear strong leadership of S&RDD sector **State** No clear leadership given to S&RDD sector **Response** Lack of direction in S&RDD sector **OVI – Reform of SDB** • Establishment of strong leadership body • Body has political support at the highest level • Body has authority to ***demand*** action from Local Authority, not ***request***
SO8 Law Enforcement and regulation				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	8.1	Activity: assign law enforcement powers to SDB as a supervisory body	Operational reform : SDB legal empowerment	**D**	**ST**	**Pressure** Illegal development in contravention of laws **State** Continual breaches of laws **Response** EPA and other agencies reluctant to take action **OVI – Empowerment of SDB** • Reconsider operational empowerment : Is a Board

						best agency for law enforcement • List actual powers, number of cases closed • List scale of fines: evaluate as effective deterrent.
IV. Discourage Inappropriate Land Use						
SO9 Land Use Restriction and development planning				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	9.1	Activity: review legal and regulatory base for land-use planning and development in the S&RD protected coastal zone	Operational knowledge : legal land use regulatory base	**D**	**ST**	**Pressure** Intensification of land use for development **State** Illegal developments in protected coastal zone **Response** Laws fragmented: need for consolidated law **OVI – Legislative strengths of SDB** • Number of legislative gaps or redundancies identified, filled, removed, etc.
	9.2	Activity: support the development of integrated spatial plans for land use planning in the S&RD protected coastal zone	Overall benefit to the physical environment including SD infrastructures, to the ecosystems including natural defences, to communities and the economy	**I**	**LT**	**Pressure** Intensification of land use for development **State** Illegal developments in protected coastal zone **Response** Need for integrated planning approach **OVI – Integrated Land Use Planning** • Number of coordination meetings between different agencies • Meetings of ICZM and ICZM committees
	9.3	Activity: support the formulation of land use conflict resolution mechanisms and arbitrage by SDB in the coastal zone	Operational : conflict management procedure for land use	**D**	**ST**	**Pressure** Intensification of land use for development **State** Conflicts between planners and developers in protected coastal zone **Response** Need for conflict resolution **OVI – Coordination / Conflict resolution** • Number of coordination meetings between different agencies • Number of conflicts resolved • Area recovered from illicit use (ha)
			Overall benefit to communities	**I**	**LT**	

	9.4	Activity: reduce the impact of sea level rise by land use restrictions and coastal features protection measures	Operational : restrictions	**D**	**ST**	**Pressure** Intensification of land use for development **State** Development in protected coastal zone increases vulnerability to sea level rise **Response** Need to restrict land use **OVI - Coordination / Conflict resolution** • Number of coordination meetings between different agencies • Number of conflicts resolved • Area recovered from illicit use (ha)
			Overall benefit to the physical environment including SD infrastructures, to the ecosystems including natural defences, to communities and the economy	**I**	**LT**	
V. Sustainable Water Management						
SO10 Water Management & Planning				**Activities**	**Main Impacts**	**Main Indicators (examples)**
	10.1a	Activity: prepare a comprehensive impact assessment of sea level rise on populations and sectors in the coastal area	Operational : sea level rise impact assessment	**D**	**ST**	**Pressure** Intensification of land use for development **State** Development in protected coastal zone increases vulnerability to sea level rise **Response** Need to restrict land use **OVI – Risk Assessment** • Areas at risk • Value of resources, property at stake • Number of lives at risk
			Overall benefit to communities and the economy	**I**	**LT**	
	10.1b	Activity: design a new tidal prevention and river drainage system based on new standards, models and methods	Operational knowledge : new standards and methods	**D**	**ST**	**Pressure** Increasing occurrence of flooding **State** Existing drainage system cannot cope **Response** Currently try to maintain outdated system **OVI – Flood Prevention** • List and kinds of new standards • Quality of predictions by new models • Potential in extra lives saved • Value of extra property protected • Damage and losses prevented
			Overall benefit to the physical environment including SD infrastructures, to the ecosystems including natural defences	**D**	**MT/LT**	
			Overall benefit to communities and the economy	**I**	**LT**	

	10.1c	Activity: define and classify the spatial extent of the domain of intervention for flood insurance system	Operational knowledge : for flood insurance	**D**	**ST**	**Pressure** Increasing occurrence of flooding **State** Existing drainage system cannot cope **Response** Insurance payouts increasing **OVI – Flood Prevention** • List extent of reckless development prevented • Extent and economic value of protected areas, property
			Overall benefit to communities and the economy	**I**	**LT**	
	10.1d	Activity: prepare a comprehensive Water Level Management Plan	D ST operational (i.e. water level management plan)	**D**	**ST**	**Pressure** Need to have full comprehensive data **State** Gaps exist in current knowledge of water management **Response** Cannot plot trends **OVI – Water Level Management** • This is a very complex undertaking and does lend itself readily to OVIs. This should be constructed from other smaller tasks; rainfall, water usage, conservancy storage capacity, occurrence of saline intrusion, communities needs, costs for irrigation and potable water production, and tariffs for sale of water.
			I LT overall benefit to the physical environment including SD infrastructures, to the ecosystems including natural defences, to communities and the economy	**I**	**LT**	
	10.2a	Activity: establish monitoring and reporting system of sea level and subsidence impact on habitats	Operational knowledge : sea level rise and subsidence impact on habitats	**D**	**ST/MT**	**Pressure** Concern over rising sea level **State** Ignorance as to exact nature of sea level rise in Guyana **Response** Assumption that model outputs reflect real situation **OVI – Sea level rise impacts** • Monitor sea level rise by tide gauges • Measure subsidence, sedimentation, erosion, accretion rate • Measure extent of disturbed area
			Mitigation of impact on ecosystems	**I**	**LT**	
	10.2b	Activity: establish monitoring and reporting system of sea defence operations impact on habitats	Operational knowledge : S&RD operations impact on habitats	**D**	**ST/MT**	**Pressure** Increased construction of sea defences impact on habitats **State**

			Mitigation of impact on ecosystems	I	LT	Habitats deteriorating **Response** Indecision over whether to continue with existing types of sea defences **OVI – Impacts on habitats** • Disturbance to water level • Change in freshwater inflow • Extent of disturbed habitat area • Change in sedimentation rate

12 Capacities to Address Environmental Challenges

12.1 Legislative Framework

The S&RD Sector is governed by four main piece of legislation, two of direct relevance, the Sea Defence Act CAP 64:01 and the Sea Defence Act CAP 64:02, and two of related concern, the Environmental Protection Act CAP 20:05 and the Drainage and Irrigation Act of May 2004. They provide the authority for the implementation of government policy on sea and river defences, but they also create overlapping responsibilities although some acts recognise the need for co-ordination, consultation and collaboration between the various authorities.

The **Sea Defence Act (CAP 64:01)** has been ineffective in preventing the removal of vegetation, including the mangrove forests, and sea sand, but this is more due to the failure by relevant agencies to enforce the penalties provided under the laws than to the lack of actual power. The act allows for some proportion of cost recovery to be imposed although this legal avenue has not been pursued.

The **Sea Defence Act (CAP 64:02)** does give the Sea Defence Board powers to control development on the foreshore. Although it provides for the imposition of fines and jail terms for illegal settlement and contravention of the Sea Defence legislation, many stakeholders interviewed during the study acknowledged the poor enforcement of the law. Also, the small level of the fine (30,000 G$) does not constitute a deterrent to many offenders.

Despite the provisions made in the **Drainage and Irrigation Act (Act 10 of 2004)** concerning the collaboration between NDIA and SDB, there are no specific procedures under the relevant laws for the co-ordination of the activities of these two entities.

Despite the provisions made by the **Environmental Protection Act (CAP 20:05)**, and even though the Cabinet approved an ICZM Action Plan in May 2001, there still is no concrete development plan for ICZM and the ISZM Committee is no longer functioning. The Integrated Coastal Zone Management Committee concluded in 2000 that *"… the legislative regime surrounding coastal zone management in Guyana represents a fragmented regulatory framework…"*. The limitations of the Acts that constrain the SDB from fulfilling its mandate include squatting, the erection of illegal structures, the destruction of the vegetation on the sea front, and the illegal removal of sea sand and shells.

Two agencies are directly involved in the protection of mangroves: the Guyana Forestry Commission and Environmental Protection Agency. Although the draft Mangrove Policy can be used as guidance, the National Mangrove Management Action Plan was never quite implemented.

The ***geographical boundaries*** of all the regions with sea and river defences, as well as the definition of the limits and boundaries of the Sea Defences, are defined in the Sea Defences Act, Chapter 64.02, Part VI. However the Coastal Zone Management Plan, and other institutions or studies (e.g. NDIA, 4SHORE) have been using different boundaries.

The inadequacy of laws to cope with the potential effects of sea level rise and climate change is emphasised by stakeholders in Guyana's Report on National Vulnerability Assessment to Sea Level Rise (2002). However, it is not the laws that are inadequate, as they are quite comprehensive, and stakeholders did not identify any specific lack of regulatory powers. Rather, it is the fragmented application, lack of enforcement and sporadic coordination that renders the laws ineffectual in controlling current coastal development. This unsatisfactory situation can only become worse under the pressures of climate change and sea level rise.

12.2 Institutional Capacity

12.2.1 Lack of Coordination

The institutional framework of the sector comprises a mixed group of institutions endowed with a long list of laws and legal references. Several ministries, governmental agencies, statutory bodies and administrative entities are involved directly or indirectly (see Table 3-1) in sea defences but their responsibilities and functions are not clearly defined under the current legislation. The absence of a clear demarcation of areas of jurisdiction, overlapping of authority, ands lack of co-ordination between institutions results in poor management of the sea defence system.

Although, the governing laws do not specifically define which ministry is in charge of enacting regulation and supervising the actions of governmental agencies and administrations, the Ministry of Agriculture and the

Ministry of Public Works and Communications currently are the main government authorities responsible for the sea defences sector.

The National Drainage and Irrigation Authority, under the Ministry of Agriculture, is responsible for flood control. The Sea Defence Board, and the Sea and River Defence Division of the Ministry of Public Works and Communications, are responsible for the management of the sea defences, which protect the coastal strip.

The overlapping responsibilities of institutions, and the general lack of operational guidelines and policy frameworks, results in inefficient data gathering, surveillance and monitoring activities. The NDC, RDC, WSG (roads and bridges), S&RDD (regional engineers), NDIA and Hydromet all have a common responsibility for analysing data and determining the potential for flooding.

The co-ordination is weak between the Ministry of Public Works and the local governments in monitoring the performance of the Sea and River Defence Sector. This is understandable at local level, as inspecting drainage, irrigation and sea defence structures requires highly experienced engineers who are fully operational and available when needed.

12.2.2 The Sea Defence Board

The Sea Defence Board has the duty to formulate policies but reportedly has not been active in recent years and has so far exerted little influence on the sea defence policy. For many years, the board has not issued an annual report, and it has neither a master plan nor a strategic business plan of its own. In fact, the board has no direct funds, no permanent office nor independent secretariat, and although it is its duty to supervise the Sea and River Defence Division, the board has no real control over the division and actually even depends on it for facilities. The board seems to duplicate the functions of MPW&C in overseeing the activities of the division without providing any leadership or direction.

12.2.3 The Sea and River Defence Division

The activities of the Sea and River Defence Division have been substantially impaired by the lack of adequate funding and the inability to retain skilled and properly trained staff.

The Division is a sub-department of the Ministry of Public Works and Communications and so funds are not made available directly to it. The S&RDD believes that the present arrangement of funding maintenance and rehabilitation from the ministry's budget, which also covers roads and bridges, is clearly inadequate unless government allocates a higher proportion of national public expenditures to sea defences. This can only come at the at the expense of other sectors.

In practice there is no development plan, and work is carried out when funds are available rather than when the works are needed. This restricts the capacity to carry out essential maintenance and leads to defences deteriorating to the point that they need to be reconstructed rather than repaired. As a result the Division is constantly reacting to emergency situations caused by breaches in the defences, rather than carrying out regular planned preventive maintenance. The lack of a development plan was addressed by the 8th EDF Institutional Capacity Building Activities (ICBA) which prepared a draft plan. However this plan was never finalised or adopted.

Keeping trained staff is a recurrent issue. The remuneration package offered to employees has also been a significant impediment in the execution of the S&RDD prime responsibilities. One of the issues is the considerable uncertainty regarding their role and responsibilities among staff who also feel that their efforts are not sufficiently recognised.

12.2.4 The Regional and Neighbourhood Democratic Councils

The decisions of the Regional Democratic Councils (RDC) to construct or maintain specific sea and river defence infrastructure e.g. such as repairing a seawall, are not made on the basis of technically reliable decision-making process in line with overall national S&RDD strategic decisions. For all infrastructures for which the S&RDD is directly responsible, decisions have to be taken by the Ministry of Public Works.

12.3 Linkages

12.3.1 S&RDD and NDIA

Legally, the responsibility of the NDIA covers agricultural areas but there is no definition of the meaning of what agricultural areas actually encompass. The NDIA is also responsible for the operation, maintenance and upkeep of all sluice gates, which results in an institutional overlap with the S&RDD, as the sluice gates are built by the NDIA in embankments which fall under the responsibility of the S&RDD. The remit of the

S&RDD stops at a distance from the sluice gates which gives rise to uncertainties when sea defence structures or sluice gates require repair. The overlap in responsibilities is indeed recognised at senior level and efforts are made in dividing tasks between the two agencies.

12.3.2 Hydromet

The Hydrometeorological Services are said to be working hand in hand with the NDIA but the same cannot be said of the working collaboration with the S&RD Sector. Even though a member of the SDB is a representative from Hydromet, this does not ensure a smooth collaboration. Processing of early warning and flood prevention data needed by the S&RD Sector could usefully be provided by Hydromet.

12.3.3 Civil Defence Commission

Information exchange must be improved with the Civil Defence Commission (CDC) and early warning of flooding must be supplied. The Commission should play a major role in the collection, storage and management of data for early warning, disaster preparedness and emergency response. It must be stressed that data is **not** information. Raw data on rainfall, tides and weather is of no use unless it is interpreted within previously agreed criteria which give direct and clear guidance on the appropriate level of emergency response. The SDB can take the lead in this but the CDC must insist that information received is useful and practical.

12.3.4 Guyana Forestry Commission

In an attempt to halt the degradation of mangroves the National Mangrove Management Action Plan of November 2001 was meant to elevate the concern for mangrove forests to the level of policy, planning and action. The plan recognises the value of mangrove forests, and makes suggestions for a mangrove protection pilot project and its location but this appears not to have gone ahead. Guyana currently has the third lowest percentage of protected areas in southern America and a major stakeholder concern is that for a variety of reasons the National Mangrove Management Action Plan has not yet properly been implemented. Mangroves could be included in the Guyana Protected Area System, but as many mangroves are still classed as private lands, the Guyana Forestry Commission is prevented from enforcing their protection.

12.3.5 National Climate Committee

Despite a National Climate Committee established to deal with climate change, and a number of important documents produced around 2001/2002, the overall capacity remains extremely low. The National Climate Unit currently consists of one single employee. One additional staff was recently hired to specifically work on Guyana's Second Communication to the UNFCCC.

There appears to be a renewed level of commitment at the management level of the National Climate Committee, and the committee recently reconvened after an extended period of inactivity. The need for more institutional, technical and financial support is consistently stressed by many stakeholders. The major concerns are the absence of adequate flood monitoring for early warning of river floods particularly inland, and of downscaling capacity of climate models for better addressing the needs of Guyana.

However, the actual mandate for monitoring the climate system lies with the Hydrometeorological Services of the Ministry of Agriculture. Many vacancies exist at the professional level. Other constraints include inadequate training, lack of equipment, inability to attract field and office technicians, of effecting proper maintenance, etc. and the poor collaboration with the sector as noted above. All these setbacks contribute towards an insufficient capacity in Guyana to monitor climate and climate change.

12.3.6 EPA and ICZM

Guyana supports participatory decision-making as expressed in the National Environmental Action Plan and the Integrated Coastal Zone Management Action Plan. The EPA currently coordinates various cross-sectoral actions, but multi-agency committees tend to have little impact. For example, the NREAC only meets on an ad hoc basis.

The recent efforts to introduce integrated coastal zone management in Guyana have failed. The EPA acts as the secretariat of the ICZMC but this Committee has been inactive and inefficient in carrying out its responsibilities. This is mostly due to the large number of members with diverging responsibilities and specific interests. Some agencies focus on infrastructure rather than attempting to formulate a coherent integrated management policy. Also the failure to sanction illegal activities contravening the Environmental Protection Act has contributed to the inaction of the Committee.

The ISZMC is not functioning. The lack of progress was recognised during the 8th EDF Institutional Capacity Building Activities (ICBA). Information was collected from organisations linked to sea defences identified in

the 9th EDF Feasibility Study in 2006. The responses showed that even those closely involved in the sector do not fully understand the roles and responsibilities of the organisations involved in the sector. One of the objectives of the ICBA was to prepare a master plan for coastal zone management, and a series of workshops were held to prepare the first draft of the plan. The draft master plan has not been accepted, adopted or implemented. There is no real progress toward Integrated Coastal Zone Management.

12.4 Technical Capacity

Currently there is extremely limited capacity for baseline monitoring and consequently availability of data concerning climate change or sea defences is severely restricted. There are explicit and deep-rooted problems in the measuring and monitoring of environmental baseline and climate change information. These include :

- Lack of budget
- Lack of technology and technical expertise
- Deficiency in the national research agenda and capabilities relating to climate change
- Low level of awareness among personnel of specific aspects such as sea level rise
- Inadequate or non-existent monitoring systems
- Severe deficiency in processing and managing limited available data.

Strategies to implement the appropriate measuring and monitoring of environmental parameters or climate change indicators are lacking, and the level of technology and human resources is insufficient. The Draft Sector Policy Framework refer to important requirements regarding the monitoring of the status of the sea defences (Activity 2.2) and of the coastline (Activity 3.3, 3.5 and 3.6f).

Qualified and trained professionals are of utmost importance to the Sea and River Defence Sector to ensure that initiatives are effectively carried through and plans are fully implemented. Working within the complex context of ICZM, S&RDD staff must have an understanding of both ecological and socio-economic characteristics, so that they can appreciate the interdisciplinary nature of engineering interventions with respect to the dynamic and interlinked characteristics of the coastal zone and marine environment.

12.5 Budgetary Capacity

The WSG and S&RDD make capital and recurrent expenditure budget projections for a 3-year time horizon, both for donor financed projects and for locally financed activities such as emergency works. However, both capital and recurrent expenditure is reprioritised on a yearly basis within the context of the annual budget. The Ministry of Finance leads this reprioritisation.

There is inadequate budgetary allocation across all ministries for assessing and addressing the environmental implications and constraints of sea defences, or the impacts of climate change and implementation of adaptation strategies. The financial capacity of a wide range of government departments appears to be extremely limited and they would need the allocation of additional financial resources for environmental and climate change issues.

Funding remains an area where creative solutions should be designed. For example, the operation and maintenance of the primary D&I system considered public goods should be funded from general tax collection by local government but moneys are often diverted to other public uses. In the areas where GuySuCo operates the co-operative contributes up to 80% of the cost. New contract arrangements between local governments and the NDIA are therefore needed. The operation and maintenance of the secondary system should be funded from the D&I fees but the empowerment of the WUA to collect and administer the fees has not been successful. The situation of many farmers is complicated by the insecurity of weak informal land tenure rights.

12.6 Public Awareness

There is a generally poor understanding of the social and economic value of coastal ecosystems and of the role that these resources play or could play in the enhancement of community livelihoods or the national economy. Although people are well aware of the role of resource-based industries e.g. sugar industry, agriculture and fisheries, in the national economy, there is little awareness regarding the economic value of the defence system as a safeguard of the coastal production and consumption. The economic value that accrues from the preservation of community livelihoods through reduced ecosystem vulnerability and increased resilience is totally unknown.

Although coastal communities are very aware of the risks of flooding, when the general public were interviewed for Guyana's National Vulnerability Assessment to Sea Level Rise (2002) a large number declared they had never heard of sea level rise and related issues.

The Environmental Protection Agency (EPA) is promoting environmental education and public awareness in Guyana, especially by the already drafted National Environmental Education and Public Awareness Strategy (NEEPAS). However, climate issues have not been directly addressed by the NEEPAS. The EPA should include climate education as one of the major issues to be addressed in NEEPAS.

The Civil defence have reported that coastal communities are often reluctant to leave properties when flooding is imminent. This is not due to lack of awareness of the risks, but due to a genuine concern to stay and protect their property and its contents.

13 Conclusions and Recommendations

13.1 General

The fact that most of the population and nearly all the major agricultural and industrial activities are on the coast puts Guyana at high risk from effects of sea level rise. Safe and secure sea defences are recognised as being essential to the growth of the national economy and the improvement of the human development index for the population who live on the coastal strip. Hence, the Government of Guyana places a high priority on the construction, rehabilitation and maintenance of sea defences.

However, the inability of the economy to sustain higher levels of public investment in sea defences prevents these objectives from being attained. A further constraint is that the objectives for sea defences have not yet been effectively transferred from national to sector level. The institutions lack definition concerning scope and responsibilities, there is no planned development strategy and maintenance work does not abide by a program, but is carried out in an ad hoc fashion. As a result there are no clear and defined objectives to guide those responsible for the management of sea and river defences.

The proposed Draft Sector Policy Framework meets some of the identified stakeholders concerns, in that it covers many environmental aspects raised by the consulted stakeholders, as well as institutional or legal aspects. However it is lacking in technical details and it needs to be established whether the choice of technical options, with associated environmental impacts, should be left to the departments and local authorities or more explicitly stated in the policy document.

Critical works on sea defences, drainage infrastructure or conservancy dams can only provide a temporary respite from the risk of more catastrophic failures in the system. The core issue is in the improvement of disaster preparedness and management on the basis of sound operation and maintenance of the system and of adequate environmental monitoring and effective early warning.

Climate change is a cross-ministerial and cross-sectoral issue and this fact must be taken into consideration by all government departments and institutional stakeholders when relating to the sea defence policy. A key element in responding to climate change is flexibility and responsiveness in seeking the best options to react to changes over time. In order to achieve this, climate change considerations should be integrated at every stage of decision-making processes and climate change should be one of the core factors woven into all government policy actions identified in the sea defence sector policy. The mainstreaming of climate change into Guyana's sea defence policy, including resource and budget allocation, will require dialogue between all government departments and commitment from all stakeholders.

Given the limited availability of data concerning the key climate change impacts affecting the sea defences and the sea defence policy in Guyana as well as the related environmental baseline information, decisions may need to be taken on insufficient information. A policy of ***No-regrets*** decisions should be developed will allows chosen decisions to be modified, or even reversed, in the light of new information, without irreversible damage being done.

There is a strong emphasis in the policy document on data gathering and research, and this is advocated as a mitigation measure. This SEA does **not** agree with this approach. The SEA has identified that even though much raw data is now collected, it produces little return for effort. Collecting more data will not in itself assist in strengthening the sea defences sector. Data is not the same as information. Data must be analysed and conclusions drawn. Data should be robust and reliable. This can mean it is based on parameters which are simple to measure. Data collection should be well planned and thought out; it should be repetitive so that trends may be established. Large amounts of data on many different parameters can be confusing. It is more effective to select a few key parameters and collect reliable data on them.

Data collection should be based on Objectively Verifiable Indicators – OVIs. These are simple to measure, easy to understand by a non expert, and lead to clear unambiguous conclusions. The emphasis should not be on ***Impacts*** (*What happened?**)*** but on ***Consequences*** (*So what?**).***

For example, tide gauge readings from the harbour are OVIs. Satellite altimetry is not. Occurrence of heavy rain in times per year, intensity of rain in millimetres, and duration of storm in minutes is an OVI. Changing weather patters based on Climate change models are not. Indicators should be selected which are within the capabilities of the existing agencies to be measured and understood.
The emphasis should be placed on how interpreted information will be used. Analysis of data should lead to conclusions and then action. This can be in the short term e.g. an imminent storm or the long term e.g. beach erosion. Actions should also be reviewed after they have been implemented, and if seen to be

ineffective, future similar actions should be modified. This feedback can be institutionalised as CAR – Corrective Action reporting. After any major incident an analysis should be made of successes and failures. Any policy decision should be similarly reviewed at least annually. The **Lessons Learned** should be used to guide future actions.

Much emphasis is placed in the Policy on Emergency Warning Systems. These will not prevent flooding but will alert residents to a danger. However, as floods have occurred on the coastal strip for centuries this seems somewhat unnecessary. Even with prior warning, residents are reluctant to leave their homes. Flood prevention would be preferable but if this is impossible than a realistic emergency evacuation plan with the full consent, approval and participation of local residents and community leaders is necessary.

Guyana will need to establish and maintain a number of management mechanisms for integrated adaptation planning and management to become a reality. These mechanisms cannot all be developed simultaneously and in almost all instances substantial human, technical, and financial resources will be required to establish and maintain the policy, legal, and institutional structures that are necessary to successfully deal with the country's vulnerability to sea level rise. The priorities are grouped as follows :

Short Term
The major benefits are obtained for the planned operational changes. They flow from the setting up of genuine infrastructure budgeting, preventive maintenance, capital investment planning, and policy monitoring and evaluation. Institutional reform is necessary. The current institutional arrangement is weak and cannot achieve progress. This is a priority action.

A program can be started to raise ***awareness*** on the dangers of inappropriate land use and lack of coordinated development planning. The measurement of local sea level rise can be initiated. This will add credibility to suggested mitigation measures and give "ownership" to the issue, rather than relying on secondary information from model predictions.

For the sea defence sector to function it requires the providing of operational tools, whereby lessons learned can be a **basis** for later research. Full research can come later. It is not necessary to have perfect knowledge before decisions can be taken. In fact skilful decision makers make good decisions based on incomplete information. This stage is considered ***essential***.

Medium Term
Other benefits are the development of networking, awareness and identifying knowledge gaps and starting-up specific operational research. Training and capacity building of departments should progress to stop loss of qualified staff. Having raised awareness on the risks inherent in lack of coordinated development planning, inappropriate land use should now be actively ***discouraged***. Water level management planning can commence as a long term undertaking.

The upgrading of the knowledge base and awareness, the understanding of the value of ecosystems for livelihoods, and the design of new alternative or preventive measures are all useful actions. This stage is considered ***desirable.***

Long Term
Coordinated and comprehensive development planning should be ratified to the extent that inappropriate land use can now be ***Prohibited.***

There is a lot of emphasis in the Policy on research. This emphasis is considered wrong. The problems facing the sea defences sector are well known – it is the implementation of solutions that is problematic. Redressing the lack of targeted research and awareness regarding linkages between ecosystem conservation and community livelihoods is ***desirable*** in the long term, but given the critical nature of more pressing issues is, it is considered ***optional. Appreciating*** and ***understanding*** the value of ecosystems is considered ***essential***.

13.1.1 Recommendations on Institutions

Although some ministries in Guyana are being engaged in capacity building and adaptation activities there remain significant gaps in institutional, technical and financial capacities to address many issues around sea defences. Institutionally there are many bodies involved in the sea defences sector but three main ones are discussed below.

The **Sea Defence Board** has legal authority to implement sea defences and to control encroachment onto vulnerable coastal lands. It is irregular for a "Board" to have statutory enforcement powers. Such enforcement is usually carried out nationally by an EPA, or locally by a municipality. This power is considered redundant and similarly there is no justification for more legislation. Reportedly the Sea Defence Board has never met. It is recommended that this Board be disbanded and a new agency created to tackle the multifaceted issues of the sea defences sector.

S&RDD is a junior subdivision of a larger organisation and suffers from inequitable salaries and employment security, inadequate budget, and no authority when dealing with other senior organisations. Given the seriousness of the current state of the sea defences sector, and the critical role it plays in the economy of the country, it is clear that these responsibilities must be handled by an agency operating under a presidential mandate. It is recommended that **S&RDD** be elevated to the status of an independent agency attached to the office of the President. Without a single agency having the prestige and authority to make decisions and implement them, any further assistance to the SEA defences sector will simply continue to propagate an ineffective regime.

The **EPA** is responsible for coordinating ICZM - Integrated Coastal Zone Management, and ICZM - Integrated Shore Zone Management. It is not clear why two committees are needed for one overlapping area, but this is immaterial as both are ineffective. It is recommended that this coordinating function be taken away from EPA and vested with the new authority.

13.2 Recommendations for Sector Policy Support Program Formulation

13.2.1 Legislative Framework

The legislation is extensive, and there is no need for more regulations, but given the inadequacy of existing laws to cope, a comprehensive review of the relevant legislation is recommended. There is a need for a more cohesive legislation that removes the overlapping responsibilities and emphasises co-ordination between agencies. A single law which consolidates all aspects, supersedes previous legislation and fills the existing gaps on effective monitoring, implementation and enforcement is recommended

13.2.2 Administrative Boundaries

The ***geographical boundaries*** of the regions with sea and river defences as well as the definition of the limits and boundaries of the Sea Defences should be consolidated in the Sector Policy. The choice of an adequate administrative envelope is required to enable the actual implementation of adequate decisions.

13.2.3 Land Tenure Consolidation

In Guyana landless people are known to settle in coastal areas, having migrated from the interior to make a living from fishing, and eventually settling as permanent communities with perceived rights to the land they have cultivated for many years. On the other hand, business and industry have powerful interests in coastal development processes and land use arrangements. Land development and housing schemes are mostly disregarding land suitability or land use legislation. Encroachment into protected areas and state lands remains a major problem, and gives rise to frequent conflicts between different resource users, local communities, the private sector and government. Examples are numerous of the illegal or inappropriate location of coastal settlements and resettlement areas, of failure to incorporate environmental safeguards into infrastructure development and of the intense land use conflicts arising within the reconstruction process. The capacity to deal with conflict management should be enhanced across the sector. Unclear or absent land tenure arrangements were also stated as a critical issue requiring attention, and as a major source of land use conflict. The improvement of the land tenure system is therefore a key recommendation. Conflict management and land tenure consolidation should obviously be priorities in the SPSP.

13.2.4 Combine Other Sector Policies

Policy makers should also make use of the opportunity to integrate sector policies such as the Sea Defence Draft Sector Policy Framework within an integrative approach linking Integrated Coastal Zone Management (ICZM), Integrated Land Use Planning (ILUP) and Integrated River Basin Management (IRBM). This would allow development of a truly strategic approach, within an integrative framework combining the principles of ICZM, ILUP and IRBM and would address comprehensively many of the concerns expressed by the stakeholders consulted.

13.2.5 Budget Support

In order to improve the efficiency and effectiveness of a capital-intensive sector within a medium-term investment horizon such as the Sea and River Defence Sector, sustainable investment planning within a budget context is a must. Otherwise maintenance activities and rehabilitation cannot be planned in an effective and efficient manner. The major advantage of a sector wide approach is its budgetary transparency and coherence that constitute an excellent means for raising additional donor assistance. The investment plan is meant to clearly identify the needed funds and also can increase the perception of the urgency of the investment. Hence, it is recommended that the Ministry of Finance upgrade its current Public Sector Investment Plan (PSIP) to a full-fledged investment plan within a budget context. This would allow presenting expenditure estimates at project level for both donor financed and locally financed projects, and the same would apply to the publication of financial results and reports. This should thus also be a priority of the Sector Policy Support Programme.

Ministry of Finance intends to improve the PSIP in the future, and so the Sea and River Defence Sector should make an early start in participating and contributing its sector specific capital investment plan.

Hence, substantial efforts need to be made to complete the development of the sector policy and strategy. The Draft Sector Policy Framework is a first step in this direction, the Sector Policy Support Programme still needs to be elaborated. Funding must be secured to cover the sector budget and medium-term expenditure. The financial capacity of the departments that cut across the sea defence sector needs to be strongly enhanced.

The Government of Guyana must reform and provide packages that attract professional staff and counteract external incentives in order to retain personnel in the public service, e.g. creating incentives and performance-related rewards that can prevent the current brain drain from the sector.

Repairing sea defences is a costly operation that does not include activities that are generating funds. Consideration should be given to land use plans when selecting locations for repair to facilitate income-generating activities that could help support the cost of the sector.

13.2.6 Knowledge Base

A more coherent approach to database linkage and networking should be delineated in the policy as well as being supported by the SPSP. The statement that reports and data sets are often scattered across different sources (i.e. government agencies, research institutions, or stakeholders) and not available to decision-makers or the public would need to be followed by a more substantiated solution. More than making a general suggestion the policy should propose avenues for common data sharing and networking. Clear specifications and recommendations for a data exchange and information-sharing platform are to be elaborated during the near development of the policy and should indeed be supported by the SPSP. More insights should be provided on the kind of data that are needed, currently and in the future, their cost-effective collection, availability and usage, and the benefits that can be expected.

13.2.7 Mainstream Climate Change Issues

Climate change poses significant and wide-ranging challenges for Guyana and its sea defence policy. A number of policy-making sectors and ministries are engaged in climate change adaptation activities and capacity building. There remains a critical requirement for an integrated, cross-sectoral approach to climate change policy-making. Whilst functioning institutional structures, i.e. the National Climate Unit under the Ministry of Agriculture and the National Climate Committee that co-ordinates climate change activities in Guyana, appear to exist, it is widely accepted that institutional capacities are extremely low and require significant strengthening. Adapting to climate change will thus require significant institutional, technical and financial capacity and assistance.

Collecting environmental baseline data and measuring and monitoring climate change impacts, indicators and variables requires investing in the required technology. A sufficient level of technology and training of human resources in the use of the technology are fundamental. The policy would therefore need to provide for a budgetary allocation to acquire, maintain and operate the technologies that will enhance Guyana's understanding of climate change issues and of their relationship to sea defences and the sector policy.
Mere collection of data is essential but not sufficient. Data processing and analysis must be installed in order to integrate climate change related aspects into the sea defence policy. Moreover, the information should be made available to an extensive network of end-users, a core element for successful implementation.

Crucial to an integrated approach to climate change and the development of pragmatic adaptation strategies is the awareness of policy-makers, government departments and the general public of the issues surrounding climate change. For example, the National Climate Committee comprises representatives from many government agencies. However, the importance of continually raising understanding and awareness of the issues and aspects of climate change and how they affect the sea defences cannot be understated as climate change threatens infrastructures, settlements, lives and livelihoods. Although the Policy aims at improving awareness, a broader canvas should be targeted.

Adaptation strategies due to climate change should be integrated into the sea defence policy. For the adaptation to be beneficial and cost effective for Guyana's sea defences it should not rely only on reactive principles but ought to be proactive and anticipatory. The process of climate change adaptation is not finite but cyclical and it is critical that the cyclical nature of adaptation be integrated into the sea defence policy.

13.2.8 Integrating Stakeholders Concerns

At present there are no regulations that enable community involvement in the construction, operation and maintenance of sea defences, although these are allowed for under the law. The major issue is in the definition of the roles and responsibilities of the different actors. A clear agreement should be reached between the various institutions involved in sea and river defences.

13.2.9 Sea Defence Alternatives

In the Draft Sector Policy Framework, a strong emphasis is put under Policy Aim I and II on the enhancement of the economic efficiency of flood and coastal defence expenditures, i.e. budgetary transparency, integration, monitoring and tracking. Also under Policy Aim II, two avenues of research are introduced :

- To develop knowledge on ***alternative solutions*** (i.e. redesign, mangroves, etc.) which provide effective flood defence functions and protect or enhance environmental resources, and on their performance in order to build confidence in their use
- To investigate the extent to which ***preventive solutions*** could be developed and adopted in the field of sea and river defence in order to limit the build up of vulnerability and damage potential

The creation of a policy research centre is presented as a first step towards the adoption of a preventive instead of corrective approach.

There is an urgent need to establish strong and effective leadership and coherence between the various entities i.e. MPW&C, WSG, SDB, S&RDD, NDIA, Hydromet et al. The policy should be used as an opportunity to establish and formalise cross-sectoral cooperation and implementation.

The Policy Framework does not make sufficient provisions for feedback and integration of public interest groups concerns and expectations for protection from flooding.

13.2.10 Mangroves

Sea defence policies will have a far-reaching impact on the environment and ecosystems. The decision to protect a particular area determines whether significant local or national habitats are lost or gained. Emphasis is put under Policy Aim II on the importance of the relationship of coastal ecosystems to community livelihoods. This should be given more prominence.

The importance of mangroves as highly productive ecosystems supporting highly diversified food chains and nursery grounds for numerous species, many of them of commercial value, and exploited for a variety of uses by local communities, justifies that their protection and restoration be fully included in the policy.

Moreover, mangroves constitute an integral part of the coastal protection and their maintenance is less costly than that of artificial defences. The rationale for including mangroves, as natural sea defences in the policy, should therefore very strongly be elaborated both from the institutional and technical point of view.
The policy suggests that Guyana's mangroves could be used as a field laboratory in order to learn more about mangrove ecology and stewardship, conduct research on the economic value of and test new approaches of alternative flood protection. This avenue could also be followed to gather understanding of the economic value of the impact of the defence system as well as on the value of ecosystem services on community livelihoods. This suggestion is ***not*** supported. The economic value of mangroves is well documented internationally. Local research would probably not make a major contribution to knowledge of the subject, and the funds could be put to better use elsewhere. It is more important that communities learn to appreciate the value of mangroves to themselves in the long term and are persuaded to stop destruction for short term benefits.

13.2.11 Inland Watersheds

Damage to coastal ecosystems does not only result from wave and storm action, or human activities in the coastal zone, but also from various activities carried out further inland. The policy suggests research on how upstream deforestation and other forms of vegetation clearance are responsible for escalating sediment loads in rivers, estuaries and coastal waters, which choke coastal and marine ecosystems. This is supported as it may alleviate the burden of regular clearing of weeds and sediments in the drainage canals.

13.2.12 Sea Defence Board

The **Sea Defence Board** has legal authority to implement sea defences and to control encroachment onto vulnerable coastal lands. It is irregular for a "Board" to enforce statutory powers and such enforcement is usually carried out nationally by an EPA, or locally by municipalities. These possibilities do not apply in Guyana as statutory powers are already delegated to S&RDD, who take limited action.

Reportedly the Sea Defence Board has never met. It is recommended that this Board be disbanded and a new board be created, or failing this, the existing Board be drastically overhauled and reduced in membership.

Policy Aim III is fully devoted to reactivating and reinforcing the Sea Defence Board through reform and empowerment. The current structure of the board responds to an old administrative organisation and there is an urgent need to review the existence of an institution, which is no longer responding to the challenges of a sector threatened by global warming, climate change and sea level rise.

A profound and dramatic institutional review is needed to respond to the scale and implications of the difficulties faced, and a reform aimed at making the sector fully operational is essential.

The policy should clearly establish the roles and responsibilities of the new board detailing:

- Composition i.e. the members
- Institutional and legal capacity
- Power of law enforcement and enactment
- Financial powers and resource allocation
- Power to argue financial and long-term investment needs at MoF level,
- Procurement and project management rules
- Authority to assign responsibilities concerning performance of the sector.

In parallel with the creation of a new board, a new agency should be created to tackle the multifaceted issues of the sea defences sector. (See 1.7.2) The new board should focus on policy issues and delegate its statutory enforcement and implementing powers to the new agency.

Key political level involvement (the president) will be required for the institutional framework to function properly.

13.2.13 Sea and River Defence Division

S&RDD is a junior subdivision of a larger organisation and suffers from inequitable salaries and employment security, inadequate budget, and no authority when dealing with other senior organisations. Given the seriousness of the current state of the sea defences sector, and the critical role it plays in the economy of the country, it is clear that these responsibilities must be handled by an agency operating under a presidential mandate. It is recommended that **S&RDD** be elevated to the status of a single independent autonomous agency attached to the office of the President. Without a ***single agency*** having the prestige and authority to make decisions and implement them, any further assistance to the sea defences sector will simply continue to propagate an ineffective regime.
S&RDD needs a higher proportion of national public expenditures on sea defences due to the critical importance of sea defences to the future of the national economy. The merger of the S&RDD into the WSG of the MPW&C may strengthen the technical abilities of the division and provide improved employment conditions for employees. On the other hand, if parity on salaries cannot be established S&RDD may find themselves separated from WSG and in a worse situation than before the merger. Also the merger may weaken the ability of S&RDD to perform its duties and meet its targets by dissipating finances allocated to sea and river defences among other departments competing for budget on roads and bridges.

13.2.14 Regional and Neighbourhood Democratic Councils

The co-ordination of the existing dual decision-making process (i.e. RDC or MPW&C) is an urgent matter to be resolved in the policy. In order to ensure adequate project implementation, the policy should include institutional arrangements and allocation of responsibilities to clarify the respective roles and hence achieve efficiency and effectiveness in S&RD public investment.

13.2.15 Link with S&RDD and NDIA

The policy discussion should be used as an opportunity to stress the need for better collaboration between the NDIA and S&RDD (who used to be one unit) and start establishing and formalising this collaboration.

13.2.16 Link with Hydromet

Monitoring and evaluation or early warning and flood prevention data and information is provided by Hydromet. A closer relationship and clear sharing of responsibilities between S&RDD and Hydromet should be realised in order to state clearly what actions are to be taken on the information passed from Hydromet to S&RDD.

Collecting environmental baseline data and measuring and monitoring climate change impacts, indicators and variables requires investing in the required technology. A sufficient level of technology and training of human resources in the use of the technology are fundamental. The policy would therefore need to provide for a budgetary allocation to acquire, maintain and operate equipment that will enhance Guyana's understanding of climate change issues and of their relationship to sea defences and the sector policy. The technologies could range from simple rain gauges and river water depth pressure sensors to sophisticated online sea level rise satellite altimetry systems. A policy decision must be made on achieving a balance between simple yet robust data collection systems, and complex systems which may provide more detail yet may be more susceptible to failure through lack of maintenance.

Collection of data is not sufficient on its own. Data processing and analysis must be installed in order to integrate climate change related aspects into the sea defence policy. This requires ensuring that the data presented to staff is not so complex that it is beyond their abilities to interpret it.

The information should be made available to an extensive network of end-users, a core element for successful implementation, and not hoarded with the agency which collected it.

13.2.17 Link with Civil Defence Commission

The Commission is responsible for emergency response, but not early warning or disaster preparedness. Much emphasis is placed in the Policy on Emergency Warning Systems. These will not prevent flooding but will alert residents to a danger. However, as floods have occurred on the coastal strip for centuries this seems somewhat unnecessary. Even with prior warning, residents are reluctant to leave their homes. Flood prevention would be preferable, but if this is impossible, then a realistic emergency evacuation plan with the full consent, approval and participation of local residents and community leaders is necessary. Otherwise there seems little point in spending a large amount of money on a sophisticated early warning system if the residents refuse to react. The FEWERS scheme alone, without a viable and workable evacuation plan, enthusiastically supported by affected persons, is not an effective solution to flood prevention.

A closer relationship should be formed between Civil Defence Commission, S&RDD and Hydromet to crystallise the use of information from FEWERS.

13.2.18 Link with the GFC

The GFC wants mangroves to be taken up in the Guyana Protected Area System. Mangroves could be declared public land and be put under the direct management of GFC as it is the overall co-ordinating and implementing agency for the National Mangrove Management Plan. At the moment, mangroves can still be private lands, which prevents the Forestry Commission from enforcing their protection. However, being public lands does not guarantee their sustainable development because appropriate sources of funding still would have to be created. Iif mangroves are to become an integral part of the sea defence system, the link with and role of the Guyana Forestry Commission must be established in the policy.

13.2.19 Link with NCC and NCU

The need for more institutional, technical and financial support of the Committee is consistently stressed by many. The policy should link with the NCU for adequate flood monitoring and early warning, and for improving the downscaling capacity of climate models for better addressing the needs of Guyana.

13.2.20 Link with EPA and other Agencies

EPA acts as facilitator in ICZM. Sea level rise adaptation measures should be incorporated into Integrated Coastal Zone Management (ICZM) and the National Development Strategy. In order to develop a rational coastal zone management plan it will be essential to involve Land and Survey Commission in the production of regional land use plans, which can then be implemented at district level, where proof of land tenure will be most important. Co-ordination with the Central Housing and Planning Authority is also needed to avoid inconsistencies. Environmental considerations should be integrated at every stage of decision-making processes. Environmental issues should be woven as a core factor into all actions identified in the sea defence sector policy. This is a vital role to be carried out by EPA.

13.2.21 Economic Exit Strategy

To support coastal conservation initiatives, the policy should promote economically sustainable approaches. The policy should identify financial and economic incentives for coastal conservation. This is of critical importance if the sea defences sector is to be sustainable without donor support. The concept of developing an exit strategy from reliance on external funding must be introduced.

Public awareness and education have unanimous support among officials as a technique for changing attitudes and building support for mangrove management. It is generally felt that public education should promote awareness, understanding, and new attitudes regarding the role of mangroves as natural protection against floods, as well as the value and appropriate use of coastal resources. Given the diversity of education level and socio-economic status of the audience, a broad-based approach to education is required, bringing together the groups who benefit from and who are damaging the mangroves, building participation in the planning process, and promoting vigilance and reporting of mangrove destruction.

14 ANNEX 1 Legislation

14.1 The Sea Defence Act (CAP 64:01)

The Sea Defence Act (CAP 64:01) dates back to the 19th century (first enacted in 1883) and was designed as *"an Act to secure the Maintenance of the Sea, River, and Outer Dams of Estates"*. It was re-issued in 1973 and last amended in 1998 under its current title of Sea Defence Act, Chapter 64:01 within a comprehensive programme to consolidate national legislation.

The Act empowers the relevant Minister (currently the MPW&C) to issue regulations to protect and conserve the foreshore, and prohibits cutting of trees or shrubs and the removal of shell, sand, or other material from the foreshore. Provisions confer the power to the Chief Hydraulic Officer appointed by the Minister to instruct owners to carry out any sea defence work deemed necessary to protect the foreshore of a district, and to apportion the costs of construction to the beneficiaries or to petition parliament for the needed funds.

The Act is generally considered to be sufficient and is currently used by the Sea and River Defence Division to protect the foreshore from sand removal.

14.2 The Sea Defence Act (CAP 64:02)

The Sea Defence Act (CAP 64:02) was first issued in July 1933, then consolidated and reissued in 1998 as *"an Act to make better provision for the maintenance and construction of sea defences"*. It contains six parts:

- Part I makes provision for the establishment of a Sea Defence Board (SDB), a statutory body in charge of the care, maintenance, management and construction of the sea and river defences;
- Part II allows for the creation of sea and river defence districts;
- Part III includes provisions for the maintenance, management and construction of sea and river defences;
- Part IV allows for Parliament to provide funds for the construction and maintenance of sea and river defences;
- Part V sets out offences and procedures for the imposition of penalties; and
- Part VI allows the Board to make proposals for regulations with the approval of the Minister.

The Act is still in force and empowers the Sea Defence Board to prepare plans and cost estimates for the construction of new defences and to implement those plans once approved by the Minister. The Act transferred the financial burden of construction and maintenance of sea and river defences from estate owners to Parliament with effect from 1937, and it basically placed the responsibility of the management of the resources with Central Government. Under the act there are eight Declared Sea Defence Districts along the coast located in Regions 2 to 6. The exclusive jurisdiction of SDB extends up to 50 feet from the coastline.

14.2.1.1 The Drainage and Irrigation Act (CAP 64:03 and Act 10 of 2004)

The Drainage and Irrigation Act (Act 10 of 2004) replaces the earlier Drainage and Irrigation Act (CAP 64:03), initially passed in 1940, then consolidated and reprinted in 1998. The present Act provides for the establishment of the National Drainage and Irrigation Authority (NDIA), a semiautonomous body with the purpose of establishing an effective mechanism for the management and financing of the drainage, irrigation and flood control system to prevent its deterioration and ensure sustained use. Moreover, it is one of the first pieces of legislation that involves first line stakeholders as it allows for the creation of water users associations (WUA) responsible for the maintenance of the secondary drainage and irrigation systems and eligible to bid for projects.

Section 10 of the Act places an obligation on the Sea Defence Board to consult and collaborate with the Authority regarding *"…the construction of sea and river defence work and the care, maintenance and management of sea and river defences"*. Besides, provisions of this Act (i.e. Article 8.1 [h] and Article 10 [Part II]) also set out that:

- The Board shall ensure the co-ordination of plans, programmes and activities between the NDIA, the SDB, Conservancy Boards (which are not defined) and other relevant authorities; and
- The functions conferred on the Sea Defence Board regarding the care, maintenance and management of sea and river defences, shall be conducted in consultation and collaboration with NDIA in connection with drainage and irrigation.

14.2.1.2 The Environmental Protection Act (CAP 20:05)

The Environmental Protection Act (CAP 20:05) established in 1996 the Environmental Protection Agency giving it overall responsibility for the management of the environment. The purpose of the Act is to provide

for the management, conservation, protection and improvement of the environment, the prevention and control of pollution, the assessment of the impact of economic development on the environment, and the sustainable use of natural resources.

The Environmental Protection Agency (EPA) is a statutory corporate body created to monitor and enforce environmental regulations, co-ordinate an integrated coastal zone management programme and carry out any other functions in relation with environment protection and enhancement. Currently the Act does not make provisions for Strategic Environmental Assessment (SEA).

14.2.1.3 The Land and Survey Commission Act (1999)

The Land and Survey Commission Act provides for the establishment of the Land and Survey Commission as a statutory (semiautonomous) body. The main responsibilities of the Commission are to advise the Government of Guyana on land policies in the following areas of relevance to the sea defence sector:

- Ensure that the management of State and Government lands is done in accordance with Government legislation and policy;
- Co-ordinate and manage the Government system and procedures for the distribution of land, in an organised system of assessment, selection criteria and appeals processes;
- Advise Government on new areas to be mapped and on the revision/reproduction of maps and plans;
- Issue land titles and leases for all purposes excluding forestry and mining;
- Co-ordinate with other agencies concerned with land-based resource management (i.e. the Guyana Geology and Mines Commission, Guyana Forestry Commission, Central Housing and Planning Authority, and Environmental Protection Agency, etc.) with the objective of ensuring orderly and sustainable occupancy and use of lands.

14.2.1.4 The Water and Sewerage Act (2002)

The Water and Sewerage Act of 2002 provides for the establishment of a National Water Council whose responsibilities include the analysis of national and regional water use, and of the threats to water resources together with the task to recommend alternatives and solutions.

The Act also defines the role of the Hydro-meteorological Services (Article 8), and provides for the creation of Guyana Water Inc., a public corporation, fully owned by the State of Guyana, responsible for drinking water supply.

14.2.1.5 The Guyana Forestry Commission Act (CAP 67:01)

Under the Guyana Forestry Commission Act (CAP 67:01), the Guyana Forestry Commission (GFC) is made responsible for the administration and management of the forest resources of Guyana. The Act relates to the Constitution of Guyana, the Charter of the United Nations, and international law. The aims include:

- The conservation of the forests of Guyana, including measures to conserve biological diversity, special species and habitats, soil and water resources;
- The protection of forests against pollution, fires, pests and diseases;
- The integrated and comprehensive regulation of the multiple and complementary functions and uses of the forests of Guyana, including traditional uses; and
- The promotion and regulation of local processing activities, including the use of environmentally sound technologies and the facilitation of market access for value-added forest products.

15 ANNEX 2 Stakeholders

15.1 Potential Stakeholders

The list of stakeholders relevant to the further elaboration of the sector policy are :

- The Delegation of the European Commission in Guyana;
- The Office of the Adviser to the President on Sustainable Development (GoG);
- The National Authorising Officer and Task Force (GoG);
- The Ministry of Finance (GoG);
- The Ministry of Public Works and Communications (GoG);
- The Works Services Group (MPW&C);
- The Sea Defence Board (MPW&C);
- The Sea and River Defence Division (MPW&C);
- The Ministry of Agriculture (GoG);
- The National Drainage and Irrigation Authority (MoA);
- The Hydrometeorological Services (GoG);
- The Guyana Forestry Commission (GoG);
- The Fisheries Department (GoG);
- The Environmental Protection Agency (GoG);
- The Integrated Coastal Zone Management Committee (EPA);
- The Natural Resources and Environment Advisory Committee (EPA);
- The National Climate Unit;
- The National Climate Committee;
- The Civil Defence Commission;
- The Guyana Land and Survey Commission (GoG);
- The Ministry of Housing and Water (GoG);
- The Central Housing and Planning Authority (MH&W);
- The Guyana Geology and Mines Commission (GoG);
- The Neighbourhood Democratic Councils of Region 1 to 6 (GoG);
- The Georgetown Sewerage and Water Commission;
- The Water Users Associations of Region 1 to 6;
- The Guyana Rice Development Board;
- The Guyana Sugar Co-operative (GuySuCo);
- The Guyanese Citizens Initiative;
- The University of Guyana;
- The Caribbean Community Secretariat (CARICOM);
- The Caribbean Community Climate Change Centre (CCCCC);
- The Caribbean Development Bank (CDB);
- The Inter-American Development Bank (IDB);
- The World Bank (WB);
- The United Nations Development Programme (UNDP);
- The British High Commission in Guyana (United Kingdom);
- The Department for International Development (DFID, United Kingdom);
- Conservation International;
- Oxfam;
- Partners for Americas; and
- Various companies from the consulting sector.

15.2 Stakeholders Consulted

Alphabetical list of people and institutions engaged with during the mission

Table 15-1 List of Stakeholders consulted/engaged

#	Surname and Name	Position	Institution	Telephone	Fax	E-mail
1	Mr Youssouf Alexander	Manager, Conservation Service	Conservation International	(592) 227-8171	(592) 225-2976	ealexander@conservation.org
2	Mr Khalid Alladin	Senior Environmental Officer, Environmental Management Division	EPA	225-2062 225-1218 225-0506 225-6917 Ex22 623-1298		
3	Mr Alexander		Conservation International	227-8171 225-2978 223-5497		
4	Mr Phillip Allsopp	Chief Engineer Sea Defence (formerly)				
5	Mr Mewburn Amsterdam	Project Manager, EU projects S&RDD	S&RDD, MPW&C	226-1070 656-6766		amo122003@yahoo.co.uk
6	Major General Michael Atherly	Director General	Civil Defence Commission	226-1117	226-1027	
7	Mr Garfield Barnwell	Director, Sustainable Development Programme	CARICOM Secretariat	222-0001/75	222-0171	
8	Mr Andrew Bishop	Commissioner	LSC	227-2582 623-1017		
9	Mr Marc Buchmann	Head of ECD Technical Section (formerly)	EU Delegation to Guyana	647-6481 618-836		marc.buchmann@ec.europa.eu
10	Dr Paulette Bynoe	Director, School of Earth and Environmental Sciences	U Guy	222-4180 616-3703		bynoep2000@yahoo.com
11	Ms Peggy Carlson	Director, Farmer to Farmer Programme	Partners of the Americas	+1 (202) 637 6230	+1 (202) 628 3306	pcarlson@partners.net

12	Ms Gitanjali Chandarpal	Coordinator	NCU	225-5842		ncuguyana@yahoo.com gitanjalic81@yahoo.com
13	Mr. Navin Chandarpal	Adviser to the President on Sustainable Development	Office of the President	223-5233		
14	Mr Rabindranauth Chandarpal	Chief Transport Planning Officer	MPW&C	625-6646		rchandarpal@gmail.com
15	Mr. Patrick Chesney	Project Manager, Guyana Shield Initiative Project	UNDP	223-6564 Ext 235	226-2942	patrick.chesney@undp.org
16	Ms Johanna Cooke	Deputy Head, DFID Guyana	British High Commission	225-5492 226-5881 (Ext.2049) 624-3578		j-cooke@dfid.gov.uk
17	Mr. Garvin Cummings	Hydrologist	Hydrometeorological Services, MoA	225-4247		
18	Ms Agnes Dalrymple	Chief Officer S&RDD	S&RDD, MPW&C	227-8294 227-2469 641-4544	225-8395	a-dalrymple@hotmail.com niks336@yahoo.com
19	Mr Philip da Silva	Coordinator of ICZMC	U Guy	624-6337		nessie159@yahoo.com
20	Ms Joselyn Dow	Executive Director	Guyanese Citizens Initiative	225-8404 618-7312		
21	Mr Christopher Engelbrecht	Head of Technical Section (currently)	EU Delegation	647-6481		
22	Mr Geer	Officer in Charge, Fisheries Dept.	MoA	226-4398 666-5073		
23	Mr Javier Grau	Water and Sanitation Division	IDB Country Office	225-7950 660-8285		

24	Mr George Howard	Head Sea Defence (formerly)		623-7237		
25	Mr Daudi Husbands	GIS Expert	Guyanese Citizens Initiative	225-8404		
26	Ms. Joylyn Jafferally	Specialist Hydrologist	Hydrometeorological Services, MoA	225-4247		
27	Mr Felix Jerra	Head	NAO Task Force			
28	Mr Tasreef Khan	Commissioner	Forestry Commission	226-7271		
29	Ms Alana Lancaster	Director, Environmental Management	EPA	222-4224		
30	Ms. Nadine Livan	Programme Associate, Energy & Environment	UNDP	226-4040/8/9	226-2942	nadine.livan@undp.org
31	Mr Bruno Lopes-Pereira	Programme Officer, Technical Section	EU Delegation to Guyana	226-4004 647-6481		bruno.lopes-pereira@ec.europa.eu
32	Mr Colin Lord	Monitoring Officer, EU projects	NAO Task Force	223-7039 223-7040	225-7603	nao_taskforce@yahoo.com
33	Ms Cecilia Lorio	Programme Officer	CAFOD	+44 (0)207326 5643		
34	Mr Rickford Lowe	Coordinator WSG	MPW&C	624-6589		ric.lowe@hotmail.com
35	Ms Indira Mattai	Senior Environmental Officer, Monitoring and	EPA	225-2062 225-1218 225-0506		

		Enforcement Unit		225-6917 Ex23		
36	Ms Donna McRae-Smith	Project Officer, Sustainable Development Programme	CARICOM Secretariat	222 0001/75 (Ext.2207)	222 0171	dms@caricom.org
37	Ms Deborah Montouth-Hollingsworth	Technical Assistant	CH&PA, MH&W	223-7261 225-6452 623-2225	223-7612	
38	Mr Otto Nagy	Programme Officer, Technical Section	EU Delegation to Guyana	226-4004 645 8934		otto.nagy@ec.europa.eu
39	Mr Shyam Nokta	Chairman	NCC	222-4565 623-0269	222-3172	emc@netwroksgy.com shyamnokta@gmail.com
40	Mr Luca Palazzotto	Project Coordinator	Oxfam	227-1501 225-3830/3 623-5859		
41	Ms Caroline Paul	Office Manager	Guyanese Citizens Initiative	225-8404		
42	Dr Dindyal Permaul	Permanent Secretary	MoA	227-5527 223-7844		
43	Mr Christopher Persaud	Project Officer, Infrastructure	IDB	225-7950 (Ext.239)	225-7138	chrisp@iadb.org
44	Mr Doorga Persaud	Executive Director	EPA	222-4224 225-2062		dpersaud@epaguyana.org
45	Ms Annie Pitamber	Project Coordinator, Second National Communication to UNFCCC	NCU	225-5842		snc_gy@yahoo.com
46	Mr. Zainool Rahaman	Team Leader, National Agriculture Adaptation Strategy	Hydrometeorological Services, MoA	225-4247		zainoolm@yahoo.com

47	Dr Ramdass	Biological Diversity Specialist	EPA	225-5892 222-5785 225-6048		
48	Ms Bheleka Saulall	Chief Hydrometeorological Officer	Hydrometeorological Services, MoA	225-4247 226-5403		
49	Ms Germene Stewart	Development Planner, Research and GIS	MH&W	227-3737 624-1177		
50	Mr Ben ter Welle	Team Leader, Protected Areas Project	GFA	225-5882 623-0261		
51	Mr. Didier Trebucq	Deputy Resident Representative	UNDP	225-6962 624-4018	226-2942	didier.trebucq@undp.org
52	Dr Ulric Trotz	Chief Scientific Adviser	Caribbean Community Climate Change Centre	(501) 822-1104	(501) 822-1365	info@caribbeanclimate.bz
53	Ms Tamara Whalen	Operations Analyst	WB Guyana Country Office (conservancy project)	223-5036	225-1384	twhalen@worldbank.org
54	Mr Fraser Wheeler	High Commissioner	British High Commission	226-5881/2	225-3555	fraser.wheeler@fco.gov.uk
55	Mr Lionel Wordsworth	Chief Executive Director	NDIA	226-9330 617-0260		

16 ANNEX 3 Actions under the Draft Sector Policy Framework

The Draft Sector Policy Framework comprehends 5 Policy Aims, 10 Strategic Objectives and 53 Activities Actions. Those actions that are rather broad in scope (especially under SO3) have been subdivided into several more narrowly itemised activities providing for a clearer assessment within the SEA Study. A more comprehensive description of each activity *quoted in the terms of the Draft Sector Policy Framework*, is given for further reference, especially because this constitutes the basis for the identification of impacts and indicators relevant to the implementation of the policy. Some explanatory [terms] have been added to ensure a better comprehension.

Policy Aim I: promote adequate economically, technically and environmentally sound and sustainable S&RD infrastructure management

Strategic Objective 1: complete S&RD infrastructure maintenance and investment plan

- ***Activity 1.1a: define a clear and SMART set of preventive maintenance priorities and targets for the S&RDD****, i.e. finalise the policy framework by focussing on maintenance with priority areas or sites for maintenance intervention and targets in terms of number, length of critical structures to be repaired over a given number* [3] *of years*
- ***Activity 1.1b: establish a year-based routine maintenance plan to support maintenance expenditure claims****, i.e. establish a financially substantiated (in terms of costs) yearly maintenance plan*
- ***Activity 1.1c: define a clear*** **[cross-sectoral]** ***strategy and set of maintenance objectives for WSG/S&RDD and NDIA under SDB****, i.e. define overall maintenance categories and objectives at strategy level; this is presented as the task for a temporary working group*
- ***Activity 1.2a: improve transparency and comprehensiveness of actual maintenance expenditures at all levels of the budget****, i.e. tackle the issue that different labels and categories currently coexist for similar expenditures by unifying the budgetary terminology used by the various parties involved*
- ***Activity 1.2b: integrate recurrent (routine maintenance) and capital expenditure for WSG/S&RDD and NDIA under MoF****, i.e. improve the linkage between capital and recurrent budget in an overall coherent budgetary framework; this is presented as the task for a temporary working group*
- ***Activity 1.2c: prepare a long-term (10 years) sector wide comprehensive S&RD infrastructure investment plan****, i.e. state purpose, scale and timing* [currently, there is a 3-years budgeting horizon] *of investments within a single framework of action providing for a unique and more sustainable programming and budgeting including maintenance and investment; this is presented as a way to upgrade the current Public Sector Investment Plan within a budget context*

Policy Aim II: establish information systems and policy research priorities aimed at cost effective flood control based on efficient EWS

Strategic Objective 2: establish a sound ecological, biophysical, socio-economic knowledge base, surveillance and M&E of S&RD infrastructure

- ***Activity 2.1: create monitoring and tracking mechanism of budget expenditures of S&RD and D&I****, i.e. focus on budget realisation and couple it to the need for capacity, i.e. trained staff, and research on the enhancement of the economic efficiency of the expenditure*
- ***Activity 2.2: establish a surveillance inspection plan and database of the condition and status of the S&RD infrastructure****, i.e. focus on the physical condition of the defences and develop an up to date and operational database that can provide reports on the current status of the defences*
- ***Activity 2.3a: optimise the ecological, biophysical, socio-economic data collection and knowledge base of the S&RD sector****; i.e. organise the overall background data collection required to establish the knowledge base for the operations of the S&RD sector*
- ***Activity 2.3b: establish the ecological, biophysical, socio-economic knowledge central clearing house of the S&RD sector****; i.e. create a centralised database system for managing the background knowledge and information*
- ***Activity 2.3c: create a monitoring and evaluation mechanism and unit for S&RD sector policies****; i.e. follow upon sea and river defence related policies and their implementation coupled to research on policy development, and assess the quality of information management in co-ordination with all stakeholders*

Strategic Objective 3: create a Research Centre on S&RD issues

- ***Activity 3.1a: create an S&RD Policy Research Centre or Unit linked to international universities and research****, i.e. create a public research unit within S&RDD*
- ***Activity 3.1b: develop a policy support and evaluation toolbox with EVA, DSS, GIS, vulnerability mapping and spatial planning****, i.e. gather a specific set of tools that includes the economic valuation of coastal resources, the appraisal of conservation and development activities, the use of decision support tools, the use of GIS and resource maps, the evaluation of trends and vulnerabilities*
- ***Activity 3.1c: pursue research on the*** **[intrinsic]** ***value of coastal ecosystems in view of conservation or development****, i.e. put emphasis on the assessment of coastal ecosystem values in response to development and conservation actions and issues, and especially on particularly high-valued or threatened ecosystems and locations;*
- ***Activity 3.1d: perform evaluation of negative impacts of land-based activities in view of mitigation or reversal****, i.e. assess existing activities that have an impact on coastal ecosystems and livelihoods;*
- ***Activity 3.1e: perform evaluation of impacts of intensification of land-based activities in view of mitigation or reversal****, i.e. assess the impact of a possible intensification of activities that currently may not have an impact but probably will in the long-term*
- ***Activity 3.2: perform gap analysis of existing knowledge resources, databases & baseline, in view of S&RD operational needs****, i.e. assess the needs of the division and the sector's institutions and personnel for information, including the reduction of environmental risk and disaster management*
- ***Activity 3.3: carry out a comprehensive national coastal baseline assessment****, i.e. assess coastal biological diversity, ecosystems and livelihoods in order to contribute to the establishment of a regional inventory including risk and vulnerability assessments*
- ***Activity 3.4: create multilevel information exchange network for S&RD with database access****, i.e. emphasise the network function of existing resource centres and between existing databases for the sector*
- ***Activity 3.5: create fully geo-referenced coastal ecosystems archive linking existing databases and GIS facilities****, i.e. emphasise the sharing by national data and GIS centres of their data and the provision of access to relevant data on coastal zone ecosystems*
- ***Activity 3.6a: target research policy in an integrated approach to coastal zone research****, i.e. develop a comprehensive research policy that will promote an integrative solution to sea and river defence and fill data gaps and information needs* [as itemised under Activity 3.6b through 3.6k]
- ***Activity 3.6b: pursue research on coastal ecosystems services to conservation and livelihoods****, i.e. examine the value of coastal ecosystems for the economy, local livelihoods and poverty alleviation, and estimate the nature and magnitude of benefits such as support to fisheries productivity, waves and storm control, shoreline protection, etc*
- ***Activity 3.6c: pursue research on the contribution of mangroves to coastal protection****, i.e. include the design of appropriate stewardship of the mangrove for the preservation of its important functions and benefits to coastal zone communities*
- ***Activity 3.6d: pursue research on the resilience and recovery of species and communities in coastal mangroves****; i.e. assess the rate of resilience and recovery of different species and communities in mangroves and in other coastal ecosystems*
- ***Activity 3.6e: pursue research on the presence and impact of invasive alien species in coastal ecosystems****, i.e. assess the rate of invasion of different alien species and communities in mangroves and in other coastal ecosystems*
- ***Activity 3.6f: pursue research on coastline evolution timeline mapping by RS/GIS****, i.e. develop a GIS database and maps* [this item allowing for the determination and measurement of coastline dynamics stems from the baseline mapping under Activity 2.3a and the creation of a geo-referenced archive under Activity 3.5, and is implicitly related to the toolbox under Activity 3.1b]
- ***Activity 3.6g: pursue research on the impact of hinterland development on coastal erosion and flooding****, i.e. examine the resulting changes in upstream hydrology caused by water abstraction or storage and modification of the timing or volume of the fresh water supply to the coastal zone among other in relation to climate change;*
- ***Activity 3.6h: pursue research on the impact of hinterland deforestation/clearing on sediment load or coastal system choking****, i.e. build awareness as well as understanding of the processes leading to increasing sediment loads in rivers, and design appropriate mitigation measures*

- ***Activity 3.6i: pursue research on the valuation of gains or losses from S&RD infrastructure and policy****, i.e. assess the economic value of the S&RD system as safeguard of coastal production and consumption, reduced vulnerability and strengthened resilience in order to improve the understanding on how solutions can be implemented without a net loss in environmental assets and preferably a contribution to an environmental gain*
- ***Activity 3.6j: pursue research on the design of alternative solutions, redesign, mangroves, etc., to S&RD approaches****, i.e. develop alternative techniques or approaches that will provide or enable effective flood defence functions while protecting or enhancing environmental resources*
- ***Activity 3.6k: pursue research on the design of preventive solutions to S&RD approaches****, i.e. investigate the extent to which such policies and technical solutions could be implemented that prevent the further build up of vulnerability and damage potential;*

Strategic Objective 4: target training and capacity building and improve public awareness

- ***Activity 4.1a: target training and capacity building of professionals towards S&RD sector management and ICZM****, i.e. train professionals and build capacity of coastal zone managers for the S&RD and ICZM sectors*
- ***Activity 4.1b: target training and capacity building of planners towards economic valuation of coastal ecosystems****, i.e. train both development and conservation planners in the use of economic valuation tools*
- ***Activity 4.2a: enhance awareness of planners and policy makers*** **[of integrative landscape approaches]***, i.e. promote the need for a "reef to ridge approach" among inland land and resource managers, river basin planners and policy makers*
- ***Activity 4.2b: enhance general public awareness of the role of ecosystems for livelihoods development****, i.e. target awareness programmes on the role of the mangrove ecosystem in community life, and of coastal ecosystems for stakeholders such as women, school children, resource users, communities, urban dwellers, local government, administrations and decision-makers*
- ***Activity 4.2c: enhance general public awareness of the contribution of mangroves to the S&RD system****, i.e. enhance the awareness, understanding and new attitudes regarding the role of mangroves as protection against floods*
- ***Activity 4.2d: enhance awareness of decision makers and general public of flooding risks and issues****, i.e. enhance awareness amongst the institutions and the affected communities*

Strategic Objective 5: develop a Flood Risk Assessment (FRA)

- ***Activity 5.1: develop a Flood Risk Assessment with specific recommendations for mitigation****, i.e. outline the main flood risks to Guyana and the mitigation measures that reduce the impact of the flooding*

Strategic Objective 6: create a Flood Early Warning and Emergency Response System

- ***Activity 6.1: design and realisation of a FEWERS in partnership between S&RDD, NDIA and Hydrometeorological Services****, i.e. install a Flood Early Warning and Emergency Response System giving forewarning of the likelihood of flooding in order to save lives and property*

Policy Aim III: achieve institutional framework strengthening and law enforcement for the S&RD policy framework

Strategic Objective 7: achieve the needed institutional framework strengthening and reform

- ***Activity 7.1a: achieve the institutional reform and strengthening of SDB****, i.e. review and reinforce the capacity of an institution which is not responding to the demands and challenges of a sector threatened by global warming and climate change, and review the legal, policy and institutional framework of the SDB and determine what changes are required for it to take a proper oversight role on the proper governance of the S&RD sector, in particular confirm the role of SDB in arguing the current financial and longer term investment needs of the sector at MoF level*
- ***Activity 7.1b: create SDB Steering Committee****, i.e. ensure fully sustainable management of the sector as a whole under a SDB Steering Committee of members that will provide direction for the new WSG during the 9th EDF;*
- ***Activity 7.2: clarify the link of SDB with local government for adequate regional maintenance co-ordination/costs sharing****, i.e. establish an adequate institutional co-ordination system between the Regional Development Councils and the overall national strategic decisions of the MPW&C, based on an analysis of the required preventive maintenance functions for the S&RD sector and of the technical, financial and human resources required at central and regional level, including the analysis of the role and sharing of responsibilities with the Regional Development Councils*

Strategic Objective 8: improve law and regulation enforcement

- ***Activity 8.1: assign law enforcement powers to SDB as a supervisory body****, i.e. empower the SDB or another supervisory body to be responsible for actively and directly assisting in the enforcement of laws, e.g. to prevent, detect and investigate non-compliance*

Policy Aim IV: discourage inappropriate land use and development planning

Strategic Objective 9: restrict inappropriate land use and development planning

- ***Activity 9.1: review legal and regulatory base for land-use planning and development in the S&RD protected coastal zone****, i.e. tackle the weaknesses and gaps in land use planning and effective regulation enforcement (shown by illegal or inappropriate location of many coastal settlements and resettlement areas, or failure to incorporate environmental safeguards into infrastructure development and reconstruction), and promote information sharing among S&RD sector policy makers, land use planners and land developers*
- ***Activity 9.2: support the development of integrated spatial plans for land use planning in the S&RD protected coastal zone****, i.e. include at national and local level the assessment of critical and vulnerable ecosystems and the needs for flood protection within the land use zoning in order to identify the most suitable use of the coastal zone*
- ***Activity 9.3: support the formulation of land use conflict resolution mechanisms and arbitrage by SDB in the coastal zone****, i.e. deal with land use conflicts around the S&RD protected land among other involving poor landless people settling in the coastal area, businesses and the industry, as well as with the encroachment on protected areas or state lands involving resource users, local communities, the private sector and government*
- ***Activity 9.4: reduce the impact of sea level rise by land use restrictions and coastal features protection measures****, i.e. define and implement the restriction and control of building in low-lying areas, the assistance of industry transformation, and the protection of wetlands and dunes, by ensuring that flood risk is taken into account at all stages in the planning process by all agencies in order to avoid inappropriate development in areas at risk, but when necessary making it safer, and to direct development away from areas of highest risk*

Policy Aim V: reduce flooding risk, damage and losses by implementing sustainable water and flood management

Strategic Objective 10: install sustainable water management and planning (WMP)

- ***Activity 10.1a: prepare a comprehensive impact assessment of sea level rise on populations and sectors in the coastal area****, i.e. delimit the potentially affected population and define the socio-economic impacts according to the local situation for the development of strategy and prevention;*
- ***Activity 10.1b: design a new tidal prevention and river drainage system based on new standards, models and methods****, i.e. establish and draw up new design standards for coastal embankment, tide and flood prevention, and drainage systems, and draft new prevention methods and carry out flood modelling analysis in order to respond to future conditions, and protect life and property in coastal regions*
- ***Activity 10.1c: define and classify the spatial extent of the domain of intervention for flood insurance system****, i.e. establish different levels of flood areas in the implementation of a flood insurance system that prevents reckless developments*
- ***Activity 10.1d: prepare a comprehensive Water Level Management Plan****, i.e. prepare a plan that is providing a strategic framework for decisions on sea and river defence management based on coastal processes, environmental and human issues and needs, and foresees for the assessment of risks and risk management policies and their impact, the monitoring of the effectiveness of the policies, and the inclusion of policies in future land use planning and coastal zone management*
- ***Activity 10.2a: establish monitoring and reporting system of sea level and subsidence impact on habitats****, i.e. include sea level, coast and coastal structure, and expand to subsidence monitoring and enhance the establishment of the coastal database*
- ***Activity 10.2b: establish monitoring and reporting system of sea defence operations impact on habitats****, i.e. establish a system for the assessment of the impact of operating sea defences on habitats covered under national action plans or multilateral agreements on biological diversity.*

17 ANNEX 4 Impacts of Actions under Draft Sector Policy Framework on Sea Defences

Policy Aim I: promote adequate economically, technically and environmentally sound and sustainable S&RD infrastructure management

Strategic Objective 1: complete S&RD infrastructure maintenance and investment plan

- ***Activity 1.1a: define a clear and SMART set of preventive maintenance priorities and targets for the S&RDD*** should yield significant direct operational (i.e. the SMART set) and locally physical (i.e. the repaired infrastructure in the first years) benefits in the short-term. The maintenance of already existing infrastructures does not quite introduce a new negative impact. The indirect benefits in the long-term are the scaling-up of the reduced flooding in the adjacent areas, the protection of communities and reduction of economic damage and losses, and the overall improvement of the coastal environment and biological diversity. These benefits will be significant but not absolute, as exceptional events always remain possible and sea defences are only part of the solution. Especially in the long-term, due to the progress made, impacts will be cumulative but if climate change data are not appropriately incorporated the impact may become reversible indeed if the structures although meant to be permanent lose their functionality in view of the new conditions. This activity only has a long-term positive impact if the required maintenance strategy, surveillance and preferably also the geo-referenced baseline are realised (Activity 1.1c, 2.2, and 3.3 and 3.5), and if the risk factor is fully taken into account by implementation of new standards (Activity 5.1 and 10.1b). However, there is a possible long-term enhancement of the positive impact in the linkage with research on existing natural defences or possibilities for alternatives or redesign (Activity 3.6c, 3.6j and 3.6k);
- ***Activity 1.1b: establish a year-based routine maintenance plan to support maintenance expenditure claims*** should yield a direct operational benefit (i.e. the existence or non-existence of a genuine financially substantiated yearly maintenance plan) at regional level for the short-term. As the plan is revised annually and in theory implemented, for each plan the benefit will be significant (but not absolute), permanent, reversible and cumulative. The indirect benefit in the medium- to long-term could be the increased clarity of the recurrent expenditure. Besides, there is a possible enhancement of the positive impact in the linkage with the overall improvement of the recurrent budget (especially Activity 1.2a and 2.1). The activity should also provide inputs among other to the risk assessment (Activity 5.1), the land use planning (Activity 9.2) and the water management plan (Activity 10.1d);
- ***Activity 1.1c: define a clear*** **[cross-sectoral]** ***strategy and set of maintenance objectives for WSG/S&RDD and NDIA under SDB*** should yield two direct operational benefits, i.e. a coherent maintenance strategy and a working group. The working group and the strategy would be effective at regional to national level and have a major impact in the sense that they constitute the highest integrated level of authority in terms of setting overall maintenance categories and objectives. Their impact is meant to be permanent, can be reversible (due to possible changes in the course of action) and is cumulative/synergistic. The activity must feed into surveillance, monitoring and flood insurance planning (Activity 2.2, 10.2b and 10.1c), and the results must be integrated in the water management plan (Activity 10.1d). The activity should also benefit from the development of new standards (Activity 10.1b), risk assessments (Activity 5.1 and 10.1a), capacity building and research on alternatives and prevention (Activity 4.1a, 4.2c, 4.2d, 3.6j and 3.6k);
- ***Activity 1.2a: improve transparency and comprehensiveness of actual maintenance expenditures at all levels of the budget*** should realise the unification of the used budgetary terminology and have a major national operational impact enabling a sector wide approach. The impact is meant to be permanent, irreversible and cumulative in the sense that it will affect all involved parties and ensure the financial effectiveness of routine and preventive maintenance as well as emergency repairs. There is no doubt that a unified terminology will enable better assessment of expenditures. This activity is a prerequisite to the successful implementation and transparency of budgets (Activity 1.1b, 1.2a, 1.2b and 2.1) and could benefit from specific research (Activity 3.6i);
- ***Activity 1.2b: integrate recurrent (routine maintenance) and capital expenditure for WSG/S&RDD and NDIA under MoF*** should improve the integration between capital and recurrent budget in an overall budgetary framework, with a major operational impact in the short-term at national level as well as at donor level. This direct impact is meant to be permanent, irreversible, and cumulative in the sense that it will affect all involved parties and ensure the financial integration of routine and capital expenditure. There is no doubt that an overall coherent budgetary framework will provide for more effective budgeting. This activity is the logical follow-up (Activity 1.2a) or prerequisite (Activity 1.2c, 2.1 and 3.6i) to the successful implementation of other budgetary planning, tracking and valuation. The position and prerogatives of the working group in relation to SDB (more specifically to Activity 7.1a and 8.1) should be clarified, though;
- ***Activity 1.2c: prepare a long-term (10 years) sector wide comprehensive S&RD infrastructure investment plan*** should within a budget context provide for a major operational impact at the level of

the sector, i.e. an integrated and financially more sustainable budget and approach to S&RD investment. The impact is meant to be permanent, can be reversible (due to possible changes in policy) and is cumulative (being a way to upgrade the current Public Sector Investment Plan). The indirect benefits in the long-term are the scaling-up of the reduced flooding in the adjacent areas, the protection of communities and reduction of economic damage and losses, and the overall improvement of the coastal environment and biological diversity. These benefits will be significant but not absolute, as exceptional events always remain possible and sea defences are only part of the solution. Impacts will be cumulative but may become reversible indeed if the structures fail although they are meant to be permanent. The activity needs budgetary monitoring inputs (Activity 2.1), should feed into the water management plan (Activity 10.1d) and has implications for the yearly planning or long-term strategy of maintenance (Activity 1.1b or 1.1c), and for the budgeting of the early warning system (Activity 6.1);

Policy Aim II: establish information systems and policy research priorities aimed at cost effective flood control based on efficient EWS

Strategic Objective 2: establish a sound ecological, biophysical, socio-economic knowledge base, surveillance and M&E of S&RD infrastructure

- ***Activity 2.1: create monitoring and tracking mechanism of budget expenditures of S&RD and D&I*** should have a major national operational impact also in relation to donors. This impact is meant to be permanent, can be reversible and is synergistic in nature. This Activity supports transparency and requires integration (Activity 1.2a and 1.2b) of the budget, and enables planning and policy evaluation (Activity 1.2c and 2.3c). It also requires the necessary capacity, operational linkages and supervisory body (especially Activity 7.2 and 8.1);
- ***Activity 2.2: establish a surveillance inspection plan and database of the condition and status of the S&RD infrastructure*** should have a direct significant operational impact on the national S&RD database. The indirect benefits in the long-term are the scaling-up of the reduced flooding in the coastal zone, the protection of communities and reduction of economic damage and losses, and the overall improvement of the coastal environment and biological diversity. As exceptional events remain possible, the benefits will be significant but not absolute, and impacts will be synergistic, permanent but may become reversible. The activity constitutes a prerequisite to maintenance and strategic planning (Activity 1.1b and 1.1c) as it provides reports on the current status of the defences at regional level and helps setting medium-term targets and priorities for specific planning activities (Activity 1.2c and 10.1d). Inputs are to be expected from risk and impact assessments (Activity 5.1 and 10.1a) and a specific link should be established to the policy research centre, baseline and early warning system (Activity 2.3b, 3.3 and 6.1, especially);
- ***Activity 2.3a: optimise the ecological, biophysical, socio-economic data collection and knowledge base of the S&RD sector*** should have an operational impact at national level, significant for the long-term, meant to be permanent and synergistic but that yet can become reversible. The activity needs to be co-ordinated (i.e. placed under Activity 2.3b) and should receive inputs especially on risk assessment (Activity 5.1 and 10.1a), link with defence and habitat monitoring (Activity 2.2, 10.2a and 10.2b), provide input to various aspects of land use legislation and planning (e.g. Activity 9.1, 9.2, 9.3, 9.4, 10.1b and 10.1c) and integrate the results from knowledge bases and research (Activity 3.1c, 3.1d, 3.1e, 3.2, 3.3, 3.5, and 3.6a through 3.6k);
- ***Activity 2.3b: establish the ecological, biophysical, socio-economic knowledge central clearing house of the S&RD sector*** should create the central clearing house that should articulate with the knowledge network (Activity 3.4) and the toolbox (Activity 3.1b) for the knowledge base (Activity 3.3 and 3.5). The institutional impact at national level would be significant for the long-term given the needed time to establish a functional unit with data, tools and linkages, and is meant to be permanent and synergistic but yet can become reversible. The activity in theory provides for the co-ordination of Activity 2.3a and possibly 2.3c but the position of the clearing house should be defined institutionally as it needs to be able to act as supervisory body within the framework of its tasks (to be specified under Activity 7.1a and 8.1) also in relation to the S&RD Policy Research Centre (Activity 3.1);
- ***Activity 2.3c: create a monitoring and evaluation mechanism and unit for S&RD sector policies*** should have a significant national operational impact. This impact is meant to be permanent, can be reversible and is synergistic in nature. The activity requires definition (i.e. under Activity 7.1a) regarding the relation of the unit to the clearing house, the board, the steering committee (e.g. Activity 2.3a, 7.1b), it should also obtain input from budget monitoring, infrastructure surveillance and gap analysis (Activity 2.1, 2.2 and 3.2), and is expected to support strategy and planning (Activity 1.1c, 1.2c, 6.1, 9.2 and 10.1d);

Strategic Objective 3: create a Research Centre on S&RD issues

- ***Activity 3.1a: create an S&RD Policy Research Centre or Unit linked to international universities and research*** should have a significant institutional impact at national level. The creation of a public research unit is a permanent, irreversible and synergistic long-term activity. The centre will co-ordinate

core-research (Activity 3.1b through 3.1e) and also cover more specific themes (Activity 3.6b through 3.6i). The centre and research can in theory support any other activity under the sector policy, but needs tools and knowledge network (Activity 3.1b and 3.4) and its position and responsibility should be clearly defined in relation to other units (e.g. Activity 2.3b and 2.3c) as well as within the overall institutional framework (Activity 7.1a and 8.1);

- ***Activity 3.1b: develop a policy support and evaluation toolbox with EVA, DSS, GIS, vulnerability mapping and spatial planning*** should have a significant operational impact at sector level but more tools could be included in the future. Although meant to be a long-term effort, elements of the toolbox can be replaced or abandoned giving the toolbox a temporary, reversible though synergistic character. The toolbox should be used in support of any research (Activity 3.1b through 3.1e and 3.6b through 3.6i) or data collection (e.g. Activity 2.3a, 3.3, 3.5 and 9.1), monitoring (e.g. Activity 2.1, 2.2, 2.3c, 10.2a and 10.2b) and assessment (e.g. Activity 5.1, 10.1a and 10.1c);
- ***Activity 3.1c: pursue research on the* [intrinsic] *value of coastal ecosystems in view of conservation or development*** should have a direct significant impact on the coastal zone knowledge base, covering two particular aspects, i.e. coastal ecosystem valuation for economic development more at community level, and for biological diversity conservation. These two areas and the related capacity (Activity 4.1b and 4.2b) are likely to benefit from a significant indirect impact in the long-term. In both cases, the gained knowledge will especially in the long-term have a permanent, reversible and synergistic character. The activity should benefit from specific knowledge and research (Activity 2.3a, 3.3, 3.6a, 3.6b and 3.6i), monitoring (Activity 10.2a and 10.2b), as well as support land use planning (Activity 9.2);
- ***Activity 3.1d: perform evaluation of negative impacts of land-based activities in view of mitigation or reversal*** should have a direct significant impact on the knowledge base for parts of the coastal zone in the short- and medium-term regarding the mitigation or reversal of physical and ecological pressures. Indirectly in the longer term it should represent a significant benefit on the mitigation and reversal of social and economic pressures. The knowledge and measures are likely to be temporary, reversible although most often cumulative or synergistic. The gained knowledge could also profit from other specific research (Activity 3.6g and 3.6h), or provide support to the capacity for coastal land use planning (Activity 4.1a, 9.1, 9.2);
- ***Activity 3.1e: perform evaluation of impacts of intensification of land-based activities in view of mitigation or reversal*** should have a direct significant positive impact on the knowledge base for parts of the coastal zone in the long-term regarding the mitigation or reversal of physical and ecological pressures. Indirectly it should represent a significant benefit on the mitigation and reversal of social and economic pressures. The measures are likely to be more permanent because of the increasing overall intensity and gravity of the situation, still reversible and most often cumulative or synergistic. The gained knowledge could also profit from other specific research (Activity 3.6g and 3.6h), or provide support to the capacity for coastal land use planning (Activity 4.1a, 9.1 and 9.2);
- ***Activity 3.2: perform gap analysis of existing knowledge resources, databases & baseline, in view of S&RD operational needs*** should have a significant operational impact on S&RDD and hence at sector level in the short- to medium-term. Although the baseline and databases would cover all possible aspects the overall impact essentially remains operational in the identification of needs. The gap analysis has a temporary, reversible though synergistic character. The activity essentially is a task for the Policy Research Centre (created under Activity 3.1a) and/or clearing house (under Activity 2.3b) to be further defined under Activity 7.1a, and should support the establishment of the knowledge base as well as of the research (Activity 2.3a, 3.3 and 3.6a). Absolutely vital to this activity are the adequate inclusion of alternative and preventive measures, regulation and new standards (Activity 3.6j, 3.6k, 9.1 and 10.1b) that will enable an appropriate response to climate change;
- ***Activity 3.3: carry out a comprehensive national coastal baseline assessment*** should have a direct significant impact on the knowledge base of the whole coastal zone, the policy putting emphasis on three particular aspects, i.e. coastal biological diversity, ecosystems and livelihoods including risk and vulnerability assessment. The accumulation of gained knowledge to a certain extent will have a permanent, irreversible and synergistic character. The Policy Research Centre and/or clearing-house (created under Activity 3.1a and 2.3b, to be further defined under Activity 7.1a), should benefit from research (Activity 3.1c through 3.1e, and 3.6b through 3.6i especially), knowledge bases (Activity 2.3a and 3.5), monitoring and assessments (Activity 2.2, 2.3c, 9.1, 10.1a, 10.2a and 10.2b). The activity should rely on the gap analysis (Activity 3.2) and the baseline should be made available in an exchange network (Activity 3.4). One may also wish that the physical environment be more specifically included in the descriptive of this activity in the policy framework;
- ***Activity 3.4: create multilevel information exchange network for S&RD with database access*** should have a largely indirect and long-term impact on the sector as it implies the linkage between a variety of sources and the passage through a learning curve that will make the system really operational. The direct impact is operational at the local and sector level. In both cases it may take a long time before

it becomes significant. The network has a permanent, reversible and synergistic character. The Policy Research Centre and/or clearing-house (created under Activity 3.1a and 2.3b, to be further defined under Activity 7.1a) should be managing the network, for the benefit of all research (Activity 3.1c through 3.1e, and 3.6b through 3.6k), capacity and awareness building activities (Activity 4.1a through 4.2d). Other activities such as monitoring and planning could also be among the possible beneficiaries depending on the legal limitations set to the availability of data and information on the network. One would certainly recommend to expand the network to the international level in view of better including the issue of climate change, for example;

- ***Activity 3.5: create fully geo-referenced coastal ecosystems archive linking existing databases and GIS facilities*** should have a largely direct and long-term impact on the sector as it constitutes the major step towards an integrative approach at the sector level. All activities are concerned and all aspects are likely to benefit from permanent, hopefully irreversible and synergistic impacts. The Policy Research Centre and/or clearing-house (created under Activity 3.1a and 2.3b, to be further defined under Activity 7.1a) should be managing the GIS facility, for the benefit of all users. Inputs will be required from databases, monitoring and other assessments (e.g. Activity 2.2, 2.3a, 2.3c, 3.3, 5.1, 10.1a, 10.2a and 10.2b). An operational link to the various tools of the toolbox (Activity 3.1b) and the exchange network (Activity 3.4) is recommended;
- ***Activity 3.6a: target research policy in an integrated approach to coastal zone research*** should have through the exploitation of results significant long-term indirect impacts on all aspects of the coastal zone at national level. The direct impact is operational at the sector level in the short- to medium-term. Research targeting is temporary, reversible but synergistic, the long-term impacts hopefully will rather be permanent. The targeting will define all research activities (especially Activity 3.6b through 3.6k already present in the draft sector policy framework);
- ***Activity 3.6b: pursue research on coastal ecosystems services to conservation and livelihoods*** should in most cases have a rather locally bound minor impact in terms of a better approach to biological diversity or livelihood development. Besides contributing to the general knowledge base (Activity 2.3a and 3.3), these direct long-term impacts should have a more temporary, reversible and often non-cumulative character. The results of this research should also benefit for example specific capacity and awareness building or land use planning (Activity 4.2b or 9.2);
- ***Activity 3.6c: pursue research on the contribution of mangroves to coastal protection*** should have a rather locally bound significant impact on biological diversity and minor impact on livelihoods in the design of appropriate stewardship measures for the preservation of this important function and of its benefits for coastal zone communities. Besides contributing to the general knowledge base (Activity 2.3a and 3.3), these direct long-term impacts should have a more temporary, reversible but possibly cumulative character. This research should also benefit to (Activity 3.6f and 3.6j) or from (Activity 3.6d and 3.6e) other research. The results of this research should also be useful for example to specific capacity and awareness building or land use planning (Activity 4.2c or 9.2). One would also recommend that the impact of climate change on the mangrove be more specifically taken into account;
- ***Activity 3.6d: pursue research on the resilience and recovery of species and communities in coastal mangroves*** should have in spite of its contribution to the general knowledge base (Activity 2.3a and 3.3), a rather minor direct impact on purely local ecological conditions. Due to the limited possibilities for implementing mitigation measures, such long-term action would have a more temporary, reversible, yet cumulative character. This research should also benefit to (Activity 3.1d, 3.1e, 3.6c, 3.6g, 3.6h and 3.6j) or from (Activity 10.2a and 10.2b) other research. The results of this research should also be useful for example to specific capacity and awareness building or land use planning (Activity 4.2c or 9.2). One would also recommend that the impact of climate change on mangroves be more specifically taken into account;
- ***Activity 3.6e: pursue research on the presence and impact of invasive alien species in coastal ecosystems*** should have in spite of its contribution to the general knowledge base (Activity 2.3a and 3.3), a rather minor direct impact on local ecological conditions. Due to the limited possibilities for implementing mitigation measures, such long-term action would have a rather temporary, reversible, yet cumulative character. This research should also benefit to (Activity 3.6c and 3.6d) or from (Activity 10.2a) other research. The results of this research should also be useful for example to specific capacity and awareness building or land use planning (Activity 4.2c or 9.2). One would also recommend that the impact of climate change on changing populations be more specifically taken into account;
- ***Activity 3.6f: pursue research on coastline evolution timeline mapping by RS/GIS*** should have a major direct operational impact at national level on the physical and ecological knowledge base (Activity 2.3a and 3.3) in a fairly short-term. The activity should support Activity 3.5 by providing a permanent, irreversible, synergistic input, and is implicitly related to the use of the toolbox (under Activity 3.1b). This research should also support other activities such as awareness building, planning (Activity 4.2d, 9.2 and 10.1d) and provide inputs to the risk assessment and early warning system (Activity 5.1 and 6.1) in

relation to coastal erosion. One would also recommend that the impact of climate change on coastal erosion be more specifically taken into account;

- ***Activity 3.6g: pursue research on the impact of hinterland development on coastal erosion and flooding*** should have a significant direct operational impact on the regional knowledge base (Activity 2.3a and 3.3) and awareness level especially regarding physical aspects (hydrology and water balance, erosion and flooding) in relation to climate change. The acquired knowledge would have a temporary, reversible but synergistic value. Indirectly in the long-term, the definition of appropriate physical mitigation measures would normally be aimed at being more permanent. The activity should support among other risk assessment, early warning, land use planning and water management planning (Activity 5.1, 6.1, 9.2 and 10.1d);
- ***Activity 3.6h: pursue research on the impact of hinterland deforestation/clearing on sediment load or coastal system choking*** should have a significant direct operational impact on the regional knowledge base (Activity 2.3a and 3.3) and awareness level especially regarding physical aspects (sediment loads, system choking) in relation to climate change. The acquired knowledge would have a temporary, reversible but synergistic value. Indirectly in the long-term, the definition of appropriate physical mitigation measures would normally be aimed at being more permanent. The activity should support among other risk assessment, early warning, land use planning and water management planning (Activity 5.1, 6.1, 9.2 and 10.1d);
- ***Activity 3.6i: pursue research on the valuation of gains or losses from S&RD infrastructure and policy*** should have a significant impact on the perception of the operational economic value of the S&RD system within the national budget. The perception will benefit from a temporary, reversible yet synergistic valuation. The activity should provide data and information to maintenance planning and policy evaluation (Activity 1.2c and 2.3c) and benefit from the needed capacity (Activity 4.1b);
- ***Activity 3.6j: pursue research on the design of alternative solutions, redesign, mangroves, etc., to S&RD approaches*** should have a significant regional impact on the technology of S&RD in the medium-term, as well as on the physical environment, biological diversity, community livelihoods, and economic development in the long-term. These are meant to be mostly permanent, hopefully irreversible and synergistic. The activity should benefit from the needed capacity (e.g. Activity 4.1a, 4.2a and 4.2c) and the knowledge gathered in risk assessment (Activity 5.1, 10.1a and 10.1b) while linking to the results of complementary research (Activity 3.6c, 3.6f and 3.6k) in order to support S&RD maintenance planning (Activity 1.1c and 1.2c);
- ***Activity 3.6k: pursue research on the design of preventive solutions to S&RD approaches*** should have a significant regional impact on the technology of S&RD in the medium-term, as well as on the physical environment, biological diversity, community livelihoods, and economic development in the long-term. These are meant to be mostly permanent, hopefully irreversible and cumulative. The activity should benefit from the needed capacity (e.g. Activity 4.1a, 4.2a and 4.2d) and the knowledge gathered in risk assessment (Activity 5.1, 10.1a and 10.1b) while linking to the results of complementary research (Activity 3.6f and 3.6j) in order to support S&RD maintenance planning (Activity 1.1c and 1.2c);

Strategic Objective 4: target training and capacity building and improve public awareness

- ***Activity 4.1a: target training and capacity building of professionals towards S&RD sector management and ICZM*** should have a minor direct operational impact in the short-term on the sector, the issue being that people tend to easily leave their job. It also has a minor indirect impact on the national physical and biological environment as well as on community livelihoods and the economy in the long-term. The direct impact is temporary, reversible and cumulative; the indirect impacts are more permanent, reversible and cumulative. The obtained capacity should especially support long-term S&RD planning and design (Activity 1.1c, 1.2c, 10.1b, 10.1c and 10.1d) and contribute to the knowledge base (Activity 2.3a and 3.3);
- ***Activity 4.1b: target training and capacity building of planners towards economic valuation of coastal ecosystems*** should have a minor direct operational impact in the short-term on the sector, the issue being that people tend to easily leave their job. The impact is temporary, reversible and non-cumulative. The obtained capacity should especially support long-term S&RD planning and monitoring (Activity 1.2c and 2.3c) and contribute to the knowledge base (Activity 2.3a and 3.3) research (Activity 3.1c and 3.6i) and capacity building (Activity 4.2b);
- ***Activity 4.2a: enhance awareness of planners and policy makers*** **[of integrative landscape approaches]** should have a minor direct operational impact in the short-term on the sector, the issue being that people tend to easily leave their job. It should also have a minor indirect impact on the protection of the national biological and physical environment in the long-term. The direct impact is temporary, reversible and cumulative; the indirect impacts are more permanent, reversible and synergistic. The obtained awareness/capacity should especially support long-term spatial planning (Activity 1.2c, 3.5, 9.2 and 9.4), risk assessment (Activity 5.1, 10.1a, 10.1b, 10.1c and 10.1d), and research (Activity 3.6g, 3.6h and 3.6j);

- ***Activity 4.2b: enhance general public awareness of the role of ecosystems for livelihoods development*** should have a significant direct impact on the approach to the mangrove ecosystem especially in the long-term at national level. Indirectly, communities in the coastal zone would also benefit from significantly better livelihoods in the longer term. The impact can be expected to be permanent, yet reversible, but synergistic. Within the policy framework, the obtained awareness can be expected to mainly support research (Activity 3.1c, 3.6b and 3.6i) and link to economic valuation capacity building (Activity 4.1b);
- ***Activity 4.2c: enhance general public awareness of the contribution of mangroves to the S&RD system*** should have a significant direct impact on the perception of the role of mangroves in the S&RD system especially in the long-term. The impact can be expected to be permanent, yet reversible, but cumulative. Within the policy framework, the obtained awareness can be expected to mainly support research (Activity 3.6c, 3.6j and 10.1b);
- ***Activity 4.2d: enhance awareness of decision makers and general public of flooding risks and issues*** should have a significant direct impact on the perception of the flooding risk that will determine the infrastructure response especially in the long-term. The impact can be expected to be permanent, yet reversible, but synergistic. Within the policy framework, the obtained awareness can be expected to mainly support maintenance planning and monitoring (Activity 1.1c, 1.2c and 2.2), risk assessment and early warning (Activity 5.1 and 6.1), related research (Activity 3.6c, 3.6f, 3.6g, 3.6h, 3.6i, 3.6j and 3.6k), and raise the support to Strategic Objective 9 and 10 in general;

Strategic Objective 5: develop a Flood Risk Assessment (FRA)

- ***Activity 5.1: develop a Flood Risk Assessment with specific recommendations for mitigation*** should have a direct significant operational impact at the sector level in the short-term. The impact is meant to be permanent, irreversible and synergistic. The activity supports strategy and planning (Activity 1.1c, 1.2c and 10.1d), land use planning (Activity 9.1, 9.2 and 9.4), the definition of standards (Activity 10.1b and 10.1c), and feeds information into awareness and early warning (Activity 4.2d and 6.1). It can benefit from inputs from the baseline (Activity 2.3a and 3.3), monitoring (Activity 2.2), research (Activity 3.6c, 3.6f, 3.6g, 3.6h, 3.6i, 3.6j and 3.6k) and assessments (Activity 10.1a, 10.2a and 10.2b);

Strategic Objective 6: create a Flood Early Warning and Emergency Response System

- ***Activity 6.1: design and realisation of a FEWERS in partnership between S&RDD, NDIA and Hydrometeorological Services*** should have a direct significant operational impact on the sector in the short-term. If proven effective (i.e. permanent, irreversible, synergistic) the system will in the long-term yield significant indirect benefits to all components of the environment, i.e. physical, biological diversity, community livelihoods and economic development. These benefits are meant to be permanent, can be reversible and could mostly be synergistic. The activity must be made operational (Activity 7.1a and 8.1), requires input from monitoring, the baseline data and the exchange network (Activity 2.2, 3.3, 3.5 and 3.4), relies on risk assessment and standards (Activity 5.1, 10.1a and 10.1b), and should link to land use planning and water management (Activity 9.4, 10.1c and 10.1d);

Policy Aim III: achieve institutional framework strengthening and law enforcement for the S&RD policy framework

Strategic Objective 7: achieve the needed institutional framework strengthening and reform

- ***Activity 7.1a: achieve the institutional reform and strengthening of SDB*** should have a direct significant operational impact on the capacity of SDB over the coastal zone, aimed at being permanent, irreversible and synergistic. At first, the reform must be fully carried out (mainly under Activity 7.1b and 8.1) after which SDB can be expected to play a leading role especially in maintenance targeting and investment planning (Activity 1.1c and 1.2c), surveillance (Activity 2.2), budgeting (Activity 2.1 and 2.3c), research co-ordination (Activity 3.1a, 3.2, 3.4 and 3.6a), risk assessment and early warning (Activity 5.1 and 6.1), and contribute to land use planning and water level management (Activity 9.2, 10.1b, 10.1c and 10.1d);
- ***Activity 7.1b: create SDB Steering Committee*** should have a direct significant operational impact on the functioning of SDB at agency level in the short-term. The overall impact is likely to be permanent, reversible but synergistic. The role of the steering committee is to be determined together with the prerogatives of SDB under Activity 7.1a, 7.2 and 8.1;
- ***Activity 7.2: clarify the link of SDB with local government for adequate regional maintenance co-ordination/costs sharing*** should have a direct significant operational impact on the regional level establishing an adequate institutional co-ordination system between the Regional Development Councils and the overall national strategic decisions of the MPW&C. The activity should be linked to research on the valuation of losses and benefits (Activity 3.6i), be complementary to budget transparency and integration (Activity 1.2a, 1.2b and 1.2c) and aimed at a permanent, irreversible, synergistic impact;

Strategic Objective 8: improve law and regulation enforcement

- ***Activity 8.1: assign law enforcement powers to SDB as a supervisory body*** should have a significant operational impact at the level of the sector in terms of the enforcement of laws. This impact is meant to be permanent, can be reversible and is cumulative. The activity should be realised through institutional reform (Activity 7.1a, 7.1b and 7.2) and the level of empowerment must cover monitoring mechanisms (especially Activity 2.1, 2.2 and 2.3c), regulation (Activity 9.1 and 9.3), planning (Activity 1.2c and 10.1d) and early warning (Activity 6.1). The position, prerogatives and relation between several entities must be clearly defined more specifically for the temporary strategy and budgetary working group[s] (Activity 1.1c and 1.2b), the central clearing house (Activity 2.3b), the policy monitoring and evaluation unit (Activity 2.3c), the policy research centre (Activity 3.1a), the exchange network and GIS facility (Activity 3.4 and 3.5), the early warning and response system (Activity 6.1), the renewed SDB and its steering committee (Activity 7.1a and 7.1b) and the local level of government (Activity 7.2);

Policy Aim IV: discourage inappropriate land use and development planning

Strategic Objective 9: restrict inappropriate land use and development planning

- ***Activity 9.1: review legal and regulatory base for land-use planning and development in the S&RD protected coastal zone*** should have a direct significant operational impact on the coastal legal and regulatory knowledge base in the short-term. It aims at a permanent, irreversible and cumulative baseline review. The activity should obviously link with land use planning (Activity 9.2, 9.3 and 9.4) and related research and awareness building (Activity 3.1b, 3.1d, 3.1e, 3.6g, 3.6h and 4.2a). It could benefit from the knowledge base (Activity 2.3a), specific research (i.e. Activity 3.1d) and risk assessments (i.e. Activity 5.1). It could also feed into sea defence maintenance and investment planning (Activity 1.1c and 1.2c), complement the early warning system and water level management assessment and planning (Activity 6.1, 10.1b, 10.1c and 10.1d). One would also recommend to make use of the opportunity to include the impact of climate change on land use regulation more specifically in the review and further legislation;
- ***Activity 9.2: support the development of integrated spatial plans for land use planning in the S&RD protected coastal zone*** should have a significant indirect impact at regional and local level on all aspects of the environment, i.e. physical planning, biological diversity, community livelihoods, and economic development. In the long-term, an integrative approach ensures rather permanent, yet reversible but cumulative benefits to the most suitable use of the coastal zone. To support Activity 9.3 and 9.4, the activity should obtain reports from sea defence planning and surveillance (Activity 1.2c and 2.2), baseline (Activity 3.3 and 3.5) and regulation information (Activity 6.1, 9.1, 10.1c and 10.1d) and risk assessments (Activity 5.1 and 10.1a). It could also benefit from research and capacity building on livelihoods and the hinterland (especially Activity 3.6b, 3.6f, 3.6g, 3.6h, 4.1a and 4.2a). One would also recommend that the impact of climate change on land use planning be more specifically taken into account;

- ***Activity 9.3: support the formulation of land use conflict resolution mechanisms and arbitrage by SDB in the coastal zone*** should have a certain direct operational impact on the resolution of land use conflicts in the short-term, as well as indirect on community livelihoods in the coastal zone in the long-term. Conflict resolution is meant to be permanent, irreversible and cumulative but practically the long-term impact should be considered temporary, reversible and yet cumulative. In support of land use planning as well as emergency response (Activity 9.2 and 6.1), the activity essentially links to land use regulation (Activity 9.1) and SDB empowerment (Activity 8.1). It also could benefit from more specific capacity and research yet to be targeted (Activity 4.1a, 4.2a and 3.6a);
- ***Activity 9.4: reduce the impact of sea level rise by land use restrictions and coastal features protection measures*** should have a direct significant impact on regional physical planning in the short- to medium-term. It should also have indirect significant impacts on the coastal environment, i.e. physical planning, resource use and conservation, community livelihood, and economic development. These can be expected to be rather permanent, reversible but cumulative. In synergy with Activity 9.1 and 9.3, the activity should support land use planning (Activity 9.2) and benefit from the available sea level rise related information and risk assessments (Activity 2.2, 5.1 and 10.1a). It should also be supported by specific capacity building and research (Activity 4.2d, 3.3, 3.5, 3.6f and 10.1b);

Policy Aim V: reduce flooding risk, damage and losses by implementing sustainable water and flood management

Strategic Objective 10: install sustainable water management and planning (WMP)

- ***Activity 10.1a: prepare a comprehensive impact assessment of sea level rise on populations and sectors in the coastal area*** should have a direct significant operational impact on decision making for the whole coastal zone. Indirectly, it should also significantly impact the communities and the economy in particular areas in the long-term. All impacts would be permanent, reversible and cumulative. A prerequisite for Activity 10.1b and 10.1d, this activity should support target setting and investment planning (Activity 1.1a, 1.1c and 1.2c), contribute to the knowledge base (Activity 2.3a and 3.3) and risk assessments (Activity 5.1), and feed results into land use regulation, planning and restrictions (Activity 9.1, 9.2 and 9.4). The activity should also include other aspects of climate change (e.g. changing rainfall patterns), be better linked to specific capacity building and training (e.g. Activity 4.2d), and be clearly related to Activity 3.6f, 3.6j and 3.6k to infer research on alternative and preventive solutions based on the evolution of the coastline;
- ***Activity 10.1b: design a new tidal prevention and river drainage system based on new standards, models and methods*** should have a direct significant impact on the operation of S&RD nationally in the short-term, and later on the status of the coastal infrastructure and natural defences especially in particular areas. The realised improvements should indirectly have a significant impact on the communities and on the economy in the broad neighbourhood in the long-term. The impacts are meant to be permanent, possibly reversible, yet cumulative or synergistic. The activity should support the setting of maintenance objectives (Activity 1.1c), provide input to the investment planning (Activity 1.2c), surveillance standards and early warning (Activity 2.2 and 6.1), and support water management planning (Activity 10.1d). To be successful the activity should benefit from adapted capacity building (e.g. under Activity 4.1a and 4.2d), research (Activity 3.1b, 3.3, 3.6c, 3.6f, 3.6j and 3.6k) and receive inputs from new land use (Activity 9.1 and 9.2) and risk assessment developments (Activity 5.1 and 10.1a);
- ***Activity 10.1c: define and classify the spatial extent of the domain of intervention for flood insurance system*** should have a certain direct impact on the operational dimension in particular areas of the coastal zone. The insurance should indirectly have a certain impact on part of the communities and the economy in the long-term but this activity definitely needs further elaboration before it can be properly evaluated. Yet, in first approximation, the impact may be expected to be rather minor, temporary, reversible but somehow cumulative or synergistic. The activity should normally support land use planning and water management (Activity 9.2 and 10.1d), and should anyhow be linked to the legal and regulatory base (Activity 9.1 and 9.3) and relevant assessments (Activity 5.1 and 10.1a);
- ***Activity 10.1d: prepare a comprehensive Water Level Management Plan*** should have a major direct impact on the operational dimension once the plan, i.e. the strategic framework for decisions at sector level, will be available. If well designed and implemented it can be expected to have a major indirect impact on all aspects of the environment, i.e. physical, ecological, the communities and the economy in all coastal regions even with possible international repercussions. The impacts should be permanent, mostly reversible, but largely cumulative/synergistic. A comprehensive water level management plan would need to incorporate baseline information (Activity 2.3a, 3.3 and 3.5), monitoring data (Activity 2.2, 10.2a and 10.2b), strategic objectives and investment planning (Activity 1.1c and 1.2c). It should also benefit from specific capacity building and research (e.g. Activity 3.6i or other actions to fit under Activity 4.1a and 3.6a). The plan should have a direct link with the planned reform (Activity 7.1a) and with the risk assessment mitigation (Activity 5.1 and 10.1a) and early warning components (Activity 6.1). This

results from this activity would also support maintenance target setting and short-term planning (Activity 1.1a and 1.1b), and feed into other activities such as land use planning (e.g. Activity 9.2). One would also recommend that the impact of climate change be more specifically taken into account;

- ***Activity 10.2a: establish monitoring and reporting system of sea level and subsidence impact on habitats*** should in the medium-term have a significant direct operational impact on the sector knowledge base. The indirect impact to be expected in the long-term is the contribution to a significantly better protection of coastal habitats in view of physical environmental change. Impacts are seen to be temporary, reversible and cumulative/synergistic. The activity obviously relates to the enhancement of the coastal knowledge base (Activity 2.3a, 3.3 and 3.5). The activity should hence concur to the optimisation of research especially for coastline mapping (Activity 3.6f) and alternative or preventive solutions (Activity 3.6j and 3.6k). It could bring about an adaptation of priorities and target setting for maintenance (Activity 1.1a), investment (Activity 1.2c), surveillance (Activity 2.2), and S&RD design (Activity 10.1b and 10.1c). Obviously it should also feed inputs to land use planning (Activity 9.1, 9.2 and 9.4) and capacity building especially for coastal zone management (Activity 4.1a and 4.2d), and be incorporated with risk assessment (Activity 5.1 and 10.1a) and early warning (Activity 6.1) components;
- ***Activity 10.2b: establish monitoring and reporting system of sea defence operations impact on habitats*** should in the medium-term have a significant direct operational impact on the sector knowledge base. The indirect impact to be expected in the long-term is the contribution to a significantly better protection of coastal habitats from the impact of S&RD operations. Impacts are seen to be permanent, reversible and cumulative/synergistic. The activity obviously relates to the enhancement of the coastal knowledge base (Activity 2.3a, 3.3 and 3.5). The activity should hence concur to the optimisation of research especially for coastline monitoring and the valuation of gains and losses (Activity 3.6f and 3.6i) and provide inputs to the land use planning regulatory base and planning (Activity 9.1 and 9.2). It could bring about an adaptation of priorities and target setting for maintenance (Activity 1.1a), surveillance (Activity 2.2), and S&RD design (Activity 10.1b and 10.1c). Obviously it should also feed inputs to capacity building especially for coastal zone management (Activity 4.1a and 4.2d), and be incorporated with risk assessment and early warning (Activity 5.1, 10.1a and 6.1) components.

18 ANNEX 5 Discussion on Indicators to be used in SEA and Policy Framework

Policy Aim I: promote adequate economically, technically and environmentally sound and sustainable S&RD infrastructure management

Strategic Objective 1: complete S&RD infrastructure maintenance and investment plan

- ***Activity 1.1a: define a clear and SMART set of preventive maintenance priorities and targets for the S&RDD*** can typically be monitored using State indicators. Based on the targets set annually for repairs in the medium-term, one may rely on the number or length (km) of critical structures restored, the extent (ha) of the hence protected areas, the number of people enjoying the protection, the monetary value ($) of the prevented damage and losses. The less easy to assess will be the benefit to the coastal environment and biological diversity wherefore indicator species could be used that need to be specifically determined;
- ***Activity 1.1b: establish a year-based routine maintenance plan to support maintenance expenditure claims*** leads typically to a yes/no assessment regarding the existence or non-existence of a genuine plan that is financially substantiated, i.e. the existence of a Driver of the financial adaptability of routine maintenance. If Yes, a good State indicator is the rate of realisation (%) of the planned recurrent expenditures;
- ***Activity 1.1c: define a clear* [cross-sectoral] *strategy and set of maintenance objectives for WSG/S&RDD and NDIA under SDB*** leads again to a yes/no assessment regarding the existence or non-existence of an adequate Response, i.e. a genuine strategy. If Yes, State indicators will have to be defined that measure the level of achievement of the overall maintenance objectives. The Driver is the operational temporary working group whose frequency of meeting can also be monitored, the membership list (i.e. number of institutions and line ministries represented) giving a measure of the level of cross-sectoral integration between agencies that has been achieved;
- ***Activity 1.2a: improve transparency and comprehensiveness of actual maintenance expenditures at all levels of the budget*** constitutes a Response action to the budgetary issue. Whether the terminology is unified should be assessed by comparing the number of labels and categories that are used, and establishing the coherence of the terminology across agencies;
- ***Activity 1.2b: integrate recurrent (routine maintenance) and capital expenditure for WSG/S&RDD and NDIA under MoF*** constitutes a Response action to the budgetary issue. Comparing the financial records under the supervision of MoF should assess whether capital and recurrent budget are integrated. The assessment of expenditures and financial effectiveness can for example be done using the rate of realisation (%) of the planned expenditures. Also, it will enable the use of a meaningful coefficient of coverage (%) by donors and national to local funding of the identified budgetary needs, i.e. altogether a State and Pressure indicator;
- ***Activity 1.2c: prepare a long-term (10 years) sector wide comprehensive S&RD infrastructure investment plan*** is intended to become the new Driver for the long-term. The existence or non-existence of the investment plan is a trivial first approximation but the overall quality of the plan needs to be examined and assessed on the basis of its contents. State indicators within a budget context are for example the coefficient of realisation (%) of the budget and of coverage by donors and national to local funding;

Policy Aim II: establish information systems and policy research priorities aimed at cost effective flood control based on efficient EWS

Strategic Objective 2: establish a sound ecological, biophysical, socio-economic knowledge base, surveillance and M&E of S&RD infrastructure

- ***Activity 2.1: create monitoring and tracking mechanism of budget expenditures of S&RD and D&I*** can be seen as the Response mechanism to assess the economic efficiency of the expenditure. The existence or non-existence of the mechanism leads to a yes/no assessment but State indicators can be imagined that measure budget clarity, coherence and efficiency (i.e. the rate of realisations in %);
- ***Activity 2.2: establish a surveillance inspection plan and database of the condition and status of the S&RD infrastructure*** can be monitored using State indicators of the quality of the database (e.g. number and percentage of updates carried out, number of redundancies removed). The quality of the updates and optimisation (i.e. the level realised) can also be assessed. State indicators are available regarding the physical condition, i.e. number or length (km) of infrastructures in a particular state, and linked to indirect impacts, the extent (ha) of the hence protected areas, the number of people enjoying the protection, the monetary value ($) of the prevented damage and losses. Less easy to assess will be the benefit to the coastal environment and biological diversity wherefore indicator species could be used that need to be specifically determined;

- ***Activity 2.3a: optimise the ecological, biophysical, socio-economic data collection and knowledge base of the S&RD sector*** can be monitored at various levels on the basis of several State indicators corresponding to the various kinds of background data stored or systems and technologies used. Pressure indicators can hence be derived. For example, Utility Functions could also be used for the valuation of ecosystems for decision support, and a coastal circulation model would be advisable;
- ***Activity 2.3b: establish the ecological, biophysical, socio-economic knowledge central clearing house of the S&RD sector*** leads to a yes/no assessment regarding the actual existence and functioning of the Response, i.e. the clearing house. Indirect ways of assessing whether the clearing house is indeed accessible and providing the required services can be a matter of discussion;
- ***Activity 2.3c: create a monitoring and evaluation mechanism and unit for S&RD sector policies*** constitutes the Response mechanism to assess the efficiency of the policy development process. The existence and functionality of the mechanism can in first approximation be assessed in yes/no manner but State indicators can be imagined that actually measure stakeholder engagement (e.g. list, number of institutions represented) and the level of policy realisation (e.g. the rate in %, and of course the Objectively Verifiable Indicators listed in the Logical Framework of the policies);

Strategic Objective 3: create a Research Centre on S&RD issues

- ***Activity 3.1a: create an S&RD Policy Research Centre or Unit linked to international universities and research*** constitutes part of the Response mechanism and leads to a yes/no assessment of the existence or non-existence of the public research unit within the S&RDD. State indicators can indicate the number of staff or projects, amount of funds per research topic, equipment and facilities, etc. The performance of the established lines of research will in principle be evaluated under the specific programmes;
- ***Activity 3.1b: develop a policy support and evaluation toolbox with EVA, DSS, GIS, vulnerability mapping and spatial planning*** constitutes a Response action where care must be taken that the appropriate tools are indeed present and used in combination. The list of tools can constitute the State indicator used in first approximation although it does not guarantee an adequate integrative use of the tools. Of course, one will also have to consider the Objectively Verifiable Indicators listed in the Logical Framework of the centre;
- ***Activity 3.1c: pursue research on the*** **[intrinsic]** ***value of coastal ecosystems in view of conservation or development*** constitutes a Driver leading to the definition of State indicators, i.e. the valuation of coastal ecosystem resources and functions (e.g. listed items and corresponding value) in response to development and conservation. Complementary is the list and vulnerability rating for particularly high-valued or threatened ecosystems and locations. Other useful State indicators can be derived such as for example the level of income or loss of habitat in an area devoted to a given economic activity;
- ***Activity 3.1d: perform evaluation of negative impacts of land-based activities in view of mitigation or reversal*** provides short- and medium-term Impact indicators for the number of activities identified, their impacts and associated potential mitigation or reversal measures envisaged, as well as indirect long-term impact indicators;
- ***Activity 3.1e: perform evaluation of impacts of intensification of land-based activities in view of mitigation or reversal*** provides long-term Impact indicators for the number of activities identified, their impacts and associated potential mitigation or reversal measures envisaged, as well as indirect long-term impact indicators;
- ***Activity 3.2: perform gap analysis of existing knowledge resources, databases & baseline, in view of S&RD operational needs*** provides State indicators in the list of gaps identified in the short-term, and the percentage of gaps filled per year and throughout the years;
- ***Activity 3.3: carry out a comprehensive national coastal baseline assessment*** contributes to provide State indicators of ecosystems, biological diversity and livelihoods, risk and vulnerability lists, and the percentage of gaps filled in the data collection;
- ***Activity 3.4: create multilevel information exchange network for S&RD with database access*** is meant to become one of the Drivers for action at the level of the sector. The existence and functionality of the network is a matter of a yes/no assessment. The network effectiveness can for example be measured by the number of hits, of contacts leading to a resolved issue, etc.;
- ***Activity 3.5: create fully geo-referenced coastal ecosystems archive linking existing databases and GIS facilities*** is the condition, i.e. the Response, that will enable the sharing by national data and GIS centres of their data. The system effectiveness can for example be measured by the number of projects or of contacts leading to a resolved issue, etc.;

- ***Activity 3.6a: target research policy in an integrated approach to coastal zone research*** constitutes the Driver for a comprehensive research policy that will promote an integrative solution to sea and river defence and fill data gaps and information needs. The indicators will be the actual installation of the adaptive research, the number of programmes, the records of published results, etc. that fit under the various research items (i.e. Activity 3.6b through 3.6k and also 3.1c through 3.1e). Besides, State indicators will be useful for assessing specific environmental benefits in all components;
- ***Activity 3.6b: pursue research on coastal ecosystems services to conservation and livelihoods*** provides for a series of State and Pressure indicators. The valuation of coastal ecosystems for the economy, local livelihoods and poverty alleviation, can be done by estimating the nature and magnitude of benefits such as support to fisheries productivity (e.g. rates), waves and storm control, shoreline protection (e.g. critical distances), etc. Economic valuation methods are appropriate. One may also define indicators of biological diversity;
- ***Activity 3.6c: pursue research on the contribution of mangroves to coastal protection*** combines Drivers, Pressure and State indicators i.e. including the design of appropriate stewardship measures (e.g. list) of the mangrove for the preservation of this important function and its parameters (e.g. extent, critical distance) and of its benefits (i.e. list and magnitude) for coastal zone communities;
- ***Activity 3.6d: pursue research on the resilience and recovery of species and communities in coastal mangroves*** provides Pressure and State indicators given by the rate of resilience and recovery of the different species and communities identified in view of particular States or Pressures;
- ***Activity 3.6e: pursue research on the presence and impact of invasive alien species in coastal ecosystems*** provides Pressure and State indicators given by the list and occurrence (e.g. density) of invasive species, of alteration of coastal zone ecosystems (e.g. area, rate of invasion per alien species and communities that replace the original populations);
- ***Activity 3.6f: pursue research on coastline evolution timeline mapping by RS/GIS*** provides for State indicators in the sense of an accurate reference (topographic position) and time series on coastline dynamics (i.e. erosion, accretion)*;*
- ***Activity 3.6g: pursue research on the impact of hinterland development on coastal erosion and flooding****,* provides Pressure and State indicators such as water level, peak flows and frequency, erosion rate, etc. linked to infrastructure development, land clearing, etc. in upland areas, as well as type and level of realisation of mitigation measures;
- ***Activity 3.6h: pursue research on the impact of hinterland deforestation/clearing on sediment load or coastal system choking*** provides Pressure and State indicators such as upland erosion rates, sediment loads, frequency of choking, etc. linked to deforestation, land clearing, etc. in upland areas, as well as type and level of realisation of mitigation measures;
- ***Activity 3.6i: pursue research on the valuation of gains or losses from S&RD infrastructure and policy*** provides Pressure and State indicators on the economic value of gains and losses (area, $) and Performance indicators in terms of reduced vulnerability (area, %) and strengthened resilience (area, %) of protected areas;
- ***Activity 3.6j: pursue research on the design of alternative solutions, redesign, mangroves, etc., to S&RD approaches*** can be expected to be the Driver for the provision of new standards as State indicators of effective flood defence functions, as well as of environmental resource enhancement. Besides, State indicators will be useful for assessing specific environmental benefits in all components;
- ***Activity 3.6k: pursue research on the design of preventive solutions to S&RD approaches*** can be expected to be the Driver for the provision of new standards of effective policy and technology evaluation. State indicators would focus on vulnerability and damage rates, avoidance, mitigation, as well as the extended cost/benefit analysis, etc. Besides, State indicators will be useful for assessing specific environmental benefits in all components;

Strategic Objective 4: target training and capacity building and improve public awareness

- ***Activity 4.1a: target training and capacity building of professionals towards S&RD sector management and ICZM*** can be assessed for Performance or State by means of the number of programmes or of S&RD and ICZM professionals trained, and who are remaining on duty. Besides, State indicators will be useful for assessing specific environmental benefits in all components;
- ***Activity 4.1b: target training and capacity building of planners towards economic valuation of coastal ecosystems*** can be assessed for Performance or State by means of the number of programmes or of development and conservation planners trained, and who are remaining on duty;

- ***Activity 4.2a: enhance awareness of planners and policy makers*** **[of integrative landscape approaches]** can be assessed for Performance or State by means of the number of programmes or of planners and policy makers reached, and who are remaining on duty. Besides, State indicators will be useful for assessing specific benefits to landscape and ecosystems;
- ***Activity 4.2b: enhance general public awareness of the role of ecosystems for livelihoods development*** can be assessed for Performance or State by means of the number of campaigns or communities reached, and by the categories of stakeholders involved. Besides, State indicators will be useful for assessing specific benefits to communities livelihoods;
- ***Activity 4.2c: enhance general public awareness of the contribution of mangroves to the S&RD system*** can be assessed for Performance or State by means of the number of campaigns or communities reached, and by the categories of stakeholders involved;
- ***Activity 4.2d: enhance awareness of decision makers and general public of flooding risks and issues*** can be assessed for Performance or State by means of the number of campaigns or decision makers, institutions and communities reached, and by the categories of stakeholders involved;

Strategic Objective 5: develop a Flood Risk Assessment (FRA)

- ***Activity 5.1: develop a Flood Risk Assessment with specific recommendations for mitigation*** leads to a yes/no assessment regarding the existence or non-existence of the FRA. The number and accuracy of true risk assessments can be used as a measure of the validity of the FRA once it will have been developed. The successful implementation of mitigation measures designed on the basis of the FRA can also be evaluated by State and Pressure indicators, for example, for the extent of area protected, the economic value of damage and losses prevented, etc.;

Strategic Objective 6: create a Flood Early Warning and Emergency Response System

- ***Activity 6.1: design and realisation of a FEWERS in partnership between S&RDD, NDIA and Hydrometeorological Services*** can be assessed by the number and accuracy of the forewarnings, of the flood predictions, as well as the number of lives saved, the economic value of the damage and losses prevented. Early Response indicators give a measure of reaction time, advanced warning, etc. but one can also assess the level of optimisation of the adaptive response to emergencies and climate change;

Policy Aim III: achieve institutional framework strengthening and law enforcement for the S&RD policy framework

Strategic Objective 7: achieve the needed institutional framework strengthening and reform

- ***Activity 7.1a: achieve the institutional reform and strengthening of SDB*** is meant to enable SDB to become the main Driver in a sector threatened by global warming and climate change. The existence and functionality of the reform are a matter of yes/no assessment. However, Performance indicators should measure the effectiveness and efficiency of the renewed legal, policy and institutional framework of the SDB, for example, by noting the frequency and minutes of meetings, agenda points and decisions, etc.;
- ***Activity 7.1b: create SDB Steering Committee*** is meant to enable SDB to become the main Driver and to ensure full sustainable management of the sector as a whole. The existence and functionality of the reform steering committee are a matter of yes/no assessment. However, Performance indicators should measure the effectiveness and efficiency of the new committee, for example, by noting the frequency and minutes of meetings, agenda points and decisions, etc.;
- ***Activity 7.2: clarify the link of SDB with local government for adequate regional maintenance co-ordination/costs sharing*** can be assessed by means of Performance indicators. These should be designed to verify the level and intensity of the co-ordination (meetings, joint decisions, etc.), the level of realisation of the planned maintenance objectives and expenditures (%), and the level of mobilisation of the required technical, financial and human resources (e.g. means, $, days) at central and regional level;

Strategic Objective 8: improve law and regulation enforcement

- ***Activity 8.1: assign law enforcement powers to SDB as a supervisory body*** can be assessed on a yes/no basis regarding the level of the Response, i.e. the actual functionality of the supervisory body. Performance indicators can be used to establish the list of actual powers, monitor the frequency of relevant meetings, number of decisions and of cases successfully closed, etc. per year and over the years;

Policy Aim IV: discourage inappropriate land use and development planning

Strategic Objective 9: restrict inappropriate land use and development planning

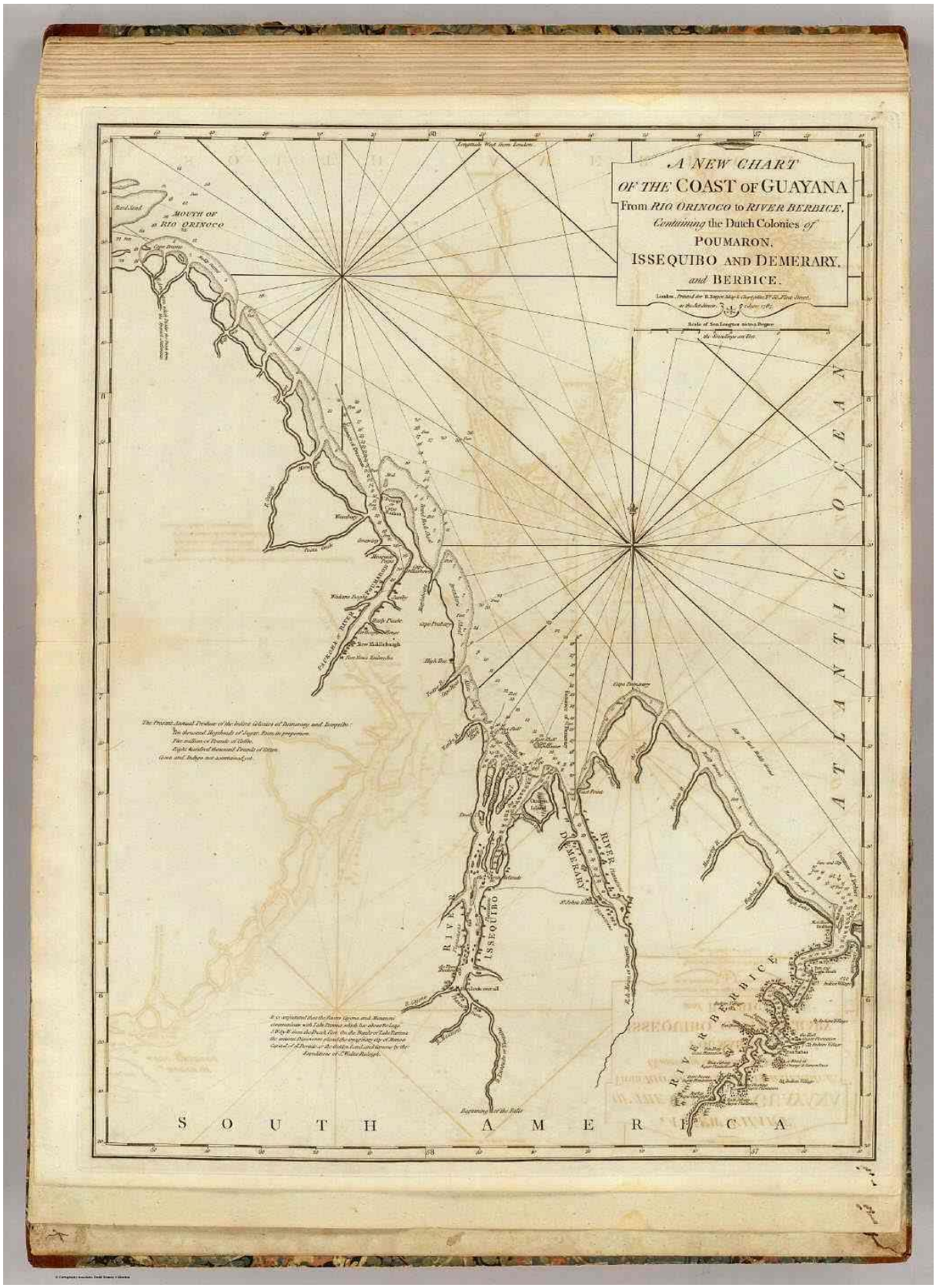
- ***Activity 9.1: review legal and regulatory base for land-use planning and development in the S&RD protected coastal zone*** leads to a yes/no assessment regarding the existence or non-existence of the review. The concrete use of the results can be monitored on the basis of the number of gaps filled, redundancies removed, and clarifications established in the regulatory framework. Performance indicators can also monitor the number of pending cases resolved;
- ***Activity 9.2: support the development of integrated spatial plans for land use planning in the S&RD protected coastal zone*** can easily be assessed on the basis of State indicators. One may hence assess critical and vulnerable ecosystems, the needs for flood protection, or the adequacy of the land use zoning of the coastal zone (e.g. carrying capacity, suitability classes, economic valuation, etc. and the measure of the realisation of potentialities);
- ***Activity 9.3: support the formulation of land use conflict resolution mechanisms and arbitrage by SDB in the coastal zone*** can be assessed by Performance indicators for the number and nature of conflicts resolved, the number and categories of stakeholders involved, the areas recovered on illicit use,
- ***Activity 9.4: reduce the impact of sea level rise by land use restrictions and coastal features protection measures*** can be assessed by listing the restrictions into force, measuring and locating the areas definitively closed to development, enumerating the number and kinds of cases of inappropriate development that have been resolved, the percent of coverage by restriction measures ensuring that flood risk is taken into account at all stages in the planning process by all agencies;

Policy Aim V: reduce flooding risk, damage and losses by implementing sustainable water and flood management

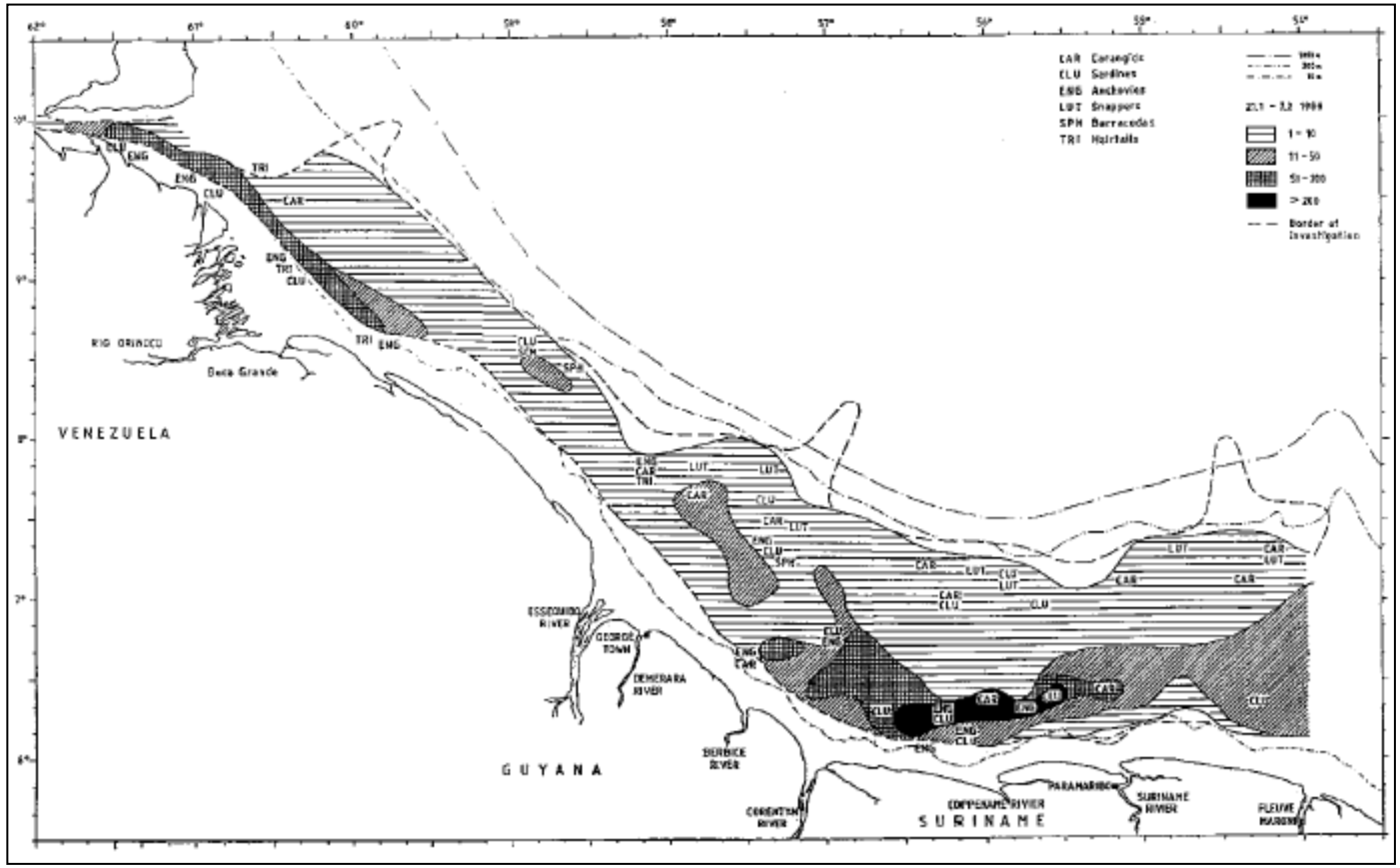
Strategic Objective 10: install sustainable water management and planning (WMP)

- ***Activity 10.1a: prepare a comprehensive impact assessment of sea level rise on populations and sectors in the coastal area*** can be assessed for the validity of the assessment (i.e. the list of impacts and their spatial dimension), and provide Pressure indicators for the coastal area, i.e. areas truly at risk, economic value of resources, property and lives at stake, etc.;
- ***Activity 10.1b: design a new tidal prevention and river drainage system based on new standards, models and methods*** is an implicit Response to climate change. It can be assessed for the number and kinds of new standards that are defined and/or successfully implemented, the extent of reconverted protections and areas (number, ha), the quality of new predictions and modelling results, etc. Classical State indicators will measure the indirect impacts on communities (e.g. extra lives saved) and on the economy (e.g. economic value of extra property protected, and hence damage and losses prevented);
- ***Activity 10.1c: define and classify the spatial extent of the domain of intervention for flood insurance system*** is actually a Response action aiming at creating a Driver that will prevent reckless developments. The extent (ha) and economic value ($) of the areas and properties covered by the flood insurance system will give a measure of the operational success of the activity, the level of disbursements correspond to the value of insured losses and damage, and to some extent constitute a measure of the risk;
- ***Activity 10.1d: prepare a comprehensive Water Level Management Plan*** is a matter of yes/no assessment regarding the existence or non-existence of the plan, which should become one of the major Drivers for the future. The level of adequacy and functionality of the plan will be delicate to assess in terms of relevance and comprehensiveness of the listed topics, mostly by using its OVI and State indicators of the impact of the realisations. The level of implementation will in principle be easier to monitor by coefficients of realisation, number of targets met per year and over the years, etc. Besides, State indicators will be useful for assessing specific environmental benefits in all components;
- ***Activity 10.2a: establish monitoring and reporting system of sea level and subsidence impact on habitats*** relates to climate change (Response) through sea level rise. It leads to a yes/no assessment regarding the existence and functionality of the monitoring system that is meant to report on the impacts of physical changes on habitats. Physical State indicators (i.e. subsidence rate, sedimentation rate, erosion/accretion rate, etc.) can be used in the process, and Pressure (State) indicators, (e.g. extent of areas disturbed, change in sedimentation rate, salinity or water level, number of flooding occurrences prevented or not, etc.) will more likely be used to monitor impacts on habitats;
- ***Activity 10.2b: establish monitoring and reporting system of sea defence operations impact on habitats*** leads to a yes/no assessment regarding the existence and functionality of the Response, i.e. the monitoring system that is meant to report on the impacts of sea defences operations on habitats. Pressure (State) indicators (e.g. extent of areas disturbed, change in sedimentation rate, salinity or water level, number of flooding occurrences prevented or not, etc.) will more likely be used to monitor impacts on habitats.

19 ANNEX 6 Map The continuous mangrove belt of Guyana in 1787



20 ANNEX 7 Marine life survey data for Guyana (FAO 1988a)



21 ANNEX 8 List of Stakeholders consulted/engaged

Alphabetical list of people and institutions engaged with during the mission

#	Surname and Name	Position	Institution	Telephone	Fax	E-mail
1	Mr Youssouf Alexander	Manager, Conservation Service	Conservation International	(592) 227-8171	(592) 225-2976	ealexander@conservation.org
2	Mr Khalid Alladin	Senior Environmental Officer, Environmental Management Division	EPA	225-2062 225-1218 225-0506 225-6917 Ex22 623-1298		
3	Mr Alexander		Conservation International	227-8171 225-2978 223-5497		
4	Mr Phillip Allsopp	Chief Engineer Sea Defence (formerly)				
5	Mr Mewburn Amsterdam	Project Manager, EU projects S&RDD	S&RDD, MPW&C	226-1070 656-6766		amo122003@yahoo.co.uk
6	Major General Michael Atherly	Director General	Civil Defence Commission	226-1117	226-1027	
7	Mr Garfield Barnwell	Director, Sustainable Development Programme	CARICOM Secretariat	222-0001/75	222-0171	
8	Mr Andrew Bishop	Commissioner	LSC	227-2582 623-1017		
9	Mr Marc Buchmann	Head of ECD Technical Section (formerly)	EU Delegation to Guyana	647-6481 618-836		marc.buchmann@ec.europa.eu
10	Dr Paulette Bynoe	Director, School of Earth and Environmental Sciences	U Guy	222-4180 616-3703		bynoep2000@yahoo.com

11	Ms Peggy Carlson	Director, Farmer to Farmer Programme	Partners of the Americas	+1 (202) 637 6230	+1 (202) 628 3306	pcarlson@partners.net
12	Ms Gitanjali Chandarpal	Coordinator	NCU	225-5842		ncuguyana@yahoo.com gitanjalic81@yahoo.com
13	Mr. Navin Chandarpal	Adviser to the President on Sustainable Development	Office of the President	223-5233		
14	Mr Rabindranauth Chandarpal	Chief Transport Planning Officer	MPW&C	625-6646		rchandarpal@gmail.com
15	Mr. Patrick Chesney	Project Manager, Guyana Shield Initiative Project	UNDP	223-6564 Ext 235	226-2942	patrick.chesney@undp.org
16	Ms Johanna Cooke	Deputy Head, DFID Guyana	British High Commission	225-5492 226-5881 (Ext.2049) 624-3578		j-cooke@dfid.gov.uk
17	Mr. Garvin Cummings	Hydrologist	Hydrometeorological Services, MoA	225-4247		
18	Ms Agnes Dalrymple	Chief Officer S&RDD	S&RDD, MPW&C	227-8294 227-2469 641-4544	225-8395	a-dalrymple@hotmail.com niks336@yahoo.com
19	Mr Philip da Silva	Coordinator of ICZMC	U Guy	624-6337		nessie159@yahoo.com
20	Ms Joselyn Dow	Executive Director	Guyanese Citizens Initiative	225-8404 618-7312		
21	Mr Christopher Engelbrecht	Head of Technical Section (currently)	EU Delegation	647-6481		
22	Mr Geer	Officer in Charge, Fisheries Dept.	MoA	226-4398 666-5073		

23	Mr Javier Grau	Water and Sanitation Division	IDB Country Office	225-7950 660-8285		
24	Mr George Howard	Head Sea Defence (formerly)		623-7237		
25	Mr Daudi Husbands	GIS Expert	Guyanese Citizens Initiative	225-8404		
26	Ms. Joylyn Jafferally	Specialist Hydrologist	Hydrometeorological Services, MoA	225-4247		
27	Mr Felix Jerra	Head	NAO Task Force			
28	Mr Tasreef Khan	Commissioner	Forestry Commission	226-7271		
29	Ms Alana Lancaster	Director, Environmental Management	EPA	222-4224		
30	Ms. Nadine Livan	Programme Associate, Energy & Environment	UNDP	226-4040/8/9	226-2942	nadine.livan@undp.org
31	Mr Bruno Lopes-Pereira	Programme Officer, Technical Section	EU Delegation to Guyana	226-4004 647-6481		bruno.lopes-pereira@ec.europa.eu
32	Mr Colin Lord	Monitoring Officer, EU projects	NAO Task Force	223-7039 223-7040	225-7603	nao_taskforce@yahoo.com
33	Ms Cecilia Lorio	Programme Officer	CAFOD	+44 (0)207326 5643		
34	Mr Rickford Lowe	Coordinator WSG	MPW&C	624-6589		ric.lowe@hotmail.com

35	Ms Indira Mattai	Senior Environmental Officer, Monitoring and Enforcement Unit	EPA	225-2062 225-1218 225-0506 225-6917 Ex23		
36	Ms Donna McRae-Smith	Project Officer, Sustainable Development Programme	CARICOM Secretariat	222 0001/75 (Ext.2207)	222 0171	dms@caricom.org
37	Ms Deborah Montouth-Hollingsworth	Technical Assistant	CH&PA, MH&W	223-7261 225-6452 623-2225	223-7612	
38	Mr Otto Nagy	Programme Officer, Technical Section	EU Delegation to Guyana	226-4004 645 8934		otto.nagy@ec.europa.eu
39	Mr Shyam Nokta	Chairman	NCC	222-4565 623-0269	222-3172	emc@netwroksgy.com shyamnokta@gmail.com
40	Mr Luca Palazzotto	Project Coordinator	Oxfam	227-1501 225-3830/3 623-5859		
41	Ms Caroline Paul	Office Manager	Guyanese Citizens Initiative	225-8404		
42	Dr Dindyal Permaul	Permanent Secretary	MoA	227-5527 223-7844		
43	Mr Christopher Persaud	Project Officer, Infrastructure	IDB	225-7950 (Ext.239)	225-7138	chrisp@iadb.org
44	Mr Doorga Persaud	Executive Director	EPA	222-4224 225-2062		dpersaud@epaguyana.org
45	Ms Annie Pitamber	Project Coordinator, Second National Communication to UNFCCC	NCU	225-5842		snc_gy@yahoo.com
46	Mr. Zainool Rahaman	Team Leader, National Agriculture Adaptation Strategy	Hydrometeorological Services, MoA	225-4247		zainoolm@yahoo.com

47	Dr Ramdass	Biological Diversity Specialist	EPA	225-5892 222-5785 225-6048		
48	Ms Bheleka Saulall	Chief Hydrometeorological Officer	Hydrometeorological Services, MoA	225-4247 226-5403		
49	Ms Germene Stewart	Development Planner, Research and GIS	MH&W	227-3737 624-1177		
50	Mr Ben ter Welle	Team Leader, Protected Areas Project	GFA	225-5882 623-0261		
51	Mr. Didier Trebucq	Deputy Resident Representative	UNDP	225-6962 624-4018	226-2942	didier.trebucq@undp.org
52	Dr Ulric Trotz	Chief Scientific Adviser	Caribbean Community Climate Change Centre	(501) 822-1104	(501) 822-1365	info@caribbeanclimate.bz
53	Ms Tamara Whalen	Operations Analyst	WB Guyana Country Office (conservancy project)	223-5036	225-1384	twhalen@worldbank.org
54	Mr Fraser Wheeler	High Commissioner	British High Commission	226-5881/2	225-3555	fraser.wheeler@fco.gov.uk
55	Mr Lionel Wordsworth	Chief Executive Director	NDIA	226-9330 617-0260		

22 ANNEX 9: Recommendations on Stakeholders Participation

Recommendation on Stakeholders to approach regarding Climate Change and Adaptation

Given:

[1] The severe limitations in the availability of data concerning the key climate change impacts affecting the sea defences and the sea defence policy in Guyana as well as the related environmental baseline information; and

[2] The extremely limited national capacity for climate change modelling, scaling down, and measuring and monitoring critical climate change related information;

The following recommendations for further consultation and contacts (more specifically of NCC and NCU) with regional and international institutions were already included in the Scoping Report and in support of the Work Plan for Phase 2 of the SEA Study.

The further collation and analysis of international scientific data and strategies in consultation with regional and international climate change stakeholders and experts is therefore strongly recommended. And indeed, all the relevant and key stakeholders in Guyana who are associated with climate change and adaptation in relation to its integration into the sea defence policy support this recommendation. These include:

- Representatives of the Office of the President (i.e. the Chairman of the National Climate Committee and Advisor to the President on Sustainable Development);
- The Coordinator of the Works Service Group (responsible for the sea defences)
- The Chief Hydrometric Officer and core staff members at the Hydrometeorological Services;
- The Coordinator of the National Climate Unit;
- The Project Coordinator of the 2nd National Communication to the UNFCCC;
- International donor representatives (i.e. UNDP, World Bank, DFID, Oxfam).

The recommended regional institutions and international organisations to contact are:

- The Caribbean Community Climate Change Centre (CCCCC);
- The Caribbean Disaster Emergency Response Alliance (CDERA); and
- The World Bank.

In addition, to the key regional and international stakeholders identified here above, other international documentation and experts from other international institutions will usefully be approached. These will include:

- The Caribbean Natural Resource Institute (CANARI) and the Association of Caribbean States (ACS);
- The Tyndall Centre on Climate Change;
- The Environmental Change Institute at the University of Oxford (i.e. the Hadley Centre);
- Members of Working Group II of the Intergovernmental Panel on Climate Change (IPCC);
- Staff with the United Nations Framework Convention on Climate Change (UNFCCC);
- The United Nations Environment Programme (UNEP); and
- The United Nations Development Programme (UNDP).

The potential benefit is the gathering of information that is vital to a highly vulnerable country and sector within that country. It will enable a comprehensive assessment and recommendations for a suite of tools, techniques and strategies for the effective integration of climate change into the sea defence policy. To bring this up to a satisfactory level, it is essential that a broader range of expertise and knowledge be drawn upon, beyond that which exists in Guyana.

The recommended activities would involve Consultations/Data Gathering/Assessments and Analysis. Missions to the Caribbean Community Climate Change Centre (CCCCC), the Caribbean Disaster Emergency Response Alliance (CDERA), and the World Bank should gather extraneous information currently unavailable in Guyana especially on:

1. **Approaches** useful for data collection, measurement and monitoring, and appropriate for the Guyana milieu. A comprehensive assessment and recommendations for a suite of tools, techniques and strategies for the effective integration of climate change into the sea defence policy is essential. Information and specifics concerning monitoring and measurement should be gathered;
2. **Fortification** of any available data supporting the understanding of the environmental baseline, i.e. the current state of the environment in the face of climate change (outlining the known impacts of climate change in Guyana - as they relate to the sea defences);

3. Projections of environmental **trends** associated with climate change and the sea defences, i.e. what impacts will climate change have in Guyana (in relation to the sea defences) over which period into the future and with which degree of certainty. The important question is what current models and studies are projecting or could project;
4. Other relevant information concerning ongoing and forthcoming projects and studies that relate to Guyana, its sea defences and vulnerabilities and resilience to climate change.

Contact persons identified for the purpose:

World Bank:
Ms. Yvonne Tsikata: Country Director for the Caribbean Unit;
Ms. Christina Malberg-Calvo: Sector Leader for Sustainable Development in the Caribbean;
Mr. Francis Ghesquiere: Senior Hazard Risk Management Specialist;
Mr. Carlos Costa: Climate Change Program Officer.

Caribbean Disaster Emergency Response Alliance (CDERA):
Mr. Jeremy Collymore: Coordinator;
Ms. Liz Riley: Programme Manager (CDERA);
Ms. Patricia Maughan: Project Coordinator;
Ms. Nicole Alleyne: Technical Officer (IDB/RPG).

Regional Head Office of the Department for International Development (DFID):
Ms. Elizabeth Carriere: Head, DFID Caribbean & UK Director Caribbean Development Bank;
Ms. Simone Banister: Head - Corporate Management / Disaster Risk Reduction Focal Point.

Caribbean Community Climate Change Centre (CCCCC):
Dr. Kenrick Leslie: Director;
Dr. Ulric Trotz: Chief Scientific Adviser;
Mr. Winston Bennett: SPACC Project Manager;
Mr. Joseph McGann: MACC Project Manager.

23 ANNEX 10 Strategic Directives: Draft Regional Strategy for Climate Change in the Caribbean

1. Human Development

1.1 Settlements and Infrastructure

To reduce the risks associated with a changing climate to settlements and infrastructure, the Government of Guyana and its development partners should:

(a) Develop adequate capacity for research and analysis of the relevant climate processes which may affect human settlements;
(b) Take early and appropriate steps to protect human settlements and related infrastructure at risk from the effects of climate and other natural hazards;
(c) Encourage the incorporation of disaster risk reduction measures in all corporate and development planning initiatives, and disaster recovery and reconstruction programmes;
(d) Introduce fiscal measures to promote the use of climate risk reduction technologies and practices;
(e) Ensure that national infrastructure standards are adequate to withstand the impacts of climate and other natural hazards;
(f) Integrate climate and other natural hazard considerations in the physical planning process;
(g) Empower local community groups and organisations to participate effectively in disaster mitigation initiatives;
(h) Deliver appropriate hazard risk reduction training programmes to improve technical capabilities and attitudes in hazard risk management;
(i) Sensitise all actors with respect to their roles and responsibilities in hazard risk management;
(j) Strengthen the financial capacity of local communities and agencies to implement hazard risk reduction measures;
(k) Maintain a regular information management system on hazard risk reduction measures and human resource capacities of the various community groups and institutions;
(l) Ensure the adoption of physical planning standards and tools that facilitate adaptation, retreat and/or relocation of human settlements from vulnerable areas;
(m) Strengthen early warning systems;
(n) Ensure the availability of purpose-built emergency shelters and trained shelter managers in each community.

1.2 Human Health

To reduce the risks associated with a changing climate to human health, the Government of Guyana and its development partners should:

(a) Conduct the necessary research and information-gathering in order to guide and strengthen decision-making;
(b) Ensure that appropriate short-, medium- and long-term measures to address the hazard risks are incorporated into national health and disaster management plans;
(c) Sensitise and educate health and disaster management personnel and the public about the hazard risks associated with a changing climate;
(d) Ensure that adequate stocks of medicines and medications are available all year-round to treat health disorders related to these hazards.

2. Economic Sector Policy Directives

2.1 Agriculture

To reduce the risks associated with a changing climate to the region food security, the Government of Guyana and its development partners should:

(a) Identify drought-resistant crop varieties that yield more mass per unit of water consumed;
(b) Promote better soil management, fertilisation, and pest and weed control;
(c) Improve irrigation management through better timing of the provision of water to help reduce stress at critical crop growth periods;
(d) Use more deficit, supplemental and precision irrigation systems;
(e) Encourage improved farming practices that reduce land degradation;

(f) Develop a hazard risk reduction strategy for the agricultural sector to address impacts over the short-, medium- and long-term.

2.2 Financial Services and the Sustainable Development of Tourism

To reduce the risks associated with a changing climate to the sustainable development of the tourism sector and encourage the adoption of appropriate hazard management initiatives within and by the financial sector, the Government of Guyana and its development partners should:

(a) Ensure the adoption and implementation of building codes and other standards in order to minimise risk from climate and other natural hazards;
(b) Work with stakeholders in the tourism sector to develop strategic development plans that incorporate climate hazard considerations and appropriate measures such as water conservation programmes as well as general sustainability concerns;
(c) Establish clear restoration policies and plans with the full involvement of all key stakeholders, and test these instruments;
(d) Ensure that corporate disaster plans are integrated into national disaster plans;
(e) Protect coastal assets including beach vegetation, mangroves and coral reefs;
(f) Develop appropriate hazard risk management measures to address the impacts of natural hazards including the development of lending mechanisms for ensuring adequate financial support for rehabilitation and reconstruction activities;
(g) Explore opportunities for pooled insurance and reinsurance arrangements;
(h) Encourage insurance companies to develop appropriate capacity to identify and forecast risk and to share data from these initiatives with other actors;
(i) Support the development of the knowledge base required to inform the provision of new insurance instruments in the region;
(j) Strengthen the Caribbean Risk Insurance Facility to facilitate a more comprehensive insurance coverage of government assets;
(k) Remove the impediments to investment and the development of financial markets;
(l) Promote the sustainable tourism thrust of the regional tourism industry (including especially nature-based tourism);
(m) Encourage the financial sector to develop mechanisms to assist human settlements affected by natural hazards.

3. Natural Resources

3.1 Coastal and Marine Resources

To address the impacts of a changing climate and other natural hazards on coastal and marine resources, the Government of Guyana in collaboration with its development partners should:

(a) Adopt integrated approaches to the management of natural resources in general and coastal and marine resources in particular;
(b) Implement a continuing monitoring and assessment programme with particular emphasis on:
    - the sustainable utilisation of living and non-living resources within coastal and marine areas;
    - the enhancement of modelling capabilities to distinguish between human-induced and natural changes in coastal processes;
    - regular assessments of the vulnerability of social and economic assets;
    - research on comparable methodologies that will facilitate decision-making based on the precautionary principle;
(c) Adopt measures to protect coastal areas and to increase the resilience of coastal ecosystems and resources, including the construction of coastal defence structures, the enforcement of setbacks and the restoration of coastal wetlands;
(d) Facilitate the restoration of impaired coastal resources and coastal ecosystems where technically and financially feasible;
(e) Develop a comprehensive coastal zone management plan, which incorporates natural hazard concerns and which guides the location of developments within the coastal zone;
(f) Identify and promote alternative fishery and resource use activities where predicted impacts on ecosystems and natural resources preclude the continuation of traditional activities;
(g) Foster increased public awareness and knowledge regarding climate hazard impacts on the coastal and marine environment;
(h) Design and implement poverty reduction programmes for coastal communities including income-generating schemes built around sustainable resource use and management, education and training, settlement upgrading and conflict resolution;

(i) Promote a culture of collaborative resource management that includes negotiated agreements between resource users and that sets out obligations, rights, responsibilities and expectations of all parties;
(j) Work in conjunction with other countries and international organisations towards the development and implementation of effective early warning systems.

3.2 Water Resources

To reduce the risks the sustainability of water resources the Government of Guyana and its development partners should:
(a) Accelerate the design and implementation of integrated water resources management (IWRM) policies and strategies;
(b) Undertake an effective planning process that takes account of potential hazards and the vulnerability of people and ecosystems to extreme events;
(c) Undertake risk assessments that can inform decisions on appropriate mitigation strategies to deal with water-related, natural and human-induced hazards, such as resource scarcity, water quality, non-average climatic events, public health and ecosystem change;
(d) Analyse the nature and distribution of potential harm from water management policies and practices;
(e) Undertake flood and drought forecasting;
(f) Develop a long-term national water management plan which incorporates and addresses climate hazard concerns including catchment and watershed protection, and saltwater intrusion issues;
(g) Undertake reforestation and other measures to increase the resilience of watersheds and catchments, and reduce the risk of floods and landslides;
(h) Assess and address needs for water storage and distribution infrastructure to ensure water availability during drought periods;
(i) Promote initiatives to identify and where necessary exploit, non-traditional water resources;
(j) Develop awareness programmes directed to the general population and other stakeholders addressing water issues such as scarcity and pollution;
(k) Continually review and update disaster management plans for dams and other water impoundment and treatment facilities.

3.3 Land Resources

To reduce the risks to the sustainability of land resources the Government of Guyana and its development partners should:
(a) Accelerate the design and implementation of land policies, especially those provisions that will strengthen the capacity of land management agencies to promote the adoption of sound land use practices;
(b) Ensure the establishment of an integrated framework for development planning at the national and local levels as a means of guiding and controlling all forms of physical development;
(c) Mitigate the negative impacts of physical development on natural and environmental resources;
(d) Preserve important sites, ecosystems and wildlife habitats, rivers and watersheds;
(e) Protect rivers, buffers and other critical watershed areas and establish riparian buffer zones;
(f) Develop and implement comprehensive land management plans which incorporate climate change concerns;
(g) Ensure the inclusion of hazard risk reduction considerations during the implementation of strategies and plans including NBSAP and the National Forest Action Plan.

4. Public Education and Outreach (PEO)

A well-informed and empowered citizenry is a prime factor in building the resilience of the region to a changing climate. Accordingly, the Government of Guyana and its development partners should:
(a) Support tertiary level training courses in vulnerability reduction and resilience building at regional universities;
(b) Support the introduction of climate change issues into regional curricula at primary and secondary school levels;

(c) Provide specific training for regional professionals in use of climate change data in carrying out their specific functions, e.g. architectural and building design, coastal engineering, protected areas management, agriculture, tourism planning, water resource management, health services, and disaster risk management;
(d) Support the implementation of the regional public education and outreach strategy developed under the Adaptation to Climate Change in the Caribbean (ACCC) regional project and more specifically:

- Develop and deliver targeted public education activities aimed at the different publics identified in the strategy, e.g. political directorate, decision makers, media, youth, civil society;
- Establish and maintain a regional clearing house facility at the CCCCC to support the dissemination, archiving and management of climate change information and the implementation of national climate change public education and outreach programmes; and
- Involve the regional media in the dissemination of climate change and climate-related information throughout the region.

24 ANNEX 11 Methodology

Impact Evaluation

Many methods and techniques are commonly used in the field of EIA and SEA in order to predict and evaluate environmental impacts. For the purpose of this study, one of the most familiar methods of evaluation of impacts, the Severity Matrix,has been used at the highest level. Hence, impacts of the sea defences on the environment, of the environment on the sea defences were rated within a Severity Matrix. The method does indeed not subjective ranking but it has the merit to provide an objective framework for a consistent ranking of impacts that increases the reliability of the overall assessment process.

Therefore, as announced in the Scoping Report (IBF, 2008b) the first task usually is the detailed listing of specific impacts in regard of each specific objective, issue or stakeholder concern that was identified. More specifically in this study a descriptive was written for each identified Activity. A simple reasoning leads from each item to a measure of the impact. Two sets of standard characteristics are used, i.e. significance and likelihood.

Significance determines whether an impact is positive or negative, and whether it has to be classified as major, moderate, minor or negligible. This rating is mainly based on three characteristics, i.e. the temporal factor (a function of duration and frequency estimates), the spatial factor (i.e. ranging from local to widespread), and the magnitude factor (an estimate of the intensity). ***Likelihood*** estimates the probability of occurrence, as very low, low, medium or high.

By adding the ranks obtained for the descriptive in the four categories of impact characteristics (i.e. frequency, duration, area and intensity), a range value is obtained and a final rank can be established according to the predefined scale. At rank 0, the descriptive is rather “nil to very …”.

Characteristics				
Rank	0	1	2	3
Descriptive				
Frequency	Very rare	Rare	Occasional	Frequent
Duration	Very short	Short	Temporary	Permanent
Area	Very punctual	Local	Neighbourhood	Widespread
Intensity	Very low	Low	Medium	High
Total value of ranks for the four characteristics				
Range	0, 1, 2	3, 4, 5, 6	7, 8, 9	10, 11, 12
Final rank	0	1	2	3
Significance	**Negligible**	**Minor**	**Moderate**	**Major**

The likelihood of the impact is simply estimated on a four-level scale.

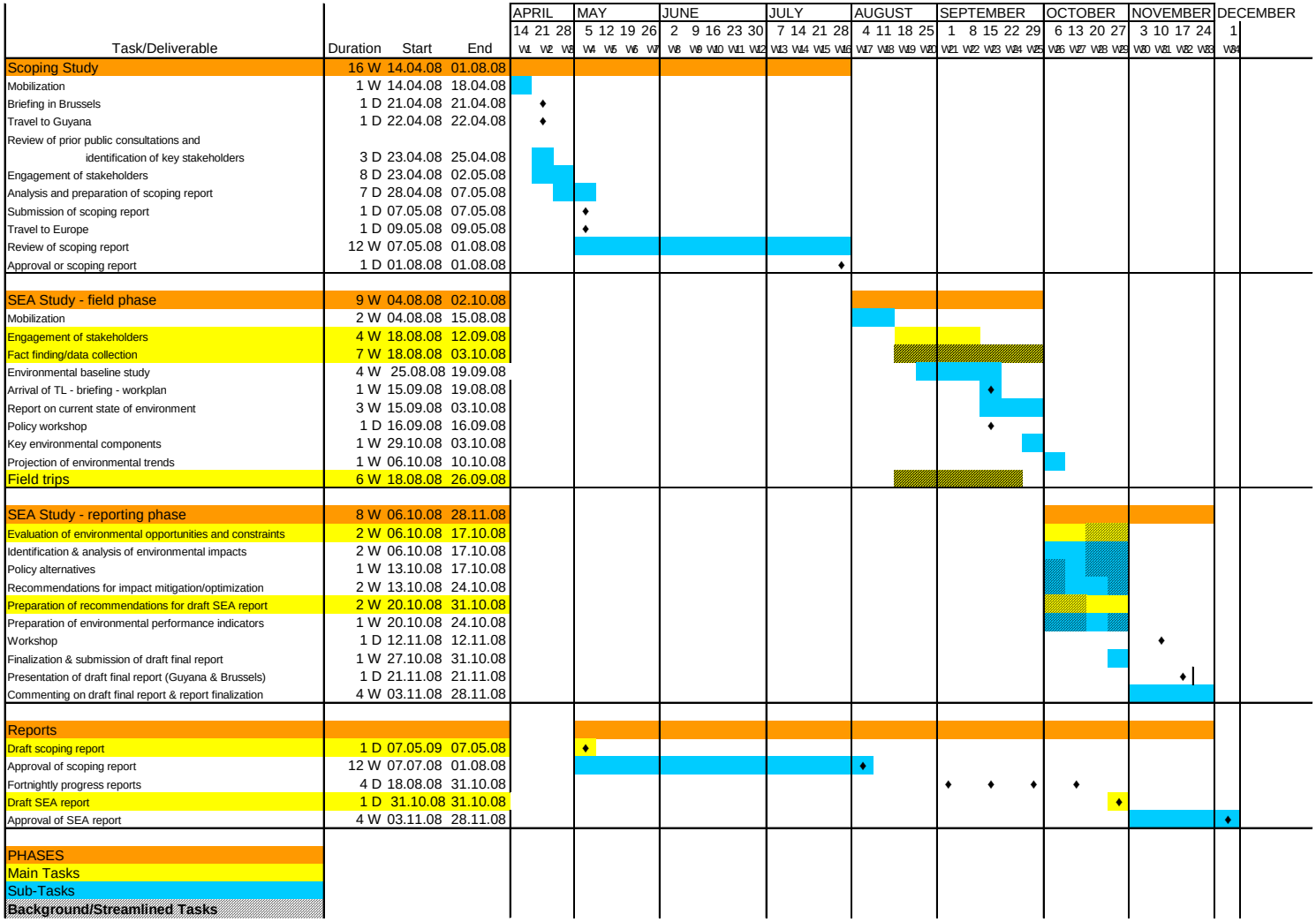
Likelihood	**Very Low**	**Low**	**Medium**	**High**
Rank	0	1	2	3

The results for these two sets (i.e. significance and likelihood) can be entered into an impact severity or potentiality matrix according to the type of impacts considered (i.e. costs or benefits).

Impact Severity Matrix

Likelihood	High						High severity	
	Medium						Moderate severity	
	Low						Low severity	
	Very Low						Beneficial	
		Positive	Negligible	Minor	Moderate	Major		
	Significance							

25 ANNEX 12: Consultants Work Plan and Itinerary



26 ANNEX 13 Consultants Itinerary (SEA Study)

August	
Sunday 17	Climate Change Specialist travels to Guyana
Monday 18 to Saturday 23: contact with stakeholders, climate change data collection	
Saturday 23	Environmentalist travels to Guyana
Sunday 24	Briefing with Climate Change Specialist
Monday 25	Climate Change Specialist travels back to Europe
Monday 25 to Saturday 30: contact with stakeholders, meetings for interviews and/or data collection	
September	
Monday 01	Submit First Progress Report; Visit ECD Guyana
Monday 01 to Saturday 27: contact with stakeholders, meetings for interviews and/or data collection	
Friday 05	Visit ECD Guyana
Saturday 06	Field trip: West of Georgetown, Demerara and Essequibo rivers
Saturday 13	Team Leader travels to Guyana
Sunday 14 to Friday 19: study Draft Sector Policy Framework document	
Monday 15	Submit Second Progress Report; Visit ECD Guyana, briefing with Team Leader
Tuesday 16	Draft Sector Policy Framework presentation workshop at Red House
Wednesday 17	Low altitude overflight over Guyana's main watershed
Thursday 18: start review of sources documents and draft SEA Study	
Friday 19	Visit ECD Guyana; Submit SEA Study final work plan
Saturday 20	Field trip to East coast and Mahaica River
Monday 22	Visit ECD Guyana
Monday 22 to Saturday 27: baseline data review and synthesis	
Tuesday 23	Meeting with DSPF consultant
Wednesday 24	Field trip to MMA area, Region 5 (Mahaica/Mahaiconi/Abary rivers)
Friday 26	Boat trip in East Demerara Water Conservancy
Monday 29	Submit Third Progress Report; Visit ECD Guyana
Tuesday 30	Debriefing Environmentalist with Team Leader
October	
Wednesday 01	Environmentalist travels back to Europe
Monday 06	Visit ECD Guyana
Monday 13	Submit Fourth Progress Report
Wednesday 15	Visit ECD Guyana; workshop preparatory meeting at S&RDD
Saturday 18 to Sunday 26: conduct RIAM simulation and process results	
Monday 20	Workshop preparatory meeting at S&RDD
Friday 24	Visit ECD Guyana
Monday 27	Submit Fifth Progress Report
Wednesday 29	Complete draft SEA Study
Thursday 30	Print and reproduce draft SEA Study
Friday 31	Submit draft SEA Study at ECD Guyana
November	
Saturday 01: start compiling figures, tables and annexes	
Wednesday 12	Validation workshop at SDB Board Room
Friday 21	Draft report presentation at Red House
Sunday 23	Team Leader travels back to Europe
January	
Thursday 15	Presentation of the report to the EC, Brussels

27 ANNEX 14: List of Documentation cited and consulted

Documents quoted or cited

[1] Atkins, 2006. Guyana Country Environmental Profile (9 ACP GUA 005/2) Final Report, 130 pages.
[2] Augustinus, P. G. E. F., 1999. Ruimte in het Kustonderzoek, Inaugural speech at the acceptance of the position of Professorship at the Utrecht University, 18 pages.
[3] DHI, 2000. Water & Environment. *RIAM Software, version basic*, DHI, Hørsolm.
[4] DHV, 2008a. Infrastructure Design for the Sea Defence Programme, [Reconstruction] Design Report (9 ACP GUA 10), Amersfoort, 99 pages.
[5] DHV, 2008b. Infrastructure Design for the Sea Defence Programme, Concrete Investigation, Rehabilitation and Maintenance Design Report (9 ACP GUA 10), Amersfoort, 78 pages.
[6] Douglas, B. C., 1995. Global Sea Level Change: determination and interpretation, in: Review of Geophysics, Supplement US National Report to International Union of Geodesy and Geophysics 1991-1994, page 1425-1432.
[7] EC, 2002. Guyana - European Community Country Strategy Paper and National Indicative Programme for the period 2002-2007, EuropeAid, Georgetown, 52 pages.
[8] EC, 2007. Guyana - European Community Country Strategy Paper and National Indicative Programme for the period 2008-2013, EuropeAid, Georgetown, 88 pages.
[9] EC, 2008. Terms of Reference for a Strategic Environmental Assessment of the Sea Defences Sector Policy in Guyana, EuropeAid, Brussels, 12 pages.
[10] ECORYS, 2008. Draft Policy Framework for the sea and river defence sector, Rotterdam, 84 pages.
[11] ECORYS, 2008. Policy Framework for the Sea & River Defence Sector, Georgetown, 27 slides, presented on 16 September.
[12] EEA, 1999. Environmental indicators: Typology and overview, EEA Technical report No 25, EEA Copenhagen, 20 pages.
[13] EPA, 2000. Integrated Coastal Zone Management Action Plan, Georgetown, 36 pages.
[14] EPA, 2002. Guyana's National Vulnerability Assessment to Sea Level Rise, Georgetown, 86 pages.
[15] FAO, 1988a. Preliminary Report Cruise No. I - Surveys of the Fish Resources in the Shelf Region Between Colombia and Suriname - Part 1: The Guianas from the Maroni River to the Serpents Mouth 21 January - 7 February, 1988, 172 pages.
[16] FAO, 1988b. Preliminary Report Cruise No. II - Surveys of the Fish Resources in the Shelf Region Between Colombia and Suriname - Part 1: The Guianas, 8 - 22 May 1988, 170 pages.
[17] FAO, 1994. Mangrove Forest Management Guidelines, Forestry Paper 117, Rome.
[18] FAO, 2005. Fishery and Aquaculture Country Profile - Guyana, http://www.fao.org/fishery/countrysector/FI-CP_GY/, 15 pages.
[19] FAO, 2008. FAO/AGL maps, Map source: Global Forest Resources Assessment 2000.
[20] GAHEF, 1992. Guyana/UNEP - Country Study of Biological Diversity, Liliandal, Greater Georgetown.
[21] Geer, T. S., 2004. Guyana Country Report, Caribbean Regional Fisheries Mechanism, First Annual Scientific Meeting, June 28-30th 2004, St. Vincent and the Grenadines, 29 pages.
[22] GFC, 2001. National Mangrove Management Action Plan, GFC and ICZMC (EPA), Georgetown, 44 pages.
[23] GoG, 2001. The Guyana Poverty Reduction Strategy Paper, Georgetown, 110 pages.
[24] GoG, 2001. Guyana Climate Change Action Plan in Response to its Commitments to the UNFCCC, Georgetown, 64 pages.
[25] GoG, 2002. Guyana's Initial National Communication in Response to its Commitments to the UNFCCC, Georgetown, 192 pages.
[26] GoG, draft 2008. Guyana's Second National Communication (SNC) in Response to its Commitments to the UNFCCC.
[27] Hussain, M. Z., 1990. Restoration and Expansion of the Mangrove Belt in Guyana, Technical Report #1, TCP/GUY/8953, FAO, 32 pages.
[28] Hydrometeorological Services, 2007. Guyana's Climate, downloadable at http://www.hydromet.gov.gy/climate.html
[29] IBF, 2008a. Outline Methodology Proposed, IBF, Brussels, 10 pages.
[30] IBF, 2008b. Scoping Report on Strategic Environmental Assessment of the Sea Defences Sector Policy in Guyana, IBF, Brussels, 62 pages.
[31] IDB, 2004. Agricultural Support Services Programme (GY-0011) - Loan Proposal, Georgetown, 53 pages.
[32] IPCC, 2007. Synthesis Report, IPCC Climate Change 2007: Synthesis Report, 52 pages.
[33] IUCN, 2007. IUCN Red List of Threatened Species, www.iucnredlist.org, downloaded 23 September 2008.
[34] Khan, M., 2001. National Climate Change Adaptation Policy and Implementation Plan for Guyana, CPACC Component 4, Georgetown, 74 pages.
[35] Laws of Guyana, 1998. Environmental Protection Act CAP 20:05, 63 pages.
[36] Laws of Guyana, 1998. Sea Defence Act CAP 64:01, 12 pages.
[37] Laws of Guyana, 1998. Sea Defence Act CAP 64:02, 18 pages.
[38] Laws of Guyana, 1999. Land and Survey Commission Act.
[39] Laws of Guyana, 2002. Water and Sewerage Act.
[40] Laws of Guyana, 2004. Drainage and Irrigation Act CAP 64:03, Act 10 of 2004.
[41] Laws of Guyana, -. Guyana Forestry Commission Act CAP 67:01.
[42] Lindeman, J.C., 1953. The vegetation of the coastal region of Suriname. In: The vegetation of Suriname: 1 (1). Van Eedenfonds, Amsterdam.

[43] Mott MacDonald, 2006. Feasibility Study for the Sea Defences Programme financed under the 9th EDF for "The Co-operative Republic of Guyana", Feasibility Report, Croydon, 220 pages.
[44] Pastakia, C. M. R., 1991. A Preliminary Study of the Mangroves of Guyana, Final Report prepared for the European Community (Article B 946/89, Contract N°: 8912), 32 pages + Appendices.
[45] Pastakia, C.M.R., 1998. The Rapid Impact Assessment Matrix (RIAM) – A new Tool for Environmental Impact Assessment, in: *Environmental Impact Assessment Using the Rapid Impact Assessment Matrix (RIAM), Jensen, K. (ed.)*, Olsen & Olsen, Fredensborg, page 8-18.
[46] Singh, B., 1997. Climate changes in the Greater and Southern Caribbean, International Journal of Climatology Vol. 17, pages 1093-1114.
[47] Smith, D.E. et al., 1999. Relative sea level rise during the Main Postglacial Transgression in NE Scotland, UK Transactions of the Royal Society of Edinburgh: Earth Sciences 90, page 1-27.
[48] Spaans, A. L. & F. L. J. Baal, 1990. The estuarine zone of Suriname: Towards a symbiosis between conservation and development of a coastal wetland area. In: Living of the tides, S. Fiselier, ed., World Wildlife Fund, Netherland.
[49] Tomlinson, P. B., 1986. The Botany of Mangroves, Cambridge University Press.
[50] Trow International, 2005: Georgetown Solid Waste Management Programme, Environmental Impact Assessment, 574 pages.
[51] UN, 1992. United Nations Framework Convention on Climate Change, 25 pages.
[52] UNEP, 2003. Global Environment Outlook Yearbook 2003, can also be fully downloadable at http://www.unep.org/GEO/yearbook/yb2003/060.htm
[53] World Bank, 2007. Guyana Conservancy Adaptation Project, Project Document (Report No. 39120-GY), 80 pages.
[54] World Resources Institute, 2003a. Earth Trends Country Profiles, Biodiversity and Protected Areas - Guyana, 7 pages.
[55] World Resources Institute, 2003b. Earth Trends Country Profiles, Climate and Atmosphere - Guyana, 7 pages.
[56] World Resources Institute, 2003c. Earth Trends Country Profiles, Water Resources and Freshwater Ecosystems - Guyana, 6 pages.

Other documents consulted

[1] Carter, R.W.G., 1988. Coastal Environments - An Introduction to the Physical, Ecological and Cultural Systems of Coastlines, Academic Press, London.
[2] CCCCC, draft 2008. A strategy to build the resilience of the Caribbean Community to a changing climate, 25 pages.
[3] Charlier, R.H. & Ch.P. De Meyer, 1998. Coastal Erosion - Response and Management, Springer.
[4] EC, 2007. Environmental Integration Handbook for EC Development Co-operation, EuropeAid, Brussels, 184 pages.
[5] ECLAC, 2005. Guyana - Socio-Economic Assessment of the Damages and Losses caused by the January-February 2005 Flooding, UNDP, 132 pages.
[6] EEA, 2005. EEA core set of indicators - Guide, EEA Technical report No 1/2005, Luxembourg, 38 pages.
[7] EPA, 1999. First National Report to the Conference of the Parties (COP) of the Convention on Biological Diversity (CBD), Georgetown, 28 pages.
[8] EPA, 1999. National Biodiversity Action Plan, GEF/UNDP, Georgetown, 136 pages.
[9] Ground Structures Engineering Consultants Inc., 2006. Strategic Environmental Assessment of Mining in Guyana (TF-051887), Georgetown, 218 pages.
[10] IDB, 2006. Georgetown Solid Waste Management Program (GY 0055), Loan and Guarantee Proposal, IDB Georgetown, 44 pages.
[11] IPCC, 2007. Summary for Policy makers, IPCC Climate Change 2007: Synthesis Report, 22 pages.
[12] ISME, 2004. ISME Mangrove Action Plan for the Sustainable Management of Mangroves 2004-2009, International Society for Mangrove Ecosystems (ISME) and International Tropical Timber Organisation (ITTO), 28 pages.
[13] MACC, 2005. Climate Change Handbook for Caribbean Journalists, MACC Project, 84 pages.
[14] MoA, 2006. Draft Fisheries Management Plan, Department of Fisheries (MoA), Georgetown, 78 pages.
[15] Nokta, S. & G. Clarke, 2005. Forestry Sector Environmental Assessment, Georgetown, 126 pages.
[16] OECD, 2006a. Applying Strategic Environmental Assessment to Development Co-operation, Paris, 8pages.
[17] OECD, 2006b. Applying Strategic Environmental Assessment: Good Practice Guidance for Development Co-operation, OECD-DAC Guidelines & Reference Series, Paris, 164 pages.
[18] UNDP, 2006. Strengthening Coastal Communities: A Workshop on Coastal Community Vulnerability and Adaptation, February 20-21, 2006, Belize, 64 pages.
[19] UNDP, 2007. Fighting climate change: Human solidarity in a divided world, Human Development Report 2007/2008, Palgrave Macmillan, New York, 400 pages.
[20] University of Guyana, 2008. Socio-Economic Survey Draft Report, Institute of Development Studies and the School of Earth and Environmental Sciences, Turkeyen Campus, 140 pages.
[21] World Bank, 1999. Environmental Performance Indicators, Environmental Economics Series Paper No. 71, Washington, 50 pages.
[22] World Bank, 2005. Guyana: Preliminary Damage and Needs Assessment Following the Intense Flooding of January 2005, Draft Report, Washington, 25 pages.
[23] World Resources Institute, 2003. Earth Trends Country Profiles, Coastal and Marine Ecosystems - Guyana, 7 pages.

28 ANNEX 15: Curriculum Vitae of the Consultants

David Lees

Role in the project: Team Leader Scoping Study (Phase 1)

1. Family name: **LEES**

2. First names: **David Gordon**

3. Date of birth: **07 May 1951**

4. Nationality: **British**

5. Civil status: **Married**

6. Higher University Degrees:

Institution [month year – month year]	Degree(s) or Diploma(s) obtained:
Imperial College, London, UK [1993 - 1998]	MSc degree in Environmental Management (Natural Resources Economics, Environmental Policy and Law)
Imperial College, London, UK [1999 - 2007]	PhD degree in International Environmental Law

7. Language Skills:

Language	Reading	Speaking	Writing
English	1	1	1
French	3	3	3
Malay	3	3	3

Scale 1 to 5 (1 – excellent; 5 – basic)

8. Other skills:

- Royal Yachting Association Offshore Yacht Masters Navigation Certificate;
- Royal Yachting Association Sailing Instructor;
- Expert user of word processing, spreadsheets, drawing and multimedia presentations;
-

9. Present position: **independent environmental consultant**

10. Years within the firm: **professionally active since 1986**

11. Key qualifications specific to the project:

- Marine Environmental Impact Assessments & Strategic Environmental Assessments;
- Comparative studies of the role of mangrove against rock structures for sea defences;
- Environmental baseline studies, calibration and environmental surveys;
- Marine infrastructure and sea defence projects;
- Monitoring and evaluation of effectiveness of public works;
- Capacity building in EIA/SEA preparation.

Murray Simpson

Role in the project: Climate Change Specialist

1. Family name: **SIMPSON**

2. First names: **Murray Charles**

3. Date of birth: **26 January 1965**

4. Nationality: **British/Australian**

5. Civil status: **Married**

6. Higher University Degrees:

Institution [month year – month year]	Degree(s) or Diploma(s) obtained:
University of Greenwich, UK [2001 - 2002]	Master degree in Tourism, Conservation and Sustainable Development
Oxford University, UK [2002 - 2007]	PhD degree in Human Geography, Tourism, Livelihoods and Sustainable Development

7. Language Skills:

Language	Reading	Speaking	Writing
English	1	1	1
French	3	3	3
Zulu	-	1	-

Scale 1 to 5 (1 – excellent; 5 – basic)

8. Other skills:

- Trained research scuba diver;
- Expert user of word processing, spreadsheets, drawing and multimedia presentations;
- Expert user of social sciences and statistics software;
- Participatory appraisals, workshop facilitation and stakeholder motivation techniques.

9. Present position: **Senior Research Associate, University of Oxford, UK**

10. Years within the firm: **6 (over 16 years total work experience)**

11. Key qualifications specific to the project:

- Climate change impacts on sectors, adaptation and mitigation strategies;
- Climate change issues policy development adviser;
- Environmental auditing, impact analysis and predictive analysis;
- Sustainability analysis, budgetary analysis and impact indicator development;
- Project cycle management, stakeholder engagement processes for strategic planning;
- Coastal zone, national heritage and protected areas management.

François Wernerus

Role in the project: Coastal Zone Environmental Scientist

1. **Family name:** **WERNERUS**
2. **First names:** **François Marie Joseph**
3. **Date of birth:** **10 March 1962**
4. **Nationality:** **Belgian**
5. **Civil status:** **Married**
6. **Higher University Degrees:**

Institution [month year – month year]	Degree(s) or Diploma(s) obtained:
University of Liège, Belgium [October 1983 - September 1985]	MSc degree in Zoology (Marine Biology)
University of Liège, Belgium [October 1985 - December 1988]	PhD degree in Zoology (Marine Biology)

7. **Language Skills:**

Language	Reading	Speaking	Writing
French	1	1	1
English	1	1	1
Italian	3	3	4
Spanish	5		

Scale 1 to 5 (1 – excellent; 5 – basic)

8. **Other skills:**
   - Trained research scuba diver;
   - Scuba Diving Instructor;
   - Expert user of word processing, spreadsheets, drawing and multimedia presentations;
   - Experienced in digital image processing, cartography and data processing, etc.
9. **Present position:** **independent consultant (Corsecologie Marine Consultancy)**
10. **Years within the firm:** **12 (over 20 years total work experience)**
11. **Key qualifications specific to the project:**
    - Large infrastructure and other EIA projects (over 20 projects);
    - Coastal processes and hydrodynamics, with link to climate change;
    - Biological diversity and Country Environmental Profiles;
    - Cross-sectoral environmental analysis;
    - Implementation of EIA, SEA, ICZM and environmental directives of the EU;
    - Public awareness campaigns and stakeholders engagement.

Marc Staljanssens

Role in the project: Team Leader SEA Study (Phase 2)

1. **Family name:** **STALJANSSENS**
2. **First names:** **Marc**
3. **Date of birth:** **03 October 1951**
4. **Nationality:** **Belgian**
5. **Civil status:** **Single**
6. **Higher University Degrees:**

Institution [month year – month year]	Degree(s) or Diploma(s) obtained:
Faculty of Gembloux, Belgium [October 1969 - September 1974]	Agricultural Engineer (Land & Water) MSc degree
Faculty of Gembloux, Belgium [October 1972 - September 1974]	Master in Teaching & Education
University of Liège, Belgium [October 1974 - November 1975]	Oceanologist MSc degree
University of Gembloux, Belgium [October 2002 - September 2005]	PhD degree in Environmental Sciences

7. **Language Skills:**

Language	Reading	Speaking	Writing
Dutch	1	1	1
English	5	5	5
French	1	1	1
German	1	3	4
Italian	1	1	2
Spanish	1	2	4

Scale 1 to 5 (1 – excellent; 5 – basic)

8. **Other skills:**
   - Trained research scuba diver;
   - Truck and bus driver's license;
   - Expert user of word processing, spreadsheets, drawing and multimedia presentations;
   - Adviser for digital image processing, geographic information systems, environmental modelling & expert systems, multi-criteria analysis & decision support systems, etc.
9. **Present position:** **freelance international consultant/civil service contractor**
10. **Years within the firm:** **professionally active since 1976**
11. **Key qualifications specific to the project:**
    - Resources survey & mapping, evaluation, and environmental impact assessments;
    - Integrated land use planning, rural development and coastal zone management;
    - Coastal processes, erosion and sea defences assessment;
    - National mangrove management master plans;
    - Training and capacity building for EIA/SEA practitioners, reviewers and conceptualists;
    - International EIA/SEA policy development adviser.

29 ANNEX 16: Terms of Reference for the SEA

Terms of Reference for a Strategic Environmental Assessment of the Sea Defences Sector Policy in Guyana

1. Background

The Government of Guyana (GoG) and the European Commission require a Strategic Environmental Assessment (SEA) to be carried out for the preparation of a Sea Defence Policy Framework and Sector Programme (SDSP), funded under the 8th and 9th EDF, and an EC programme to support that policy (EC SPSP), to be funded under the 10th EDF by means of sector budget support.

The major policy/plan/programme documents to be considered under the study include but are not limited to:

Classification	Documents	Status
Policy and Legislative	Sea Defences Sector Policy Framework	Preparation
	Poverty Reduction Strategic Paper I	Finalized
	Poverty Reduction Strategic Paper II	Preparation
	National Development Strategy	Finalized
	Sea Defences Act (CAP 64:01)	Finalized
	Sea Defences Act (CAP 64:02)	Finalized
	Environmental Protection Act (CAP 20:05)	Finalized
	Drainage and Irrigation Act 10 of May 2004	Finalized
Strategic / Profiles	Guyana Climate Change Action Plan	Finalized
	Country Strategy Paper	
	Country Environment Profile	Finalized
Studies	9th EDF Feasibility study	Finalized
	Coastal Zone Management	Finalized
	Coastal Zone Biodiversity	Finalized
	Socio Economic Study	Preparation

***** *The main objective is that the results of SEA can influence the Sector Policy preparation.*

The EDF has funded several projects since the 7th EDF mainly for rehabilitation works, supply of materials and also numerous interventions for institutional strengthening of the Sea and River Defence Division (SRDD).

The Financing Agreement for the interventions funded under the 7th EDF between the European Commission (EC) and the Government of Guyana was signed in 1994 and physical works were completed in 1999. Simultaneously with the completion of the 7th EDF interventions, an appraisal study under the 8th EDF identified approximately 5 km of the sea defences in two designated Regions (2 and 3) for reconstruction. The study also outlined the need for a separate programme which should address the implementation of institutional strengthening measures through the development of a shore zone management system.

The Financing Agreement for the 8th EDF Sea Defence Programme was signed in March 2000 and is expected to be completed in December 2008. Interventions under the 8th EDF programme included institutional capacity building through, development of a Shore Zone Management System (SZMS) consisting on data collection, modelling, database management and training. However, the system is not fully utilised due to the inability of the Division to retain the qualified staff necessary to manage the database and carry out the sea defence monitoring and maintenance programme. Other weaknesses identified are the institutional status and the organisational structure of the SRDD. A recent Monitoring Mission from the European Commission has concluded that the rate of progress currently being experience with the Programme is undesirable and management need to be more proactive. Towards this end, funds have been provided under the contingency component of the Financial Agreement for the appointment of a Technical Assistant to the SRDD. His services were delivered for a period of 8 months that ended in November 2007.

For the 9th EDF, a pre-feasibility study identified the need for further interventions in policy and Shore Zone Management System (SZMS) development, strengthening of the management procedures, investment in maintenance and medium term rehabilitation and continuation of works in reconstruction of "critical" lengths of the sea wall. On the basis of this a feasibility study was undertaken and it was completed by August 2006. This feasibility study forms the basis of the 9th EDF Sea Defences Programme by identifying locations for the maintenance and reconstruction works, appraising existing policy elements, developing the SZMS interventions (including a mangroves pilot programme) and analyzing the existing institutional set-up and concluding on a framework for its strengthening.

Under the 10th EDF Country Strategy Paper (CSP) and the respective National Indicative Programme (NIP), the Government of Guyana (GoG) and the European Commission (EC) have jointly identified "Economic and Social Infrastructure: contribution to Government's sector policy on coastal management (support to Sea Defences as a final hand-over intervention)", to be the proposed areas of concentration. 14,8 million EUR have been allocated to this focal sector.

The proposed action under this focal sector will support GoG's increasing emphasis on a combination of points: 1) prioritizing the investments needed to upgrade critical sea defence structures and locations and 2) supporting the preventive maintenance programmes, a strategy that has already been emphasized under the 9th EDF NIP. A specific target of the 9th EDF programme is the capacity development within Sea Defence administration in order to prepare for final hand-over of responsibility for the maintenance of this crucial infrastructure from the EC to the national authorities.

The 10th EDF sector budget support evolved out of project support with the objective to support Guyana's Sea Defences Sector Policy. Technical Assistance (TA), funded from 8th EDF contingencies, will be procured to assist GoG in drafting a Sea Defences Sector Policy, for which fragmented elements already exist. A sector policy formulation mission is planned to be carried out in Guyana from April to August 2008. The Strategic Environmental Assessment (SEA) is expected to complement and feed as early as possible into the policy development process.

2. Description of the Assignment

2.1 Objectives

The objective of this SEA is to describe, identify, and assess the likely significant implications on the environment of the Sea Defences Sector Policy and Programme (SDSP) and to identify opportunities to enhance the programme resulting from a better understanding of environmental interactions[1]. This information should be taken into account in the preparation of the support to be provided by the EC and during the implementation of the SDSP itself. The SEA will provide

[1] Throughout this document the term environment interactions refers both to impacts of the programme on the environment and environmental opportunities/constraints on the programme

decision-makers in the EC the partner country with relevant information to assess the environmental challenges and considerations with regard to Sea Defences Sector Programme and the envisaged Sector Budget Support. This information should help to ensure that environmental concerns are appropriately integrated in the decision-making and implementation processes.

2.2 Results

The **Strategic Environmental Assessment** will deliver the following results:

- An environmental assessment to feed into the Sea Defences Sector Policy formulation taking into account environmental constraints and opportunities and potential environmental impacts of its implementation. Consistency with Guyana Government's and EC's environmental policies and objectives should be part of the assessment.
- Recommendations for the EC Sector Programme (Budget Support) formulation including performance indicators and /or possible accompanying measures to be taken during sector programme implementation.

2.3 Issues to be studied

The SEA is composed of two parts: the **Scoping study** and the **SEA study**. The scoping study will define the issues that need to be addressed in the SEA study, considering the specific context in which the Sector Programme is being developed and is likely to be implemented.

The SEA ***Scoping study*** will contain:

- A description of the Sector Policy and Programme under formulation and any alternatives that might be considered; If deemed necessary the consultants may suggest variants to the alternatives, which must be justified;
- A description of the institutional and legislative framework related to the sea defence sector;
- A presentation of the country's relevant environmental policies and objectives (taking into account the information in the Country Environmental Profile – CEP and other relevant sources);
- An identification of key stakeholders likely to be more directly affected by the sector policy and their concerns. The involvement of stakeholders in the SEA process is a key success factor[2]. The strategy should provide stakeholders an opportunity to influence decisions.
- Description of key environmental aspects to be addressed in the SEA[3]. Depending on expected impacts on society and the scope of other studies, there is also a need to determine to which extent social impacts should be assessed[4].

- A description of the scope of the environmental baseline to be prepared. This will include a proposal of the geographical units that will need to be covered by the study. The area to be considered has a surface plan of 15,200 km^2 (430 km extension along Atlantic Coast and a width varying from 26 to 77 km).

[2] Consultants shall review records of any national public consultation processes that may have taken place in relation to sea defence interventions. In planning additional consultations particular attention shall be paid to most vulnerable groups and stakeholders who may not have been adequately represented in previous consultations.
[3] Any other SEA or studies carried out in the same area and in relation to other environmentally sensitive programmes or plans should be considered in this context.
[4] Impacts on humans should be disaggregated according to sex, age, or other relevant social criteria. A socio-economic study is being implemented by a pool of specialists from the University of Guyana that was subcontracted by a Consultant Company (Royal Haskoning) under 8th EDF. This study will be finished at beginning of 2008.

- Identification of the impact identification and evaluation methodologies to be used in the SEA study. Special attention should be given to identifying those environmental interactions that will require quantitative analyses and those for which qualitative analyses should be carried out.
- A more precise indication of the timeframe for completion of the SEA study

The SEA study

The scope of the SEA study will be agreed upon with the Commission and Government of Guyana on the basis of the results of the scoping study. The SEA will include an environmental baseline study, an identification of environmental opportunities and constraints, an identification and assessment of the potential environmental impacts for each alternative being considered, an analysis of performance indicators, an assessment of the institutional capacities to address environmental challenges and conclusions and recommendations for Sea Defences Sector Programme (Budget Support) formulation.

Environmental baseline study

A description and appraisal should be made of the current state of the environment, focusing on those key environmental components identified by the scoping study. The trends for the various environmental components must be identified and a projection must be made of the state of the environment on the short-, medium- and long-term in the assumption of no implementation of the Sector Programme. If the "no implementation" scenario is unrealistic the most probable "business as usual" scenario should be selected.

Identification and evaluation of environmental opportunities and constraints

The environmental factors and resources that can affect (positively or negatively) the effectiveness, efficiency and sustainability of the (GoG) Sector Policy and Programme should be identified, described and assessed for each alternative considered. In particular the foreseen local effects of climate variability and change should be considered[5], with a view to preventing the sector policy and programme from negatively affecting exposure, hazard risks and underlying vulnerability. Other external factors should also be taken into account, such as the influence played by other sector policies. This part of the study should look at the conditions allowing for a most adequate response to these opportunities and constraints. .

Identification and evaluation of impacts

The potential environmental impacts and risks from implementing the Sea Defences Sector Programme shall be identified and described for each alternative being studied, taking into account the views and concerns of stakeholders. Their significance should be determined according to their characteristics (e.g. duration, probability, magnitude, mitigability, reversibility) and the sensitivity of the environment. Those impacts which are significant should be assessed in detail taking into account:

- the views and concerns of stakeholders,
- the consistency with international commitments (MEAs),
- the socio-economic consequences (especially on vulnerable groups and ethnic minorities),
- compliance with environmental regulations and standards,

[5] Indirect and direct expected impacts shall be considered, based on available information. Information gaps in this area should be identified. More guidance on these aspects will be provided at kick off meeting.

- consistency with environmental objectives and policies, and
- their implications for sustainable development.

Assessment of the capacities to address environmental challenges

The capacity of regulatory institutions to address the environmental issues, especially the impacts identified, should be assessed.

Preparation of performance indicators

Performance indicators, from an environmental perspective, should be proposed, i.e. their usefulness to identify the environmental effects (positive and negative) of the Sea Defences Sector Programme implementation. Proposals should be made for performance indicators and monitoring system.

The set of indicators may include:

- "Pressure" indicators;
- "State" indicators, for sectors with a direct and major link with key environmental resources;
- Indicators related to other specific issues, such as key institutional weaknesses identified by the SEA.

Stakeholder engagement

Stakeholders should be engaged throughout the SEA study according to the stakeholder engagement strategy agreed in the scoping stage.

Conclusions and recommendations

This chapter will summarise the key environmental issues for the sector involved, including policy and institutional constraints, challenges and main recommendations. Recommendations should be made on how to optimise positive impacts and the opportunities to enhance the environment, as well as on how to deal with environmental constraints, mitigate negative effects and risks. They should suggest the selection of alternatives or possible changes in the Sea Defences Sector Policy formulation.

Recommendations for the sector policy definition and enhancement should be distinguished from those related to the EC Sector Programme (Budget Support) formulation. While the first focus on the contents of the proposed policy, the latter should consider the most appropriate measures to enhance its implementation, i.e., the possible need for complementary measures to address specific weaknesses in the environmental institutional, legal and policy framework and implementation capacities. They should also include proposals for adequate performance indicators.
The limitations of the SEA and its assumptions should be presented. The recommendations should take into account the views presented by the stakeholders and explain how these were integrated. In the case of concerns that were not integrated in the final recommendations, the reasons thereof should be given.

2.4. Requested outputs

Draft SEA Scoping report, including stakeholder engagement plan
Final SEA Scoping report
Draft SEA study Report
Final SEA Study Report
(See section 5 below - Reporting)

3. Expertise Required

It is expected that a maximum of three experienced professionals (all category II) will be required to carry out this assignment, having relevant qualifications and proven track record in conducting environmental assessments, preferably in a developing country context, preferably at the level of major plans, programmes and policies (PPP). At least one of the team members shall have significant Sea defence sector-related experience, ideally in the country or region concerned. At least one of the team members should have thorough understanding of climate change adaptation issues. At least one of the team members shall have significant knowledge of EC development cooperation and related working experience. At least one the team members shall have significant prior experience in combining environmental and socio-economic assessments. Team members shall have excellent drafting skills (EN) and be good communicators. A total of up to 200 working days – to be shared amongst the experts – are expected to be provided to carry out this assignment.
Bidding companies shall specify how the individual team members' skills complement each other to ensure an appropriate combination of competences to carry out this study successfully. For each specialist proposed, a C*urriculum Vitae* shall be provided, setting out the relevant qualifications and experience.

4. Location and Duration

The assignment is indicatively expected to start in March 2008 and be completed by the end of October 2008. Most of the assignment will be carried out in Guyana. Consultants will be expected to travel to Brussels on 2 occasions[6]: To attend the kick-off meeting, and to present the final SEA study. The consultants will integrate comments to draft SEA scoping and SEA study reports from their home base. Up to 15 working days in total for whole team are expected to be required to this end, including the aforesaid meetings in Brussels.

Planning

The work plan should include but not necessarily be limited to the following activities:

Kick off meetings at EC HQs in Brussels and EC Delegation in Guyana.

1. Scoping study (in Guyana - Indicative duration: two weeks)

- Fact finding/data collection;
- Review of prior public consultations, identification of key stakeholders;
- Engagement of stakeholders;
- Analysis/preparation of recommendations and scoping report.

2. SEA study (in Guyana - Indicative duration: up to 10 weeks)

- Fact finding/data collection;
- Field trips;
- Engagement of stakeholders;
- Identification and detailed analysis of the potential environmental impacts;

[6] Should the team include local consultants they will not be requested to travel to Brussels, except for the team leader.

- Preparation of recommendations to mitigate negative environmental effects (and constraints) and optimise positive effects (and opportunities);

- Preparation of recommendations and draft SEA report;

- Preparation and submission of the final SEA report.

Presentation of the final report in Guyana and at the EC in Brussels

A more detailed work-plan for both the scoping and the study phase should be provided in the methodology to be submitted alongside the financial offer based on this indicative sequence and the timeframe for reporting below.

5. Reporting

Scoping study

The draft scoping report, including the stakeholder engagement plan, shall be submitted (in English, in electronic form), to the EC (Delegation in Guyana and EuropeAid in Brussels) and to the Government of Guyana (see below, last paragraph under this section, for government bodies concerned) for comments no later than 2 weeks after kick off. Consultants will take account of those comments in preparing the final scoping report to be submitted no later then two weeks after receiving the comments. The scoping study shall be maximum 25 pages excluding annexes and presented in the format given in Appendix 1. The SEA study will begin soonest upon approval of the final scoping study.

SEA study

The draft SEA report shall be submitted (in English, in both electronic and paper version – A total of 10 copies) to the EC Delegation in Guyana and EuropeAid in Brussels and the Government of Guyana (see below last paragraph under this section for main government bodies concerned) for comments no later than 10 weeks[7] after the start of the study phase.

The company will take account of those comments in preparing the final SEA report which shall be submitted no later than two weeks following receipt of comments.

The SEA study shall be maximum 100 pages excluding annexes and presented in the format given in Appendix 2. Again it will be submitted in both electronic and paper versions – 10 copies.
Copies of draft and final reports shall be transmitted to National Research & Environmental Advisory Committee (**NREAC**), Ministry of Finance, Ministry of Public Works and Communications, Ministry of Local Government, Sea and River Defence Division, Environmental Protection Agency, Ministry of Agriculture, Ministry Housing and Water, Lands and Surveys Commission for comments no later than **three weeks** after kick-off. The **NREAC** will be the main counterpart institution from the Government of Guyana for this study.

6. Administrative Information

This request for services will be managed by the European Commission EuropeAid Cooperation Office, Unit C/4, on behalf of AIDCO Unit E/6 and the EC Delegation in Guyana. Names of contact persons will be provided soonest upon contract signature.

Items foreseen as reimbursable costs will be related to the consultants' international (2 international return flights to Guyana per expert, up to 2 return flights to Brussels), local travel, and per diems.

[7] The scoping study will provide more accurate indications concerning the time requirements for the study phase - see 4.1.f above

Global Amount

A maximum amount of Euro 170.000 is foreseen for the implementation of the assignment.

Presentation of the proposal

The proposal shall include a description of the general approach to the assignment in accordance with the present ToR, highlighting the following aspects: Proposed methodology for the participation of stakeholders; Proposed approaches for the definition of the environmental baseline, Methodologies for assessing environmental interactions and impacts; A proposal for the organisation of work and time schedule, based on the broad timeframe proposed in section 4 and 5.

10. Appendices

Appendix 1- Standard Format for the SEA scoping report

Maximum length of the main report (without appendices): 25 pages.

The following text appears on the inside front cover of the report:

This report is financed by the European Commission and is presented by the (*name of consultant*) for the European Commission. It does not necessarily reflect the opinion of the European Commission.

1. Executive summary
2. Description of the Sector Programme under consideration
3. Overview of the policy, institutional and legislation framework
4. Description of key stakeholders and their concerns
5. Description of key environmental aspects to be addressed in the SEA study
6. Description of the scope of the environmental baseline to be prepared in the SEA study
7. Recommendations on specific impact identification and evaluation methodologies to be used in the SEA study
8. Proposal of time frames and resources needed for the SEA study
9. Technical appendices

I. Stakeholder engagement methodology

II. List of stakeholders engaged or consulted

III. Records of stakeholder participation

IV. List of documents consulted

Appendix 2. Standard Format Sector SEA report

The following text appears on the inside front cover of the report:

This report is financed by the European Commission and is presented by the (*name of consultant*) for the European Commission. It does not necessarily reflect the opinion of the European Commission.

Maximum length of the main report (without appendices): 100 pages.

1. Executive summary
2. Scope
3. Background
3.1 Sector Programme justification and purpose
3.2 Alternatives
3.3 Environmental policy, legislative and planning framework
4. Approach and methodology
4.1 General approach
4.2 Geographical or environmental mapping units
4.3 Assumptions, uncertainties and constraints
5. Environmental baseline study
6. Impact identification and evaluation
7. Analysis of alternatives
8. Mitigation or optimising measures
9. Indicators and institutional capacities
10. Conclusions and recommendations
10.1. General conclusions
10.2. Recommendations for SPSP formulation
10.3. Recommendations for Sector Programme enhancement
11. Technical appendices
    - Maps and other illustrative information not incorporated into the main report
    - Other technical information and data, as required
    - List of stakeholders consulted/engaged
    - Records of stakeholders' participation

11. Other appendices
    - Study methodology/work plan (2-4 pages)
    - Consultants' itinerary (1-2 pages)
    - List of documentation consulted (1-2 pages)
    - *Curricula vitae* of the consultants (1 page per person)
    - Terms of Reference for the SEA