DRAFT FOR CONSULTATION

Climate Resilience Strategy and Action Plan for Guyana

Ministry of the Presidency
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Abbreviations and acronyms

A2	High Emissions Scenario
ADF	Amerindian Development Fund
AF	Adaptation Fund
CAP	Conservancy Adaptation Project
CARICOM	Caribbean Community
CCCCC	Caribbean Community Climate Change Centre
CDB	Caribbean Development Bank
CALC	Climate Action Line of Credit
CDC	Civil Defence Commission
CGCM1	Canadian Global Coupled Model (version 1)
CH&PA	Central Housing and Planning Authority
CPAC	Caribbean Planning for Adaption to Climate Change
CI	Guyana Conservation International Foundation (Guyana) Inc.
CIMH	Caribbean Institute for Meteorology and Hydrology
CMRVS	Community Monitoring, Reporting and Verification System (for Guyana's REDD+ Programme)
CPACC	Caribbean Planning for Adaptation to Climate Change
CTF	Clean Technology Fund
DNRE	Department of Natural Resources and the Environment
ECD	East Coast Demerara
ECLAC	Economic Commission for Latin America and the Caribbean
EDWC	East Demerara Water Conservancy
EHU	Environmental Health Unit
EIA	Environmental Impact Assessment
ENSO	El Niño-Southern Oscillation
EWS	Early Warning System
FAO	Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility
FCPF-RF	Forest Carbon Partnership Facility - Readiness Fund
FIP	Forest Investment Programme

GCCA	Global Climate Change Alliance
GDP	Gross Domestic Product
GEA	Guyana Energy Authority
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GGMC	Guyana Geology and Mines Commission
GGDMA	Guyana Gold and Diamond Miners Association
GHG	Greenhouse Gas
GINA	Government Information Agency
GIS	Geographic Information System(s)
GLDA	Guyana Livestock Development Agency
GL&SC	Guyana Lands and Surveys Commission
GMSA	Guyana Manufacturing Services Association
GMSTC	Guyana Mining School and Training Centre
GoG	Government of the Co-operative Republic of Guyana
GPL	Guyana Power and Light
GRDB	Guyana Rice Development Board
GRIF	Guyana REDD+ Investment Fund
GSA	Guyana School of Agriculture
GTA	Guyana Tourism Association
GTS	Global Telecommunication System
GUYSUCO	Guyana Sugar Company
GWI	Guyana Water Incorporated
HadCM3	Hadley Centre General Circulation Model (version 3)
Hydromet	Hydrometeorological Service
ICZM	Integrated Coastal Zone Management
IDA	International Development Association
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IICA	Inter-American Institute for Cooperation on Agriculture
INC	Initial National Communication

IPCC	Intergovernmental Panel on Climate Change
IPED	Institute of Private Enterprise Development
ITCZ	Inter-Tropical Convergence Zone
Iwokrama	International Centre for Rainforest Conservation and Development
JICA	Japan International Cooperation Agency
LDC	Least Developed Country
LCDS	Low Carbon Development Strategy
LDCF	Least Developed Countries Fund
LIDCO	Livestock Development Company
M&CC	Mayor and City Council
MACC	Mainstreaming Adaptation to Climate Change
MIPA	Ministry of Indigenous Peoples' Affairs
MoA	Ministry of Agriculture
MoC	Ministry of Communities
MoE	Ministry of Education
MoF	Ministry of Finance
MoLA	Ministry of Legal Affairs
MoPH	Ministry of Public Health
MoT	Ministry of Tourism
MOU	Memorandum of Understanding
MPI	Ministry of Public Infrastructure
MRVS	Monitoring, Reporting and Verification System (for Guyana's REDD+ Programme)
M&E	Monitoring and Evaluation
NAMAs	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programme of Action
NAREI	National Agricultural Research Extension Institute
NCC	National Climate Committee
NCCAP	National Climate Change Action Plan
NCSA	National Capacity Self-Assessment
NDC	Neighbourhood Democratic Council
NDIA	National Drainage and Irrigation Authority
NDS	National Development Strategy

NGOs	Non-Governmental Organisations
NREAC	National Resources and Environment Advisory Committee
OCC	Office of Climate Change
ODA	Overseas Development Aid
OECD	Organisation for Economic Co-operation and Development
PPCR	Pilot Programme on Climate Resilience
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing Emissions from Deforestation and Forest Degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
SCCF	Special Climate Change Fund
SDSM	Statistical DownScaling Model
SIDS	Small Island Developing States
SNAP	Stocktaking for National Adaptation Planning
SNC	Second National Communication
SRDD	Sea and River Defence Division
SREP	Scaling Up Renewable Energy Programme
SRES	Special Report Emissions Scenarios
UG	University of Guyana
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
VRR	Vulnerability, Risk and Resilience (in reference to the workshop help in Georgetown, Guyana in April 2015)
WB	World Bank
WFP	World Food Programme
WMO	World Meteorological Organisation

Executive summary

The adverse, and potentially catastrophic, impacts of climate change are already being experienced in Guyana. Since the 1960s, Guyana has observed significant changes in its climate system with marked increases in temperatures, sea levels and the frequency and intensity of extreme rainfall events. The impacts on Guyanese people, society, economy and environment, are from flooding events in 2005, 2006, 2008, 2010, 2011, 2013, 2014 and 2015 and the droughts of 1997-8, 2009-2010 and 2015 are poignant examples of the devastation caused by climate change. Flooding in 2005, for example, caused damage estimated at US$ 465 million (60% of GDP)[1] and during the drought in April 2015 potable water had to be trucked into communities in Regions One and Nine[2,3]. Guyana has been described as being 'particularly vulnerable' to climate change because of high levels of exposure and sensitivity to climate risks and limited capacity to adapt.

Climate models project that temperatures will continue to increase and that sea levels and the height of storm surges will rise. Projections also indicate that average annual precipitation will decrease and that the proportion of heavy rainfall events will increase. These in turn are expected to exacerbate adverse social, economic and environmental impacts, and act additional stress factors on systems with vulnerabilities derived from non-climate drivers[4,5].

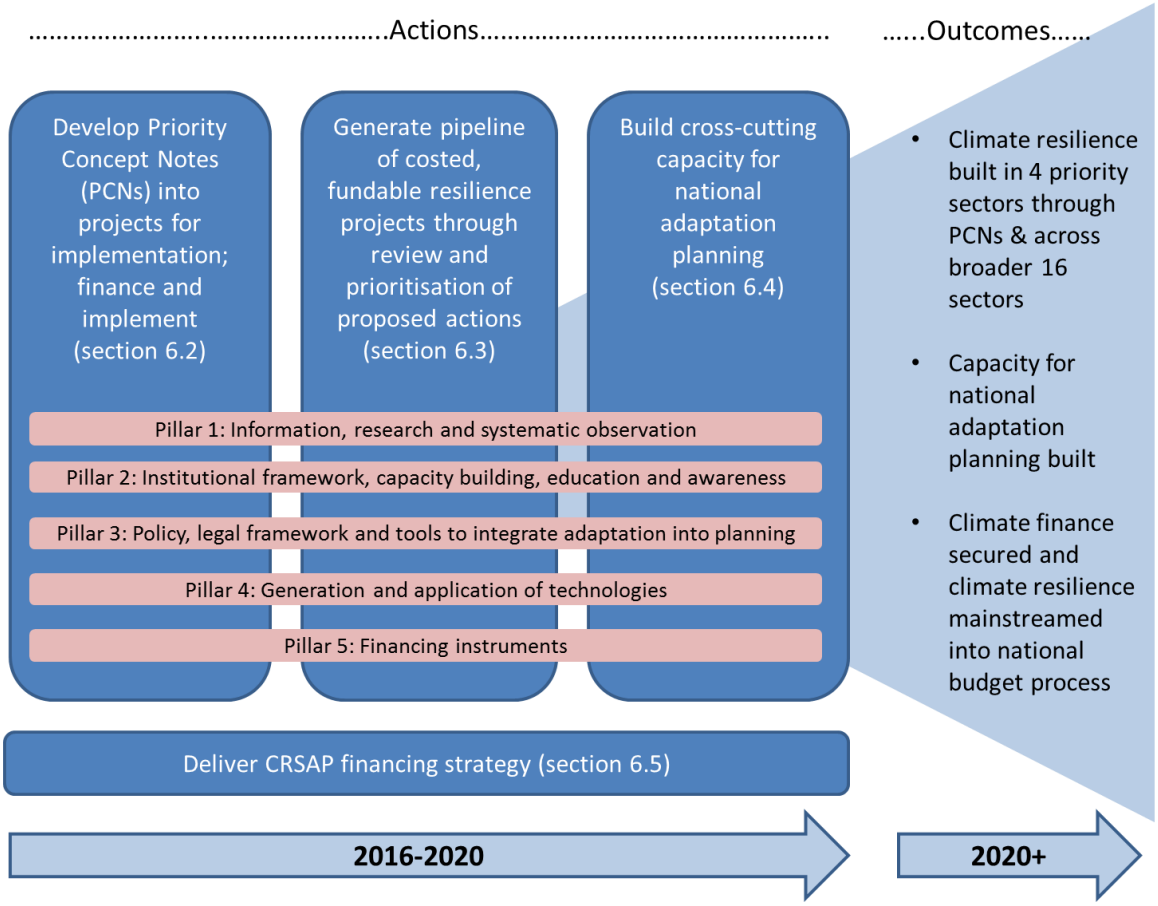
Guyana has already started to take action to build resilience to change impacts and to enhance capacities to adapt. Indeed, the Government of Guyana (GoG) is committed to a green economy to sustain economic prosperity, environmental security and social well-being. Policies which support this vision include the Low Carbon Development Strategy, the Second National Communication to the United Nations Framework Convention on Climate Change, the National Integrated Disaster Risk Management Plan, and the National Adaptation Strategy to Address Climate Change in the Agricultural Sector. Guyana has also made progress in implementing adaptation and resilience building actions principally through interventions to the drainage and irrigation and sea defence systems to reduce the risks of flooding. Guyana has accessed external finance to support the implementation of these actions from several sources including through the Memorandum of Understanding with the Government of Norway, the European Union and multilateral arrangements.

Despite these strides, Guyana still requires an overarching framework for planning and implementing climate resilience actions so as to achieve the Government's 'Vision 2020' for a green economy[6]. This Climate Resilience Strategy and Action Plan (CRSAP) addresses this gap and aims to provide a comprehensive and overarching framework for adapting and building resilience to climate change impacts. The CRSAP builds on the work that has been in Guyana over the years and identifies key climate risks and priority resilience building actions. The Strategy and Action Plan are underpinned by the five cross-cutting pillars of adaptation identified in the Second National Communication namely information, research and systematic observation; institutions and capacity building; policy and legal frameworks; infrastructure and technology; and finance.

Specifically, the CRSAP provides:

- A **roadmap** for the next five years.
- **Project Concept Notes** for four priority climate resilience programmes which can now be developed into full proposals and submitted for funding.
- A summary of the most significant **climate risks and required resilience actions across 15 key sectors**. These actions are proposed as the basis for the design of new interventions and a pipeline of projects which can be presented for funding and implemented within five years and beyond.

- A set of **capacity building actions** that enhance Guyana's capacity for national adaptation planning and becoming climate resilient to be undertaken within the next five years.
- A **strategy to finance the CRSAP** inclusive of the PCNs.



The CRSAP Roadmap summarises the key strategic actions that need to be taken to deliver the CRSAP and increase Guyana's resilience to a variable and changing climate. It also articulates a timeframe for action focussed on the next five years (2016-2020) as well as a proposal for a review and iteration process in 2020. This approach is largely synchronised with the newly commenced government term and national planning cycle (2015-2019). The roadmap recognises that building climate resilience is a journey that requires cycles of action, reflection and iteration as lessons are learnt about effective implementation and resource allocation.

To deliver the Strategy, an Action Plan has been prepared which includes the draft PCNs, detailed findings of the climate change vulnerability and risk assessment and identification of resilience actions in the form of 15 sectoral briefing notes. The summary of the most significant **climate risks and required resilience actions across 15 key sectors** is provides an overview of the most serious risks (i.e. higher likelihood of occurring and severity of consequence) t. This is likely to provide crucial guidance to sectors on prioritising and implementing these actions through the application of an 'adaptive management' approach.

Capacity building actions are presented according to the five pillars on adaptation defined in the Second National Communication. These actions have been defined based on feedback provided by

stakeholders and by a review of the available literature. Both the PCNs and the 15 sectoral briefing notes can be used to further develop, finance and implement resilience actions.

A key component of the CRSAP has been to identify early-start, costed and evidence-based climate resilience programmes which can be moved quickly through funding, design and procurement stages and into implementation. These early-start priority **Project Concept Notes (PCNs)** are:

- **'Building Climate Resilient Agricultural Systems'**, by improving water management, developing climate proof sustainable farm systems and building the adaptive capacity of the sector to reduce the vulnerability of farmers (in particular small to medium scale).
- **'Guyana's Sea Defence Enhancement and Maintenance'**, through coordinated and complementary actions of mangrove development and restoration and rebuilding the most critical sea and river defences in low-lying coastal areas. This will help increase the coverage of and strengthen the existing sea defence against high tide, which in turn will reduce flood risk in coastal communities.
- **'Public Health Adaptation to Climate Change',** through strengthened national disaster risk management (with specific reference to health) and early warning response systems, enhanced access by communities to clean water and sanitation facilities and food hygiene, reduced impacts of water-borne diseases, increased human and physical sectoral capacity and increased public awareness.
- **'Strengthening Drainage and Irrigation Systems'**, by improving the capacity of the network starting with the most critical areas, upgrading the existing drainage and irrigation system with a focus on the agriculture sector, institutional strengthening of the National Drainage and Irrigation Authority (NDIA) and development of a training curriculum on drainage and irrigation.

The total financing need for all four PCNs is estimated at US$104.34 - 112.30 million. This is but a fraction of the total financing costs for adaptation and resilience building actions. The CRSAP financing strategy has aims to prepare the infrastructure needed to finance the implementation of the CRSAP; to accurately capture climate-related expenditures in the national budgeting process; and that funding can be secured for the implementation of the PCNs.

Engaging stakeholders has been an essential component in the process of preparing the CRSAP. Stakeholders have actively participated in key initiatives under the project including the Inception Mission, the Stocktaking for National Adaptation Planning Workshop (SNAP), the Vulnerability, Risk and Resilience Workshop and the Final Consultation Workshop. Stakeholders were also engaged through electronic and telephone exchanges.

1 Introduction and background

The world's climate is warming because of the increase in greenhouse gases, and the process of change has been underway for several decades. The atmosphere and oceans have warmed, glaciers are retreating, the Greenland and Antarctic ice sheets are diminishing and sea levels are rising. These changes have caused impacts on natural and human systems on all continents and across the world's oceans. Increases in temperature, changes in precipitation and in the frequency and intensity of extreme events such as droughts, heat waves, floods and wildfires have led to impacts such as reductions in food production, disruptions to water supply, damage to infrastructure and settlements, impacts on ecosystems as well as consequences for health, human well-being and livelihoods. The impacts of climate change are expected to worsen and accelerate over time causing changes in all components of the climate system, which in turn increase the likelihood and consequence of severe, pervasive and irreversible impacts for people and ecosystems[7].

The adverse, and potentially catastrophic, impacts of climate change are already being experienced in Guyana. Since the 1960s, Guyana has observed significant changes in its climate system with marked increases in temperatures, sea levels and the frequency and intensity of extreme rainfall events[8]. The impacts on Guyanese people, society, economy and environment, are from flooding events in 2005, 2006, 2008, 2010, 2011, 2013, 2014 and 2015 and the droughts of 1997-8, 2009-2010 and 2015 are poignant examples of the devastation caused by climate change. Flooding in 2005, for example, caused damage estimated at US$ 465 million (60% of GDP)[9] and during the drought in April 2015 potable water had to be trucked into communities in Regions One and Nine[10],[11]. The increasing frequency of these extreme events is certainly alarming especially because of Guyana's particular vulnerability to climate change.

Climate models project that temperatures will increase and that sea levels and the height of storm surges will rise. Projections also indicate that average annual precipitation will decrease and that the proportion of heavy rainfall events will increase, though there is greater uncertainty about these values. These in turn are expected to exacerbate adverse social, economic and environmental impacts, and act additional stress factors on systems with vulnerabilities derived from non-climate drivers[12, 13].

Guyana has already started to take action to build resilience to change impacts and to enhance capacities to adapt. At a global level, Guyana ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Since that time, two National Communications have been prepared and submitted to the Convention. In 2015, Guyana submitted its Intended Nationally Determined Contribution to the UNFCCC. Further, Guyana ratified the United Nations Convention on Biological Diversity in 1994 and the United Nations Convention to Combat Desertification in 1997.

At the national level, Guyana has prepared a Low Carbon Development Strategy (LCDS) to foster low carbon and climate resilient development. The LCDS, prepared in 2009 and updated in 2013, highlighted the importance of adaptation and building resilience and in this regard identified thematic priorities such upgrading infrastructure to protect against flooding, hinterland adaptation, addressing systematic and behavioural concerns, and developing innovative financial risk management tools among others[14]. The LCDS is supported by sectoral policies including the National

Integrated Disaster Risk Management Plan, the National Strategy for Agriculture in Guyana, and the Sea and River Defence Policy among others. Guyana has also made progress in implementing adaptation and resilience building actions principally through interventions to the drainage and irrigation and sea defence systems to reduce the risks of flooding.

Despite these strides, Guyana still requires an comprehensive framework for building climate resilience so as to achieve the Government's vision for a green economy[15]. This Climate Resilience Strategy and Action Plan (CRSAP) addresses this gap and aims to provide a comprehensive and overarching framework for adapting and building resilience to climate change impacts. The CRSAP identifies potential changes in Guyana's climate (both slow-onset and extreme events), identifies current and projected cross-sectoral climate vulnerabilities and risks and assesses Guyana's current capacity for building climate resilience. The CRSAP provides:

- A **roadmap** for the next five years.
- **Project Concept Notes** for four priority climate resilience programmes which can now be developed into full proposals and submitted for funding.
- A summary of the most significant **climate risks and required resilience actions across 15 key sectors**. These actions are proposed as the basis for the design of new interventions and a pipeline of projects which can be presented for funding and implemented within five years and beyond.
- A set of **capacity building actions** that enhance Guyana's capacity for national adaptation planning and becoming climate resilient to be undertaken within the next five years.
- A **strategy to finance the CRSAP**.

Both the PCNs and the 15 sectoral briefing notes can be used to further develop, finance and implement resilience actions.

1.1 Guyana's climate profile

Guyana is located within the equatorial trough zone at 5° 00' N and 59° 00'W. It has a total territory of 214,970 square kilometres (km^2) and is bounded by the Atlantic Ocean to the north, Venezuela to the west, Suriname to the east, and Brazil to the west and south. Guyana has a tropical climate, and has experienced significant changes in its climate since the 1960s Climate models indicate that these changes will exacerbate over the forthcoming century[16].

1.1.1 Observed temperature and precipitation trends

Temperatures in Guyana vary geographically with high altitude regions experiencing cooler temperatures than the coastal, lowland and savannah zones. Mean air temperatures in the upland regions and the interior (west) side of the country are between 20°C to 23°C. Mean air temperatures across the rest of the country are from 25°C to 27.5°C, reaching as high as 31°C, due to the stabilizing effect of the sea and the north-easterly trade winds[17],[18]. Appendix 1 provides a visual representation of annual and seasonal mean temperature variation across the country.

Observed climate data shows mean annual temperatures have increased by 0.3°C since the 1960s, corresponding to an average rate of temperature increase of approximately 0.07°C per decade, with the highest changes occurring in the August-September months (~ 0.10°C per decade). This rate of increase is below the global average warming of ~ 0.08°C per decade[19]. The average number of cold days per year has decreased by 37 (10% of days) and the frequency of cold nights has decreased at a similar rate[20].

With respect to precipitation, Guyana's coastal areas are dominated by a 'tropical wet' marine climate where mean annual precipitation is greater than 2000mm/year and which is distinguishable by two wet seasons (from April to July and from November to January) and two dry seasons (from February to April and from July to November). During the second wet season, northern coastal regions receive between 150mm and 300mm of rain per month. However, Guyana's savannah is dominated by a drier 'tropical wet-dry' climate where total precipitation is lower (with a mean of 1400-1800mm/ year) and less well distributed throughout the year. Savannah areas tend to have a shorter wet season and longer and drier dry season[21],[22]. Appendix 1 provides a visual representation of annual and seasonal mean precipitation variation across the country.

In addition to its tropical location, the principal factor influencing Guyana's precipitation patterns is the seasonal shift of the Inter-Tropical Convergence Zone (ITCZ), a cloud and rain-bearing belt of rising air where south-easterly and north-easterly trade winds converge, in turn affecting trade wind direction and rainfall patterns[23]. On an inter-annual and decadal basis, Guyana is also influenced by the effects of the El-Niño Southern Oscillation (ENSO), which is a naturally occurring phenomenon that involves fluctuating ocean temperatures in the equatorial Pacific. During El Niño years, there is a reported weakening of the trade winds and a move to drier conditions; during la Niña years there are stronger than average trade winds and significantly higher precipitation levels[24].

Since the 1960s, observed climate data shows increases in mean annual precipitation, with an average rate of increase across Guyana of 4.8mm per month, equal to 2.7% increase per decade[25]. However, trends in seasonal precipitation are not statistically significant. Where data are available, there is also no evidence of any significant trends in maximum one- or five-day rainfall events[26].

1.1.2 Projected future climate trends

The climate scenarios for Guyana using the outputs from several General Circulation Models (GCMs) indicate that temperatures will increase and that sea level will continue to rise together with the height of storm surges. Ensemble median projections also indicate that average annual precipitation will decrease and that the proportion of heavy rainfall events will increase. There is uncertainty about these values as both positive and negative projections of change are generated when minimum and maximum values are considered. Table 1 provides a summary of the direction and extent of change for the 2030s, 2040s-2070s and 2070s-2100.

Table 1: Summary of climate change scenarios for Guyana. (Source: McSweeney et al., 2010[27], Government of Guyana, 2012[28]).

Climate variable	2030s	2040s – 2070s	2070s – 2100
Average annual temperature[i] (°C)	↑ 0.4°C to 2.0°C	↑ 0.9°C to 3.3°C	↑ 1.4°C to 5.0°C
Average annual precipitation[ii] (% change)	Median: 0% to -4% Min-max: -29% to +14%+	Median: -4% to -8% Min-max: -41% to +13%+	Median: -4% to -5% Min-max: -63% to +20%+
Proportion of total rainfall that falls in heavy events[iii]	No data	Median: ↑ 1-2% Min-max: -3% to +10%+	Median: ↑ 2-3% Min-max: -8% to +12%+
Sea level rise[iv] (m)	↑0.14 m to 0.26 m	↑ 0.21 m to 0.43 m	↑ 0.25 m to 0.51 m
Sea level rise + storm surge[v] (m)	↑ 2.94 m to 5.94 m	No data	↑ 2.93 m to 6.19 m

With respect to geographic variation, the projected rate of warming is similar in all seasons, but more rapid in the southern interior region of the country than in the northern, coastal areas[29]. Reductions in precipitation conversely are projected as greater in the north in the 2030s and 2070s-2100. Appendix 1 provides a visual representation of spatial patterns of projected change in mean annual temperature and precipitation across the country.

Table 2 provides temperature and precipitation projections for Regions Five, Six and Ten for the period between 2040 and 2069 where a model with greater spatial resolution (10 - 50km), the

[i] Results presented are minimum to maximum values across a range of General Circulation Models (GCMs) and scenarios (A2, A1B, B1). Source: McSweeny et al., 2010.

[ii] Results presented are median values as well as minimum to maximum values across a range of General Circulation Models (GCMs) and scenarios (A2, A1B, B1). While the GCMs project a range of changes including increases as well as decreases when maximum and minimum values are considered, ensemble median values of change by the 2060s are consistently negative for all seasons and emissions scenarios. Source: McSweeny et al., 2010.

[iii] A 'heavy' event is defined as a daily rainfall total which exceeds the threshold that is exceeded on 5% of rainy days in current climate of that region and season. This table refers to median annual change in %, as well as minimum and maximum values of change. While the proportion of total rainfall that falls in heavy events does not show a consistent direction of change when minimum and maximum values are considered, it does tend towards positive changes, particularly in the southern parts of the country in the seasons November, December, January and February, March, April. Source: McSweeny et al., 2010.

[iv] Source: Government of Guyana, 2012.

[v] Source: Government of Guyana, 2012.

Statistical DownScaling Model (SDSM), has been applied[vi]. While results are largely consistent with annual average figures at the national level, it is also worth noting that the downscaled projections demonstrate a slight differentiation of impact in different regions. While reduction in average precipitation is projected as between 7% to 8% in Timehri from 2040-2069 for example, reductions in Ebini are projected to be greater from between 8.9% to 9.7%.

Table 2: Changes in mean monthly temperature and precipitation for Timeheri, New Amsterdam and Ebini stations under future climate (2040- 2069)[vii]. (Source: Government of Guyana, 2012[30])

Climate variable	Mean monthly minimum temperature (°C)	Mean monthly maximum temperature (°C)	Mean monthly change in precipitation (%)
Timehri (Region 4)	↑ 1.1°C	↑ 0.7°C to 1.1°C	-7.0% to -8.0%
New Amsterdam (Region 6)	↑ 0.9°C to 1.1°C	↑ 0.5°C to 1.1°C	-7.4% to -8.3%
Ebini (Region 10)	↑ 1.0°C to 1.5°C	↑ 1.0°C to 1.1°C	-8.9% to -9.7%

1.2 Guyana's vulnerability to climate change

Vulnerability is defined by the Intergovernmental Panel on Climate Change (IPCC) as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity"[31]. This is represented diagrammatically in Figure 1.

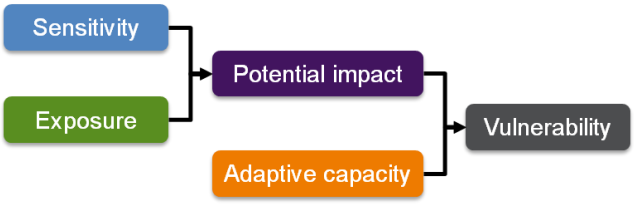


Figure 1: Vulnerability and its core components.

[vi] SDSM was applied to two GCMs (the CGCM1 and HadCM3 models).
[vii] Ranges are presented where the output from SDSM applied to the two GCMs differed, at the request of OCC.

To understand Guyana's vulnerability to and the impacts of climate change, it is necessary to examine the exposure to climate hazards, the sensitivity of assets, instratructure and wider society to these hazards, and the ability to adapt to the changes hazards may cause. It is important to acknowledge that, in many instances, climate drivers act in conjunction with other social, economic and environmental drivers. Indeed, climate change may not always be the primary driver of vulnerability but may act as an additional stressor on systems already affected. This occurs, for example, when improper solid waste disposal practices may lead to a reduction of drainage capacity. The CRSAP examines how climate change impacts interact with Guyana's baseline socio-economic and environmental systems.

1.2.1 Exposure to climate hazards

Guyana is currently exposed to extreme weather events which can be caused by a range of factors including heavy rainfall, sea state and tidal conditions, and inadequate or poorly maintained drainage and sea defence infrastructure. In terms of average annual loss to natural hazards, floods represent by far the greatest threat with United Nations International Strategy for Disaster Reduction (UNISDR) reporting that 99.9% of the expected losses per annum is associated with small, moderate and extreme flood events[32]. Guyana is classified as a high flood risk country, with the greatest vulnerability experienced within the coastal zone[33]. Indeed, especially since 39% of Guyana's population and 43% of its GDP are located on the coastal zone in regions that are exposed to significant flooding risk[34] by virtue of the concentration of the population, economic activities, critical infrastructure (e.g. transport) in these areas.

The IDB Disaster Exposure Index (DEI)[35] identifies Guyana as the fourth most exposed country, 0.60 on a scale of 1.00, in the Latin American and Caribbean region to natural disasters. This is primarily the result of the country's high exposure to and experience of flooding as well as drought. Guyana's DEI score is particularly high given that the country is not significantly exposed to tropical storms, is not on the Caribbean hurricane belt and also has no significant earthquake or volcano risk.

As illustrated in Box 1, in January 2005, an unusual weather system produced the heaviest rainfall on record in Guyana resulting in the most devastating floods in Guyana's history. Box 1 demonstrates the impact on the agricultural sector. However, it is important to note that the social sectors, in particular the housing sector, suffered the largest economic losses and damage. Although a climate disaster of similar magnitude has not since occurred, the Government of Guyana (GoG) has noted with increasing concern that heavy precipitation events are occurring more frequently resulting in flooding and disruptions to the social, productive and infrastructural sectors. Indeed, since 2005 there have been seven extreme rainfall events which resulted in floods in 2006, 2008, 2010, 2011, 2013, 2014 and 2015. The UNISDR estimates that the floods of 2006 and 2008 affected approximately 135,000 people and those of 2006 and 2010 resulted in cumulative economic damage of US$ 183,700,000.

Box 1: Impact of floods on the agriculture sector in Guyana

One of the most significant flood events occurring in recent history was in early 2005. This event is reported to have affected close to 275,000 people (37% of the population) and caused economic damage estimated at US$ 465,000,000 (60% of GDP)[36]. It was caused by a combination of a wetter than average December (2004), which left the ground saturated, followed in January 2005 by some of the heaviest rainfall the country has experienced since records began in 1888[37]. Some areas reported as much as 120-150cm of standing water, which remained for several days. The heavy rainfall also caused an increase in the water levels of the East Demerara Water Conservancy Dam (EDWC), which came close to a critical breaching level (59ft) and could have resulted in the failure of the dam wall[38].

A socio-economic assessment of the damage and loss caused by the 2005 flood revealed major impacts to the agriculture sector, particularly in the regions of West Demerara/Essequibo Islands, Demerara/Mahaica and Mahaica/West Berbice[39]. Region 4 was most severely affected, experiencing close to 55% of the total damage, followed by Regions 2 (23%) and 5 (19%)[40]. Considerable losses were recorded in the sugar, rice, livestock and other crop (fruits, vegetables, roots and tubers, and herbs and spices) subsectors.

However, the hinterland region is also exposed to flood risk. In June 2011, continuous heavy rainfall in region 9 resulted in the worst flooding event since 1973. The two of the most populous areas were the most significantly affected and critical infrastructure such as roads, bridges and electricity plants were damaged and emergency supplies like food and water had to be flown in from Georgetown.

On the other extreme, in 2014-2015, some hinterland areas experienced a prolonged period of drought, which caused significant problems for local communities highly dependent on subsidence agriculture and reliable groundwater supplies. This experience is summarised in Box 2.

Climate change will alter the characteristics of hazards Guyana is exposed to (e.g. average annual rainfall) and the nature of variability (e.g. more intense storms, irregular seasonal rainfall), which will cause associated knock-on consequences for Guyana's socio-economic development objectives. It is estimated that by 2030 Guyana could be exposed to cumulative annual flood-related losses totalling US$150 million and that an extreme event similar to the serious flooding in 2005, which resulted in losses equivalent to 60% of GDP, could result in some US$0.8 billion in losses and harm to more than 320,000 people[41].

Box 2: Impact of droughts in Guyana's hinterland

Following an extended period of dry weather in late 2014 and early 2015, the hinterland was facing drought conditions by April 2015. Region Nine (Upper Takutu-Upper Essequibo) and parts of Region One (Barima-Waini) were particularly affected, resulting in reduction in the agricultural output in the Region, reduction in available water supply and increased dust pollution among other issues .

The lack of rainfall caused decreased water levels in the wells, lakes, ponds, rivers, creeks and other water sources[42], and frequent bush fires, which destroyed several farms at Aranaputa[43]. Local communities experienced limited access to potable water for domestic and agriculture use. Residents were forced to go to local rivers, including the Rupununi River, for untreated water for domestic use, which at the time were flowing at low levels and with higher concentrations of particles[44]. There were reports of an increase in the number of people suffering from vomiting and diarrhoea[45]. The drought conditions were also linked to a resurgence of pests, including acushi ants and caterpillars[46], which attacked the few remaining crops[47]. Dasheens, cassavas, eddoes and cash crops were observed to be particularly severely impacted by the drought[48].

In response, various ministries undertook actions to support local communities to cope with the effects of the dry weather conditions. For instance, the Ministry of Agriculture (MoA) deployed mist blowers and chemicals to various communities to fight the caterpillar and acushi ants' infestations, and provided veterinary assistance and vaccines to address disease outbreaks amongst cattle/livestock[49]. The Ministry of Health (MoH) undertook awareness raising actions, including the distribution of health alert flyers and advisory on water purification, together with supporting efforts to identify and prevent water borne diseases[50].

Forecasters linked the drought to the El Niño weather phenomenon[51], when warmer than usual water stretches across the surface of eastern equatorial Pacific Ocean, about every three to seven years. The warmer water influences climate patterns in many places around the world. In response to the drought, the MoA set up a Special El Niño Working group to monitor and plan actions to reduce any adverse impact of a possible El Niño on agriculture production[52].

In 1998, Guyana experienced another major drought, when a state of emergency was declared because of widespread devastation to agriculture and mining.

1.2.2 Sensitivity of assets, infrastructure and wider society

Guyana's vulnerability to weather- and climate-related impacts is partly a result of inherent characteristics of the country's geography and socio-economic development profile. These factors interact with the climate hazards to which Guyana is exposed and result in a range of climate impacts. They include ageing and inadequately maintained critical infrastructure, limited access to the latest knowledge and technology, and wider poverty and development challenges. Unless addressed, these factors will increase Guyana's sensitivity, and in turn vulnerability, to future climate impacts.

At a national level, one of the main indicators of sensitivity is the currently condition of some of the sea defence infrastructure. Despite significant investments to rehabilitate sections of Guyana's sea defence system, a 2014 survey[viii] showed that 2.28 km (1%) is in critical condition, 20.53km (9%) is poor and 80.22km (34.4%) is in fair condition[53]. Regions 2, 4 and 6 have the weakest points. Under a carbon intensive development pathway, the Intergovernmental Panel on Climate Change has projected that sea levels could rise by almost one metre at the turn of the century. In Guyana, a one metre rise in sea level is projected to increase the risk of inundation across all coastal administrative regions; with regions 4 and 6 having the highest expected exposure[54]. Changes in sea level of this magnitude will cause significant increases in overtopping discharges for sea defences, increased flood volumes and frequency, and enhanced coastal erosion[55]. The rate of shoreline recession will increase in areas not protected by seawalls[56]. These physical impacts will cause a range of knock-on consequences for communities, infrastructure and economic activities located in these areas, which are fully explored in the sector briefing notes (section 4). For example, the rise in informal housing settlements in Guyana, especially within the coastal zone, increases the degree to which socio-economic systems could be affected by climate change[57].

Furthermore, maintenance regimes of the drainage and irrigation infrastructure over the past few decades, due to insufficient financial, technical and human resources, has resulted in much of the system not operating at full capacity, and some sections being inoperable. In early June 2015, several days of heavy rainfall resulted in extensive flooding in Georgetown and surrounding areas[58]. The city's drainage system depends mainly on 13 sluices, of which 10 were fully functional in early June[59]. Six pumps are used to drain water off the land when the sluice gates are closed, but at the time only one of them was functional[60]. Among the measures suggested to prevent flooding in the future are more frequent openings of the kokers, regular cleaning of canals and ensuring that drainage pumps are in working order[61].

In terms of access to the latest knowledge, sectoral best practice and technology, Guyana, like many developing countries, still has a far way to go. For example, in the agricultural sector small scale farmers generally have no or limited access to the finance, technology and technical knowledge on the climate resilience practices thereby restricting their ability to manage the impacts of climate variability and change. This may include integrated pest management and disease control, crop rotation, crops tolerant to saltwater, water logging and drought, for instance. Indeed, amongst the resilience actions identified for the agricultural sector, it is acknowledged that the development and trial of the aforementioned agricultural techniques could be scaled-up.

Guyana is a Lower Middle Income country and the World Bank estimates that 43% of the Guyanese population can be classified as poor[62]. Climate change introduces an additional burden as already scarce resources already are being diverted to measures to build resilience and adapt to climate change. People who live in poverty, like subsistence farmers, wage labourers and pensioners, are the least able to finance measures to adapt to climate change[63].

[viii] The survey covered 91.2% of the total length of sea defence structures.

1.2.3 Adaptive capacity

Potential climate impacts interact with adaptive capacity to determine levels of vulnerability to climate change. Adaptive capacity is defined as the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences[64]. Adaptive capacity is a precondition for the design and implementation of effective adaptation strategies[65] and in turn for national adaptation planning and resilience building[66]. There are a broad range of approaches to assessing adaptive capacity[67] and measures and indicators used vary according to circumstances[68].

The current status of Guyana's adaptive capacity can be described according to five broad criteria established by the IPCC, namely: informational, human, institutional, financial capacity and the policy/regulatory environment. In conjunction with these criteria, the CRSAP has used the seven measures of success for national adaptation planning that have been posited by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) to assess Guyana's adaptive capacity. The GIZ's seven success factors are: climate information, human and institutional capacities, long term vision and mandate, implementation, mainstreaming, participation, and monitoring and evaluation. The measures deployed by GIZ have been used as they are particularly focussed on capacity for national adaptation planning and are informed by the latest guidance on how to prepare and implement effective National Adaptation Plans (NAPs) including the Technical Guidelines for the NAP Process prepared by the Least Developed Countries Expert Group under the UNFCCC.

Information on Guyana's adaptive capacity has been generated by outputs from the academic literature, email engagements and national workshops which involved expert stakeholders assessing capacity at the national and sectoral level[ix].

Overall, Guyana can be considered in the early stages of development in terms of building adaptive capacity to address climate variability and change.

1.2.3.1 Informational capacity

Making informed decisions about adaptation actions and reducing vulnerability depends largely on the availability of climate data and information; vulnerability, impact and risk assessments; and information on the costs and benefits of adaptation measures. Additionally, effective use of these data and information is partly dependent on functioning monitoring and evaluation systems[69].

Climate vulnerability and risk assessments have been generated for a subset of sectors and regions by a range of public and non-governmental entities. Currently, there is no institution responsible for generating/collating and providing climate projections and a comprehensive suite of vulnerability, risk and adaptation assessments to end-users. Due to resource constraints, such assessments are conducted when only when Guyana prepares its National Communications to the UNFCCC. In spite of these challenges, the Hydrometeorological Service monitors, collates and archives meteorological and climate, and provides weather services to support food production and food security[70].

[ix] Detailed results from the two workshops, the Stocktaking for National Adaptation Planning (SNAP) workshop and Vulnerability, Risk and Resilience (VRR) workshop, are available in Annexes B and C, respectively.

Additionally, in order to enhance informational capacity monitoring and evaluation systems have to be strengthened to capture differential impacts on and responses by men and women[71]. Limited resources also constrain the establishment of effective monitoring and evaluation systems.

Resilience building actions aimed at enhancing informational capacity in presented in Section 4 for each sector in its respective 'Sectoral Briefing Note'.

1.2.3.2 Human capacity

Human capacity, in the form of trained and skilled personnel is required to implement adaptation actions[72],[73]. The GoG's Second National Communication to the UNFCCC notes that Guyana has limited human resources and technical capacity for climate change management, specifically to:

- Undertake and interpret regional climate change projections.
- Conduct research on the vulnerability of key sectors and regions to the impacts of climate change.
- Implement and maintain the technologies and equipment necessary to monitor climate and climate-related impacts.
- Develop technologies, such as sea defences, irrigation systems and early warning systems, which are critical to successful adaptation[74].

Sectoral experts participating in the SNAP workshop expressed that there is technical knowledge on adaptation to climate change in both government and non-government institutions (with stronger capacity in non-governmental institutions), but that it is generally inadequate for Guyana's needs and should be strengthened. Workshop participants indicated that likely reasons for low capacity are the human capacity drain from Guyana and high rate of staff turnover in organisations, particularly governmental organisations[75].

Resilience building actions aimed at enhancing human capacity in presented in Section 4 for each sector in its respective 'Sectoral Briefing Note'.

1.2.3.3 Institutional capacity

In Guyana, there are several government organisations and committees that have an official mandate related to climate change management and these are identified in **Error! Not a valid bookmark self-reference.**. Three of these agencies were established to implement the LCDS, namely: the Office of Climate Change (OCC), the Project Management Office (PMO) and the REDD Secretariat (within the Guyana Forestry Commission). Other governmental as well as non-governmental organisations also have climate-related mandates; however these may not be their primary function.[x]. However, it should be recognised that the successful deployment of the CRSAP will require broad-based institutional action.

Indeed, in terms of the role of institutions in mainstreaming climate change into national policy, plans, programmes, projects, budgets and decision-making processes, the National Capacity Self-Assessment (NCSA) indicated that mainstreaming of climate change into national and sectoral

[x] In order to provide an exhaustive list, a thorough institutional review would need to be undertaken.

policies, programmes and projects was a capacity gap. This remains a gap, and the Second National Communication recommended better harmonization of policies to account for adaptation without overlaps[76]. Stakeholders also indicated that improvements in mainstreaming climate change adaptation are necessary. Stakeholder participation in adaptation planning through institutional and governance structures should also be improved including with greater emphasis on gender responsiveness.

Table 3: State organisations/ committees and their climate-related mandates

Organisation/ committee	Climate-related mandate
LCDS Project Management Office (PMO) (within the Ministry of the Presidency)	The PMO is the GoG body responsible for managing the development and oversight the implementation of all projects funded by the Guyana REDD+ Investment Fund (GRIF).
Office of Climate Change (OCC) (within Ministry of the Presidency)	The OCC was established to support work on climate change adaptation, mitigation and forest conservation and has the overall responsibility for coordinating and aligning the efforts of various government agencies around the issue of climate change. The OCC is the UNFCCC National Focal Point and also serves as the secretariat to the MSSC.
Guyana Forestry Commission (GFC) and REDD Secretariat (RS)	The GFC and the RS oversees the national implementation of all Reduced Emissions for Deforestation and Degradation Plus (REDD+), readiness activities under the Forest Carbon Partnership Facility, and. the development of a monitoring, reporting and verification system (MRVS).
The Multi-Stakeholder Steering Committee (MSSC)	The MSSC supports the implementation of Guyana's LCDS and provides guidance and strategic direction for stakeholder engagement. The Committee is comprised of representatives from the government, indigenous NGOs, the private sector, labour, forestry, mining, youth, women, academia, NGOs and civil society.
Hydrometerological Service (Hydromet), Ministry of Agriculture	Hydromet is responsible for observing, archiving and understanding Guyana's weather and climate. It provides meteorological, hydrological, and oceanographic services in support of Guyana's national needs and international obligations.
Environmental Protection Agency (EPA) (within the Ministry of the Presidency)	The EPA is the GoG agency responsible for overseeing the effective management, conservation, protection and improvement of the environment.
Civil Defence Commission (CDC)	The CDC has the responsibility for coordinating and monitoring disaster risk management and comprehensive disaster management in Guyana. It effectively responded to the impacts of climate change events including the major floods of 2005 and 2013, and droughts of 2010 and 2015 among others.

Resilience building actions aimed at enhancing institutional capacity in presented in Section 4 for each sector in its respective 'Sectoral Briefing Note'.

1.2.3.4 Financial capacity

Economic resources, or finance, is a key determinant of adaptive capacity and an enabling factor for implementation of adaptation measures[77],[78]. Separate from the national budget, the main source of climate finance in Guyana has been via its Memorandum of Understanding (MOU) with the Kingdom of Norway through which Norway pledged to provide eq. US$ 255.5 million between 2010 and 2015[79] to help deliver 'low carbon, low deforestation, climate resilient development' in Guyana. Guyana has also received grant and loan based funding, though a relatively small amount in comparison to other Caribbean countries[80].

In its Intended Nationally Determined Contribution (INDC), the GoG indicated that given its limited resources, Guyana will continue basic work on water management infrastructure; sea defences rehabilitation; improving water supply and sanitation; introduction of new agricultural techniques such as hydroponics and fertigation; and the inclusion of climate change considerations in sectoral planning documents. Nonetheless, it noted that significant resources will be required to build resilience in Guyana including through the implementation of the CRSAP. It was estimated that Guyana will require up to US$ 1.6 billion in the period to 2025 for adaptation and resilience building. The Financing Strategy, presented in Section 3, is intended to chart the course for accessing the financing Guyana needs to adapt and build resilience to climate change.

Resilience building actions aimed at enhancing financial capacity in presented in Section 4 for each sector in its respective 'Sectoral Briefing Note'.

1.2.3.5 Policy/ regulatory environment

Guyana's long-term vision for a green and climate resilient economy is guided by the LCDS. Significant strides have been made in the policy and regulatory environments of the most vulnerable sectors. For example, the National Strategy for Agriculture in Guyana 2013 – 2020, outlines plans for enhancing climate change management including through a disaster risk reduction programme. Further, the National Adaptation Strategy to address Climate Change in the Agriculture Sector outlined specific actions to reduce sectoral vulnerability and mainstream climate considerations into agricultural policy and practice.

Climate change was one of the key rationales in the development of the National Land Use Plan including considerations of the viability of long-term settlement on the coast and the consideration of climate change impacts in zoning areas for development. Moreover, the Sea and River Defences Policy includes strategic direction on sea defence goals including goals for climate resilience. The key climate related strategies, policies and plans are presented in Table 5. Stakeholders have indicated that although the policy and regulatory environment are in place, the long term vision is not fully appreciated by some organisations and the wider public. In this context, the GoG's commitment to undertake a nationally inclusive approach based on transparency, meaningful stakeholder involvement has the potential to bridge this gap.

Table 4: Key Climate Related Strategies, Policies and Plans

Title	Year	Executing organisation	Description
Low Carbon Development Strategy (LCDS)	2009/2013 update	Office of the President	The LCDS fosters low carbon and climate resilient development. The Strategy highlighted the importance of adaptation and building resilience identified thematic priorities such upgrading infrastructure to protect against flooding, hinterland adaptation, among others.
Integrated Disaster Risk Management Plan	2013-2023	Civil Defence Commission	The NIDRMP focuses on risk identification, prevention, financial protection and risk transfer, preparedness and recovery. Links to climate change are articulated.
National Adaptation Strategy for the Agricultural Sector	2009-2018	Ministry of Agriculture	The goal of this strategy is to more effectively reduce the risks posed by climate change and position the agricultural sector to adapt. Among its objectives is to build resilience and adaptive capacity within the sector.
Initial National Communication (INC)	2002	Office of the President	Guyana is required to submit national reports to the UNFCCC on its efforts to implement the Convention and address climate change. The SNC built on the INC and addresses the 'National Circumstances' of the country and a 'Vulnerability and Adaptation Assessment'.
Second National Communication (SNC)	2012	Ministry of Agriculture	
Climate Change Action Plan	2001	Office of the President;	A supplement to the INC, this action plan identifies adaptation as one of nine programme areas. It links the climate change to the national development agenda.
Climate Change Adaptation Policy and Implementation Plan	2001	National Ozone Action Unit/ Hydromet	It complements the INC and Guyana Climate Change Action Plan with a more detailed focus on coastal low-lands.

1.3 Current actions to build climate resilience

In light of Guyana's vulnerability, GoG has already started to take action to build resilience to change impacts and to enhance capacities to adapt to current and project future climate impacts. Indeed, GoG is committed to a green economy to sustain economic prosperity, environmental security and social well-being. The meaningful efforts to create an institutional and policy framework for promoting climate resilience has been discussed (Section 1.2.3). In addition to these efforts, Guyana has begun to implement measures to build climate resilience.

The Mangrove Restoration Project aimed to bolster sea defences against rising sea levels is one such example. There have also been interventions to enhance sea defences to address adverse climate change impacts are currently on-going, which include securing bilateral technical and financial support for adapting local infrastructure to climate change; loans to upgrade infrastructure to, inter alia, better cope with climate impacts.

Significant efforts have also been made in managing the risks of flooding by upgrading critical sections of water management infrastructure such as the East Demerara Water Conservancy (EDWC), and strengthening institutional capacities for hydraulic and hydrological modelling and data management. Table 36 presents these national-scale programmes and projects on climate resilience to date.

In addition to action at the national level, Guyana is also involved in climate change at the international level through the UNFCCC. Guyana ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Since that time, two National Communications have been prepared and submitted to the Convention. These National Communications, among other things, highlight Guyana's particular vulnerability to climate change as well as the efforts to plan adaptation and build resilience to climate change. Guyana has cemented its commitment to global climate action by ratifying the Kyoto Protocol in 2003 and the Doha Amendment to the Protocol in 2014, and by submitting its Intended Nationally Determined Contribution to the UNFCCC in 2015. Further, Guyana ratified the United Nations Convention on Biological Diversity in 1994 and the United Nations Convention to Combat Desertification in 1997.

At the regional level, the Guyana is also signatory to the CARICOM Liliendaal Declaration (July 2009), the Regional Framework for Achieving Development Resilient to Climate Change (July 2009)[81] and its Implementation Plan (March 2012)[82]. These three foundation documents set out the Caribbean Community's (CARICOM's) response to climate change and provide helpful guidance on the impacts Caribbean countries face and the policies, strategies and actions they need to consider. The Implementation Plan adopts the 'three-ones' approach to sustainable resource mobilisation and co-ordination of actions in the context of climate change:

- 'One Plan' that provides the framework for co-ordinated action on climate change by all partners. ('One Plan' means one agreed set of shared and common goals and objectives);
- 'One Co-ordinating Mechanism' to manage the process; and
- 'One Monitoring and Evaluation (M&E) Framework'.

The 'three-ones' is promoted at regional and national level and provides a useful structure for Guyana's CRSAP approach.

Table 3: Climate resilience policies, plans, programmes and projects

Title	Year	Executing organisation	Description
Cunha Canal Rehabilitation Project	Currently in appraisal stage	World Bank *(Funder: GRIF).*	This project (proposed in the LCDS) aims to increase the capacity of the Cunha Canal to drain the East Demerara Water Conservancy (EDWC) and local agricultural areas in this territory, reducing vulnerability to climate change.
Climate risk adaptation and insurance in the Caribbean (Belize, Grenada, Guyana, Jamaica, Saint Lucia)	2012-2014	Munich Climate Insurance Initiative (MCII). *(Funder: German International Climate Initiative).*	This project developed solutions for managing weather-related risks such heavy rainfall and flood and supported the development and launch of public safety networks and public-private insurance schemes for vulnerable population groups. This project contributes to the delivery of the LCDS priority of 'developing innovative financial risk management and insurance measures to resiliency'.
Sustainable coastal zone protection through mangrove management	2009-2014	National Agriculture Research and Extension Institute (NAREI), Ministry of Agriculture. *(Funder: European Union (EU) Global Climate Change Alliance).*	This initiative was focussed on restoring and planting new mangrove forests to contribute to carbon sequestration, forest preservation and adaptation through the strengthening of natural sea defences and supporting coastal zone biodiversity. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Conservancy Adaptation Project (CAP)	2007-2013	Ministry of Agriculture; the World Bank. *(Funder: Global Environment Facility (GEF), Special Climate Change Fund (SCCF)).*	This project aimed to reduce the vulnerability of catastrophic flooding in the low-lying coastal area that is currently threatened by sea level rise. It was developed to guide a comprehensive upgrading program of the EDWC and lowland drainage system, aimed at increasing discharge capacity and improving water level management. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against

Title	Year	Executing organisation	Description
			flooding through urgent near-term measures'.
Project for the Rehabilitation of the East Demerara Water Conservancy I(EDWC)	2011	*Funder: Japan International Cooperation Agency (JICA)*	Phase I aimed to facilitate the procurement of equipment for the rehabilitation of banks in order to improve flood control capacity of the EDWC. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Project for the Rehabilitation of the EDWC II	2011	*Funder: Japan International Cooperation Agency (JICA)*	Phase II of the rehabilitation of EDWC project was focussed on four intake structures: Ann's Grove, Hope, Annandale and Nancy, and two relief sluices: Maduni and Sarah Johanna. This project contributes to the delivery of the LCDS priority of 'upgrading infrastructure and assets to protect against flooding through urgent near-term measures'.
Mainstreaming Adaptation to Climate Change (MACC): Caribbean Community	2003-2009	CCCCC, CARICOM, World Bank, Government of Canada, GEF, Government of US. *(Funder: GEF Trust Fund).*	The objective of the MACC project was to facilitate an enabling environment for climate change adaptation in the Caribbean Community small islands and coastal developing states participating in this effort. In Guyana, among other things, a vulnerability and adaptation assessment was conducted in the agricultural sector, and an adaptation strategy was elaborated for this sector (see National Adaptation Strategy to Address Climate Change in the Agricultural Sector above). This project contributes to the delivery of the LCDS priority of 'switching to flood resistant crops'.

2 Methodology

2.1 Overview

The CRSAP has been developed using a methodology based on international best practice, consistent with the UNFCCC Least Developed Country Expert Group guidance document, 'National adaptation plans: Technical guidelines for the national adaptation plan process'[83], whilst remaining unique and pragmatic to the specific needs and situation in Guyana.

A twin-track process has been used to develop Guyana's CRSAP as set out in **Error! Reference source not found.**. This was undertaken recognising that although the next five years require significant commitment to build adaptive capacity, create a robust evidence base and fill knowledge gaps; the CRSAP should also create early-start programmes and projects which could be moved to implementation as soon as possible.

- **Track 1** has focused on the development of a set of early-start fundable, costed and evidence-based climate resilience projects. The projects have been designed for sectors where there is an existing evidence base which is robust and includes supporting appraisal documentation, allowing project concepts to be developed and assessed by bilateral and multi-lateral partners/funds.
- **Track 2** has focused on gathering the evidence on climate vulnerabilities, impacts and risks and their associated uncertainties. Recognising that Guyana needs to continue building resilience to climate change across its national development planning themes, the second track ensures that the CRSAP covers all key sectors, uses the best available information on vulnerabilities, impacts and risks and develops a programme of actions to provide the detailed evidence required to design new interventions.

Each component within the two tracks (red arrows in **Error! Reference source not found.**) contains a number of tasks and activities, which are described in more detail in sections 2.2 and 2.3, and associated Annex A. Across all the components, there are a number of common, overarching elements:

- **Stocktaking and literature review**: The CRSAP builds on existing available data, information and practice and has involved extensive stocktaking and literature review of relevant policies and strategies, peer-reviewed academic and grey literature. This ensures that the latest information is incorporated within the CRSAP and opportunities to maximise synergies with existing and/or on-going regional and national initiatives are fully exploited.
- **Stakeholder engagement and consultation**: Engaging stakeholders at both the national and sub national levels adds great value to the process of developing the CRSAP, because it ensures that the final plan responds to stakeholder needs and can be supported by those implementing and affected by it. Through a series of 1-to-1 and small focus group meetings, workshops and email/telephone correspondence, stakeholders' views have been shared and integrated into the CRSAP. The CRSAP has also been presented to a wide audience in a workshop setting, before and after final drafting. The full list of engagement events is presented in section 2.4.

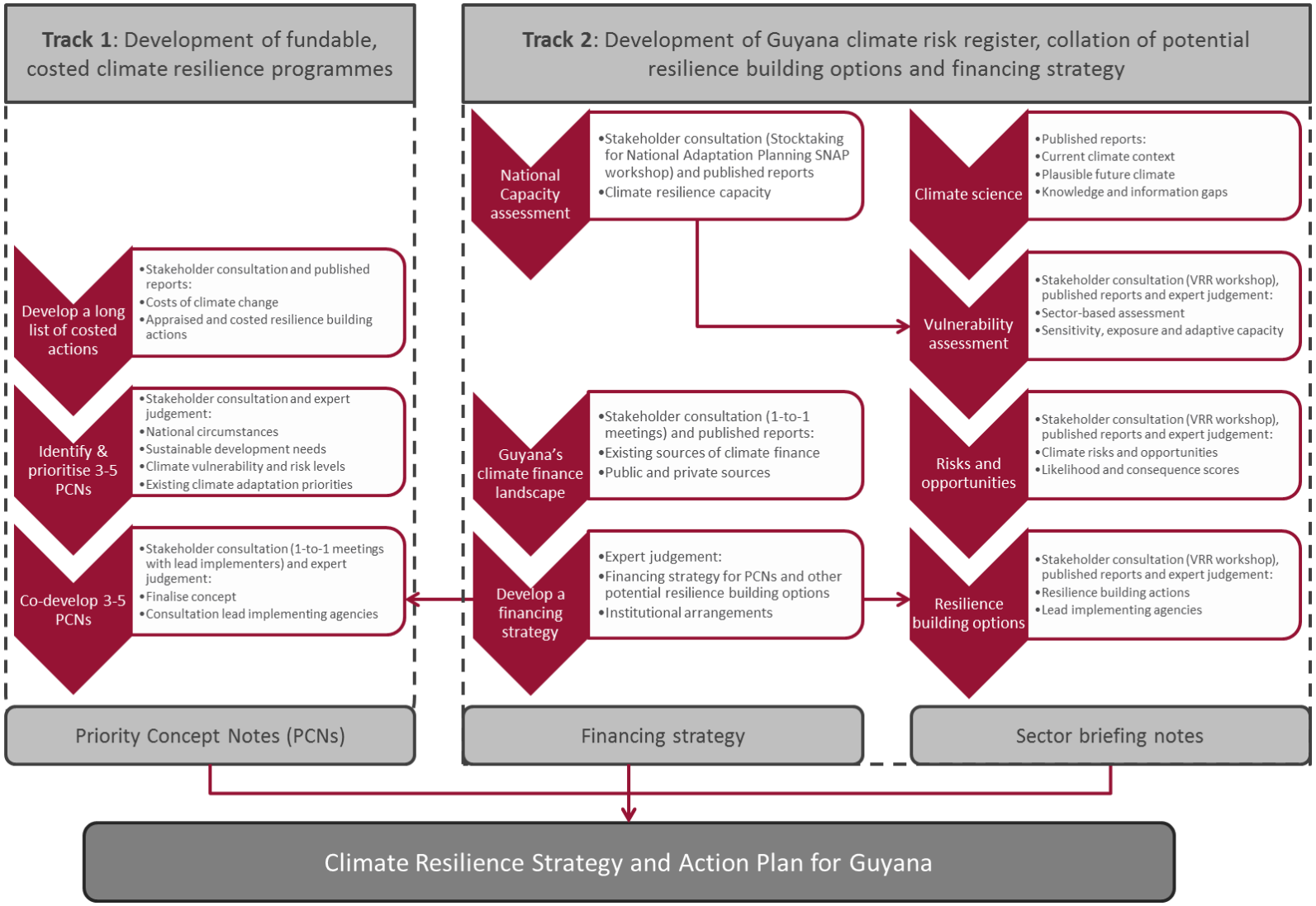


Figure 2: Overview of the methodology used to develop Guyana's CRSAP.

2.2 Track One: Development of fundable, costed climate resilience projects

The GoG requested the preparation of costed Project Concept Notes (PCNs) for priority climate resilience investments in Guyana. The objective of the PCNs is to deliver early-start bankable projects for discussion with potential funding bodies. They are intended to move forward, in the shortest possible time, projects which already have information on costs, and which are aligned with Guyana's priorities. Priority investments were identified as those which build on past and/or on-going climate-related projects, are grounded in Guyana's sustainable development needs and national circumstances, and those which respond to identified climate vulnerabilities and risks and existing climate change priorities.

The following three-tiered approach was applied to identify and develop Guyana's PCNs:

- Identification of a long list of PCNs based on where information on cost was available.
- Prioritisation and ranking of PCNs using three prioritisation criteria, as follows:
  - Supporting the continuity of past and/or on-going climate related projects.
  - Sustainable development needs and national circumstances.
  - Climate vulnerability and risk levels, and existing climate change priorities.
- Development of the four highest ranking PCNs.

This approach is described in more detail in Annex A.

2.3 Track Two: Development of Guyana climate risk register, collation of potential climate resilience options and financing strategy

Under this track, climate vulnerabilities and risks facing Guyana were assessed using existing published information, and climate resilience actions were identified across economic and social sectors, and at national, sub-national and local levels wherever possible.

The approach taken was tiered and utilised the following components:

- **Vulnerability assessment** – reviewing available published literature and holding discussions with stakeholders to identify the sectors most vulnerable to current climate variability and future climate change, in terms of sensitivity, exposure and adaptive capacity.
- **Capacity assessment** – collating information on climate resilience capacity in Guyana, utilising the Stocktaking for National Adaptation Planning (SNAP) methodology.
- **Risk assessment** – drilling down into specific climate-related risks and opportunities that the most vulnerable sectors face and assigning likelihood and consequence scores based on published information and discussions with stakeholders.
- **Action identification** – taking the highest risks and opportunities identified, and proposing possible climate resilience actions.

This approach is described in more detail in Annex A.

Under this track, potential sources of funding were also identified to finance the CRSAP. The approach taken followed two key steps:

- **Mapping out existing and new sources of climate finance.** This involved undertaking a review of sources of funding already accessed by Guyana (including public and private sources) and of new sources of funding not accessed yet. The review covered information publically available through existing clearing houses and websites on climate-related finance, published reports and stakeholder consultation (via email and one-to-one meetings).
- **Developing a financing strategy.** Based on the review undertaken, concrete and actionable recommendations were provided for financing the implementation of the PCNs and other resilience building actions. With regards to the PCNs, specific sources of funding that have already been accessed for similar initiatives were identified during the one-to-one meetings with lead implementers. In addition, potential new sources that could be explored to supplement existing sources were also recommended based on the review undertaken above.

It should be noted that the focus of this review was on sources of finance that Guyana is eligible for and that directly support adaptation and climate resilience programmes or projects (i.e. excluding funds that only finance climate change mitigation or REDD+ activities). For each of these funds, details have been provided on the fund's operating entity, mandate, type of finance provided, eligible organisations, eligible programmes/projects, proposal evaluation criteria, application procedures, ease of access, funding limit for individual projects and website link.

Ease of access was assessed based on the complexity and time requirements of the application process, and scored using expert judgement and understanding of the funding application process of the relevant funds. In assessing the ease of access for each fund, three possible answers were available: Easy to access (defined as single-stage proposal process, generally going straight to full proposal development); Complex (long lasting application process); and, Very complex (defined as multi-stage proposal process, including two review stages for a concept note and full proposal with budget and timeframe).

2.4 Participatory stakeholder engagement and review

Table 4 provides a summary of each stage of stakeholder engagement utilised in CRSAP development and a description of stakeholders engaged

Table 4: Stakeholder engagement utilised in CRSAP development.

Stakeholder engagement	Stakeholders engaged
Inception focus group meetings	OCC; PMO; the Low Carbon Development Strategy (LCDS) Multi Stakeholder Steering Committee; representatives from government, civil society, academia, NGOs and the private sector.

Stakeholder engagement	Stakeholders engaged
SNAP workshop	51 state and non-state representatives of sectors in which climate change impacts are direct and present, sectors which are more indirectly affected and which are important 'decision-making' hotspots, and representatives of coastal and hinterland populations were invited. The workshop report is presented in Annex B.
Email and telephone engagement	>140 representatives from government, civil society, academia, NGOs and the private sector were engaged.
Vulnerability, Risk and Resilience (VRR) workshop	67 representatives from key sectors across Guyana, state and non-state actors, national and sub-national decision makers, a range of regions and representing a variety of demographics were invited. The workshop report is presented in Annex C.
Policy shapers meetings	Senior policy makers, including Ministers, Permanent Secretaries and Directors of 10 key state and non-state actors were engaged in one to one meetings.
Final CRSAP workshop	To be completed following the Workshop in December 2015.
Periodic one-to-one meetings throughout life of project	Representatives from government, civil society, academia, NGOs and the private sector.

3 Climate resilience strategy

The Strategy's vision is to create a green, climate resilient economy, society and environment aligned with 'Vision 2020' Guyana still requires an overarching framework for planning and implementing climate resilience actions so as to achieve this vision. The Strategy addresses this gap and provides:

- A roadmap for the next five years.
- Costed Project Concept Notes for a first set of four priority climate resilience programmes which can now be developed into full proposals and submitted for funding.
- A summary of the most significant climate risks and required resilience actions across 15 key sectors. These actions are proposed as the basis for the design of new interventions and a pipeline of projects which can be presented for funding and implemented within five years and beyond.
- A set of capacity building actions that enhance Guyana's capacity for national adaptation planning and becoming climate resilient to be undertaken within the next five years.
- A strategy to finance the CRSAP.

The strategy is underpinned by the five pillars of adaptation set out in the Second National Communication (2012)[84], namely:

- Pillar 1: Information, research and systematic observation in order to reduce uncertainty regarding sectoral and territorial vulnerability, and to provide information for accurate decision-making and Early Warning Systems.
- Pillar 2: Institutional framework and capacity building, education and awareness for building human and technical resources and increased social awareness to address the impacts of climate change.
- Pillar 3: Policy, legal framework and tools to integrate climate change adaptation into development planning.
- Pillar 4: Generation and application of physical / engineering-based technologies, both for knowledge management and for building infrastructure and service design, including and articulating knowledge and practices from different social groups. It is noted that this pillar covers the types of action that are often referred to as physical/structural, including engineered/ built environment options, technological options, ecosystem-based options and service delivery.
- Pillar 5: Use of financing instruments for the implementation of adaptation measures, and to expand/adjust mechanisms and platforms, including international cooperation and funding, and investments from the private sector and public budget.

The various components of the strategy, the PCNs, sectoral actions and enabling actions are organised according to these pillars to facilitate understanding and cross sectoral collaboration.

3.1 CRSAP roadmap

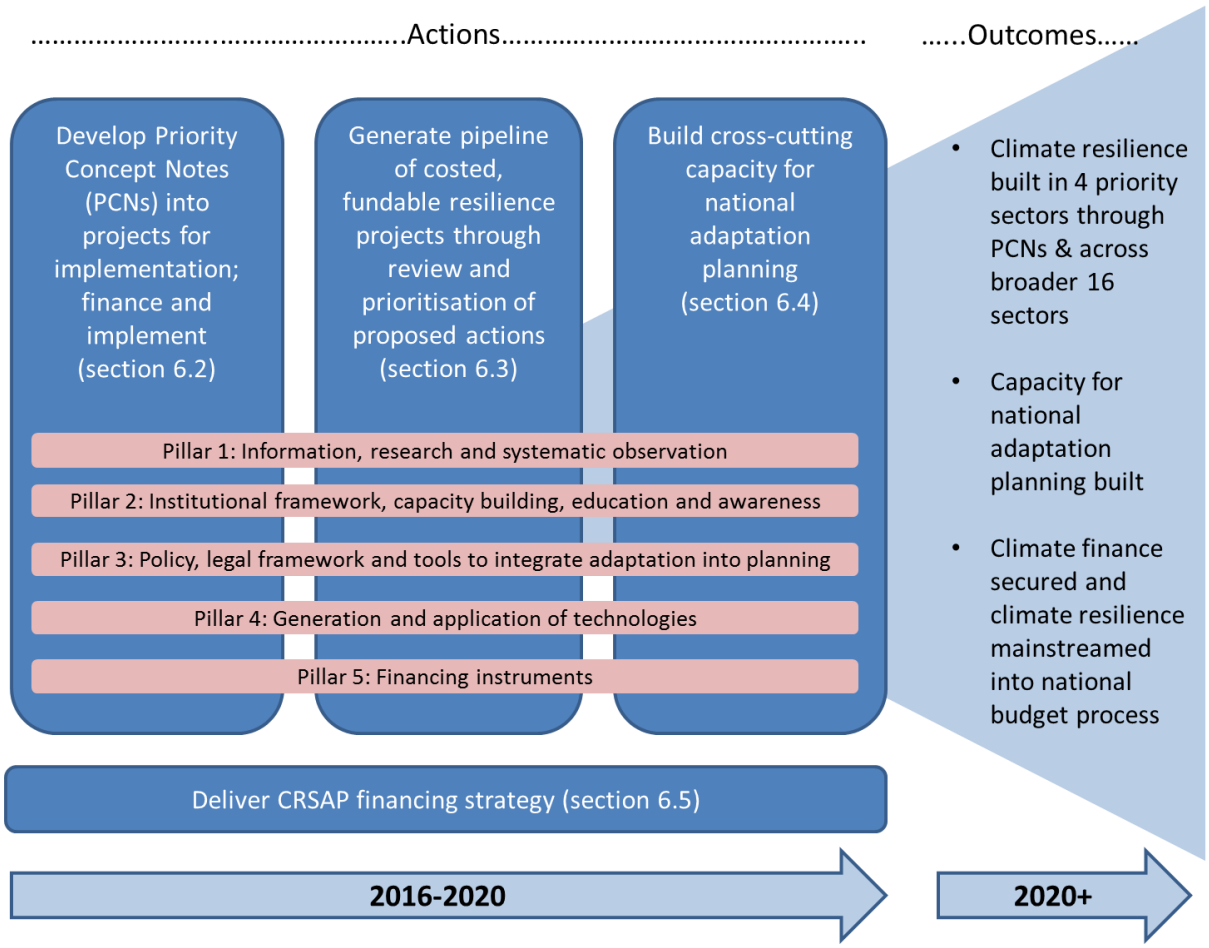


Figure 3: CRSAP roadmap

The Roadmap identifies the key strategic actions that need to be taken to deliver the CRSAP and increase Guyana's resilience. Delivery of the CRSAP should focus on the next five years (2016-2020) and should then involve a review and iteration process in 2020 before commencing on delivery of the subsequent five year period. This approach is largely synchronised with the newly commenced government term and national planning cycle (2015-2019). Action in the near-term should follow the 'adaptive management approach' and be based the best data and information on climate science, sectors with the greatest vulnerability, and 'low-hanging' resilience currently available. Moving forward in this way allows Guyana with the opportunity to take stock and adjust to emerging information. The roadmap therefore recognises that building climate resilience is a journey that requires cycles of action, reflection and iteration as lessons are learnt about effective implementation and resource allocation. As noted in the UNFCCC technical guidelines for the NAP process, a national adaptation or climate resilience plan should be 'a living document… revised on a regular basis to incorporate new knowledge and experience, and to take into account changing national development priorities' (UNFCCC, 2012, p81)[85].

At the end of the first CRSAP period, implementation of the roadmap is expected to achieve the following tangible outcomes:

- Climate resilience built in four priority sectors (agriculture, health, sea defence, drainage and irrigation) as implementation of the priority PCNs commences. Lead implementers and potential sources of finance were identified during CRSAP stakeholder engagement sessions.
- Climate resilience built across Guyana's 15 sectors as mainstreaming efforts are scaled-up and are guided by the sectoral briefing notes.
- Capacity for national adaptation planning enhanced as a result of implementing capacity building actions under five pillar themes.
- Climate finance secured and climate resilience mainstreamed into national budgeting process.

In order to facilitate the delivery of the CRSAP, the GoG should mandate an institution to coordinate the CRSAP implementation and monitor its delivery against the roadmap. Given the linkages between sectors, it is important to ensure that the efforts of various agencies are aligned around the implementation of the CRSAP. This should not be limited to agencies with strict climate related mandates. For example, it would be particularly important to include the Ministry of Foreign Affairs as this entity has a pivotal role in accessing resources to support implementation. One of the challenges such an institution would be to ensure that it does not add to the existing capacity burdens. In this context, it is recommended that existing organisations are considered to perform the function of the CRSAP coordination unit with the support of cross-sectoral committees.

3.2 Priority Concept Notes (PCNs)

The implementation of PCNs is a key objective of the CRSAP. As described in section 2, Track 1 of the CRSAP development involved preparing a first set of early-start fundable, costed and evidence-based climate resilience programmes/ projects for sectors.

Below is a brief description of each of the four PCNs that were selected and developed in discussion with OCC and stakeholders:

- **'Building Climate Resilient Agricultural Systems'**, by improving water management, developing climate proof sustainable farm systems and building the adaptive capacity of the sector to reduce the vulnerability of farmers (in particular small to medium scale).
- '**Guyana's Sea Defence Enhancement and Maintenance'**, through coordinated and complementary actions of mangrove development and restoration and rebuilding the most critical sea and river defences in low-lying coastal areas. This will help increase the coverage of and strengthen the existing sea defence against high tide, which in turn will reduce flood risk in coastal communities.
- **'Public Health Adaptation to Climate Change'**, through strengthened national disaster risk management (with specific reference to health) and early warning response systems, enhanced access by communities to clean water and sanitation facilities and food hygiene, reduced impacts of water-borne diseases, increased human and physical sectoral capacity and increased public awareness.

- **'Strengthening Drainage and Irrigation Systems'**, by improving the capacity of the network starting with the most critical areas, upgrading the existing drainage and irrigation system with a focus on the agriculture sector, institutional strengthening of the National Drainage and Irrigation Authority (NDIA) and development of a training curriculum on drainage and irrigation.

Each PCN addresses all five pillars of adaptation described in the introduction to section 3, reflecting the programmatic and comprehensive nature of the PCNs. It is noted that there is a particularly strong link between the sea defence enhancement and maintenance PCN and the strengthening of drainage and irrigation systems PCN. As such, these should be closely coordinated. The pipeline of four PCNs can be used as the basis for the preparation of full funding applications (drawing on the financing strategy in section 3.5) to interested donors or selected funds. Finalisation of funding sources should be done on the basis of using the most readily available sources and those consistent with the national government budget, which in turn will facilitate the identification of counterpart resources which are often a feature of development partner requirements.

Table 5: Overview of PCNs, lead implementers, proposed locations, indicative project timeframes and costs (USD$).

Title	Building Climate Resilient Agricultural Systems	Guyana's Sea Defence Enhancement and Maintenance	Public Health Adaptation to Climate Change	Strengthening Drainage and Irrigation Systems
Potential locations	Interior zone (Regions 8 and 9) and coastal zone (Regions 5 and 6)	East Bank Berbice from Logsdale, Brothers, Sisters and up to Mara-Region 6	Interior zone (Regions 1, 7 and 9) and coastal zone (Region 6)	Georgetown and the immediate surrounding parts of the Demerara Coast
Lead implementer[xi]	MoA	WSG, MoPI	MoPH	NDIA, MoA
Indicative project duration and timeframe	2015- 2020	2015- 2020	2015- 2018	2015- 2020
Indicative project costs	US$13.48-14.18 million (adj.)	US$41.96-46.29 million (adj.)	US$17.35-18.60 million (adj.)	US$31.55-33.23 million (adj.)

[xi] A series of implementation partners have been identified for each PCN (presented in full in section 4). As such, they will not be implemented in isolation and will benefit from the expertise and views of a range of stakeholders. This will be particularly important in coordinating actions on sea defence and on drainage and irrigation.

Table 5 provides information on PCN lead implementers, proposed PCN locations[xii] and their indicative timeframe and costs (US$). The total investment needed to finance all four is estimated at US$104.34 - 112.30 million (adjusted for inflation) based on the appraisal work already undertaken (this figure may change once fully designed and costed projects are prepared). The PCNs are presented in the 'Action Plan' in section 4. These four PCNs represent an important first step in implementing the CRSAP, as they relate to four sectors particularly exposed to 'serious' and 'high' climate risks and address these risks (see Section 3.3). However, the effective implementation of the PCNs will be contingent on delivering enabling actions identified in the roadmap and in section **Error! Reference source not found.**, and securing necessary financial resources.

3.3 Climate risk and resilience

As described in section 2, Track 2 of the CRSAP development involved gathering the latest and most robust evidence on climate vulnerabilities, impacts and risks across Guyana's main sectors and developing a programme of actions per sector to provide the baseline for the design of new interventions.

This section of the climate resilience strategy presents a high-level summary of the climate change risk assessment (section 3.3.1) and the associated action areas (section 3.3.2) for each of the 15 sectors included in this assessment[xiii]. It provides an overview of the most serious risks (i.e. higher likelihood of occurring and severity of consequence) and the key resilience themes to focus on in the short term, as identified by stakeholders and in the literature. Demonstrating a well-informed and robust link between climate risks and resilience actions is key when assessing the priority areas for funding and implementation going forward.

Table 6 and Table 7 provide a summary of the highest magnitude risks identified for each sector and associated resilience objectives, respectively. Risks are described in terms of their magnitude, which results from a combination of the likelihood of occurrence and severity of consequence. Table 6 should be read in conjunction with the risk matrix in Figure in order to understand the scale of risk magnitude (Serious, High, Medium and Low). In support of the high-level summary of climate risks and resilience themes presented here, the detailed findings of the climate change vulnerability and risk assessment and identification of resilience actions are provided in a series of sectoral briefing notes presented in section 4 (Action Plan).

In order to ensure actions are implemented, sectoral representatives will be required to review the full list of actions for their sector and agree on those that should be delivered first. In line with latest thinking about robust decision-making to climate change, the approach advocated is one of 'adaptive management', which is discussed further in section 3.3.3. This approach provides a means for prioritising actions, which should be employed by sectoral leads during the review of the full list of actions. This approach prioritises, for example, the response to serious and high risks and actions

[xii] Proposed PCN locations were identified in consultation with the lead implementers, but may be revised at a later stage if deemed relevant when preparing the detailed project design.

[xiii] Agriculture, Amerindian Affairs, Community and Regional Development, Ecosystems and biodiversity, Energy, Fisheries, Forestry, Health, Housing, Mining, Sea and river defence infrastructure, Tourism, Trade, Transport and Water.

which are considered ‘no’ and ‘low’ regret. Once the chosen actions have been agreed, the next step is to scope project activities, timeline and budget, in order to access appropriate financing and deliver.

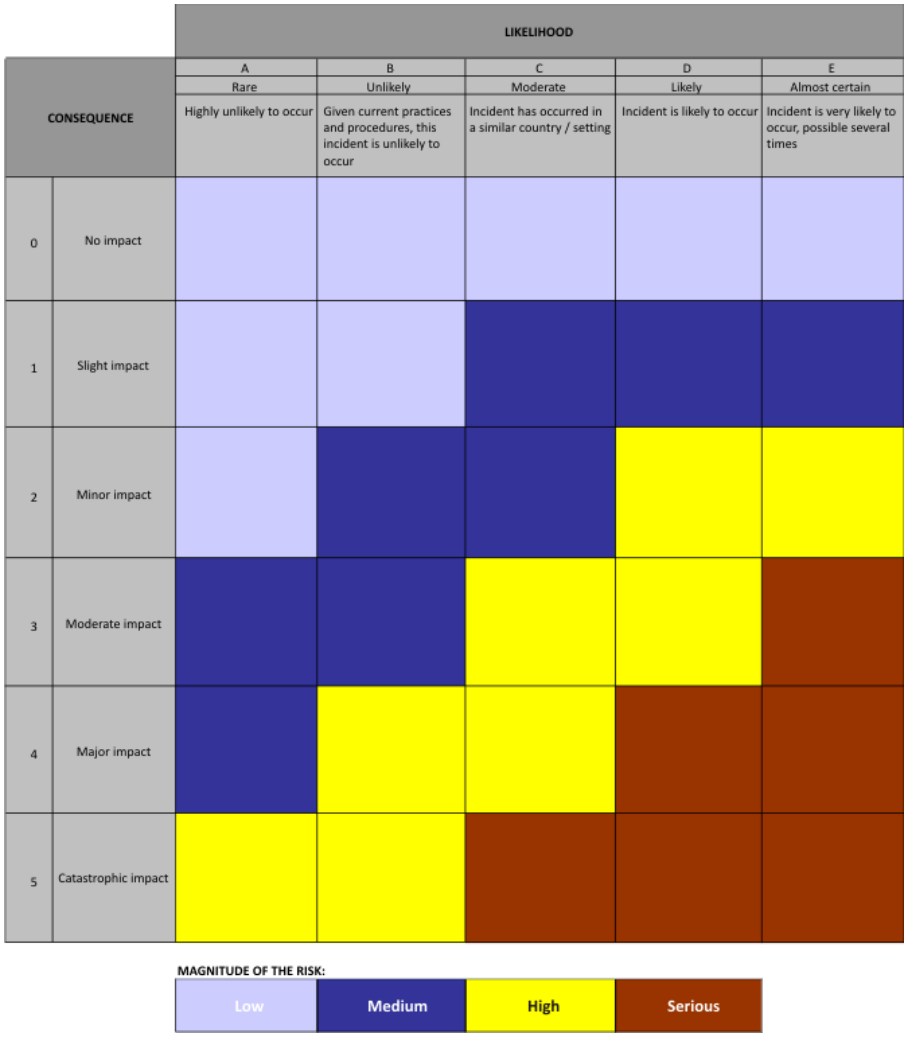


Figure 4: Matrix for determining magnitude of risk.

3.3.1 Climate risks

Climate change will create serious and high magnitude risks for all sectors. There are 47 serious risks (i.e. those falling within the red zone of Figure , based on their higher relative consequence and likelihood scores) across 12 different sectors. The only sectors not judged to be facing serious risks are trade and transport. 17 risks could have catastrophic impacts and a further 22 risks are almost certain to occur. 4 risks have been identified with the combination of catastrophic consequences and almost certain likelihood; these are found in the agriculture (risk ref A1), indigenous peoples (risk ref In1 and In2) and housing sectors (risk ref Ho1) (see Table 6 for details of these specific risks).

Table 6: Most serious risks identified by sector, developed in collaboration with in-country stakeholders and based on literature review. Risk reference codes have been generated for all 15 sectors and full details are provided in the Sectoral Briefing Notes.

Sector	Most serious risks[xiv]
Agriculture	• Sea level rise and saline water intrusion causing damage to crops (risk ref A1) • Flooding causing a reduction in the discharge window available for coastal drainage, which could affect sugar cane crop production (risk ref A4) • Changes in water levels in the East Demerara Water Conservancy (EDWC), which would have impacts for irrigation (risk ref A6) • Climate-induced changes in production will have significant consequences for the nation's economy and the livelihoods of those working in the sector (risk ref A2 and A3) • Climate-induced changes in yield of staple crops, for example rice, would have detrimental impacts for food security and human health (risk ref A5)
Indigenous Peoples	• Decreases in agricultural production due to changes in water resource availability, with consequences for livelihoods (risk ref IP1), food and health (risk ref IP2 and risk ref IP6) • Sea level rise and flooding impacting livelihoods (risk ref IP3), and potentially resulting in relocation of coastal and riverine communities (risk ref IP4) • Drought and a result wildfires causing destruction of forests, savannah and Amerindian farms, and health risks associated with the increased dust and restricted access to potable water for domestic use and water for agriculture (risk ref IP5)
Community and Regional Development	• Impacts of sea level rise on agricultural land is identified as having cascading consequences for regional development and socio-economic growth (risk ref CRD2) • Impacts of floods and droughts on mining operations could lead to detrimental consequences for the livelihoods and health of rural communities in these areas (risk ref CRD3) • Flood damage to infrastructure, including housing, roads, telecommunications and utilities, and the risk of human injury and death (risk ref CRD1)
Ecosystems and Biodiversity	• Environmental degradation caused by changes in freshwater and groundwater systems (e.g. flows and salinization) (risk ref Ec1), flooding, landslides and soil erosion (risk ref Ec3), with implications for ecosystems, livelihoods and human health • Sea level rise and increase in storm surges causing coastal erosion or sediment deposition (risk ref Ec2) • Changes in sea surface temperatures impacting ocean ecosystems and functioning (risk ref Ec5) • Increased pressure or changes in ecosystems and habitats may cause increased tension between different interested stakeholder groups (risk ref Ec4)
Energy	• Impacts of extreme temperatures on transmission and distribution lines, causing reduced efficiency and potential power outages (risk ref En1) • Flood damage to critical energy infrastructure, causing energy insecurity (risk ref En2)

[xiv] These are the risks that fall within the red zone of Figure 5, based on their higher relative consequence and likelihood scores.

Sector	Most serious risks[xiv]
Fisheries	• The disruption of critical fisheries habitats due to sea level rise, which will result in decreased fisheries production and lost revenue (risk ref Fi1)
Forestry	• Climate-driven loss of critical ecosystem services provided by the forest, such as soil erosion protection and water catchment management, which will result in broad-scale environmental degradation (risk ref F1)
Health	• Water scarcity causing detrimental impacts on health (e.g. access to clean drinking water and good sanitation) and social inequalities (e.g. gender, education, poverty) (risk ref H2) • Climate-induced changes in living and working conditions potentially causing internal and external migration, with associated consequence for development objectives, including human health (risk ref H3) • Climate-induced declines in agricultural production and revenue may cause detrimental consequence from community services, including health and education (risk ref H1) • Changes in vector-borne diseases (such as malaria, dengue) driven by potential increases in rainfall (risk ref H7 and H11) and water-borne and food-borne diseases (such as diarrhoeal diseases) driven by flood impacts on sanitation (risk ref H4 and H5)
Housing	• Housing infrastructure damage, personal injury and community displacement resulting from flooding of rivers and drainage canals, specifically in Georgetown, (risk ref Ho1 and Ho2) and sea level rise and storm surge (risk ref Ho3)
Mining	• Flooding, erosion and land instability impacting the transport of mining material from the mine (risk ref M1) and the supply chain into mining communities (risk ref M4), • Flood-related impacts on drainage, tailings and landform management (risk ref M3 and M6) and • Extreme weather events impacting workforce health and safety (risk ref M5) • Water scarcity may disrupt hydraulic mining, the main mining method in Guyana, resulting in stoppages in operations and loss of revenue (risk ref M2)
Sea and river defence infrastructure	• Sea level rise and increase in storm surge height causing overtopping of the current sea defence infrastructure (risk ref SRD1 and SRD5) and damaging drainage and irrigation systems (risk ref SRD4) • Sea level rise and increase in storm surge is likely to increase coastal erosion and sediment movements (risk ref SRD2) and potentially destroy mangroves, which currently offer natural coastal protection (risk ref SRD3)
Tourism	• Damage to tourism assets (e.g. national landmarks, beaches, coastal and interior ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) from sea level rise (risk ref To1), causing environmental degradation and loss of revenue from tourism-related activities
Trade	• Damage to critical transport infrastructure, upon which trade is dependent, from flooding, (risk ref T1), sea level rise and storm surge (risk ref T2), or decreases in precipitation rendering some rivers are no longer navigable and infrastructure along the banks (e.g. wharves and stellings) is no longer accessible (risk ref T4)

Sector	Most serious risks[xiv]
	• Climate impacts on the agricultural and mining sectors may cause detrimental consequences on export earnings, from sugar cane and rice for example (risk ref T1) and gold (risk ref T2)
Transport	• Damage to critical transport infrastructure from flooding, due to overflowing drainage canals and culverts (risk ref TP1), sea level rise and storm surge (risk ref TP3), or landslides (risk ref TP2) • Decreases in precipitation may mean that some rivers are no longer navigable and infrastructure along the banks (e.g. wharves and stellings) is no longer accessible (risk ref TP5), with potential to have knock-on consequences for trade and industry
Water	• Risks to water supply due to sea level rise and saline intrusion of aquifers, freshwater systems and water supply distribution networks (risk ref W1), incremental changes in rainfall and temperature affecting surface water systems (e.g. rivers, creeks, ponds, springs and wells), particularly in riparian and hinterland regions (risk ref W3 and W2) and groundwater recharge (risk ref W5). However, recharge patterns will be variable across the country, depending on different hydrogeology and aquifer systems. • Damage to water supply and sewerage systems / networks due to overtopping of drainage canals and flooding during extreme rainfall events, in both the low coastal plain, including Georgetown, and interior townships (risk ref W4)

3.3.2 Resilience objectives

Stakeholders in each sector identified a series of resilience objectives for their specific context and needs, which are presented in Table 7. These can be synthesised across the 15 sectors and mapped against the 5 pillars of the Second National Communication (2012)[86] (as shown in section 4). It is important to recognise that a high proportion (70%) of the resilience objectives relate to building adaptive capacity (pillars 1 to 3), rather than practical / technical actions[xv] to reduce vulnerability to climate risks (pillar 4). This is frequently the case in country contexts comparable to Guyana, where one of the key early priorities is to address current climate variability and also build resilience for the future. In practical terms, this means developing the institutional capacity to respond effectively to climate change, by compiling the information needed and creating the necessary regulatory, institutional and managerial conditions to undertake practical adaptation actions.

[xv] Practical actions can range from simple low-tech solutions to large scale infrastructure projects.

Table 7: Key resilience objectives identified by sector, developed in collaboration with in-country stakeholders and based on literature review.

Sector	Resilience Objectives
Agriculture	• Improve knowledge on climate vulnerability of the sector, particularly the impact of climate change on water resources • Improve climate modelling and weather forecasting / research, climate data storage and access for a range of user groups (Hydromet services) • Promote adaptation good practice and develop innovative solutions (e.g. new germplasm, crops and water management best practice, including drip irrigation and protected agriculture) • Provide farmers with skills, training, knowledge and tools to understand and manage climate change risks • Upgrade and maintain drainage and irrigation supporting systems • Embed climate change adaptation responses into agricultural policies and develop appropriate climate change regulations for the sector (e.g. water abstraction quotas and land use planning)
Indigenous Peoples	• Improve food security and health, expanding the use of renewable energy, adding value to agricultural goods and developing ecotourism • Increase and improve potable water security and access, particularly for remote satellite communities • Improve early warning systems for extreme events, particularly for remote satellite communities • Use traditional and scientific knowledge to inform decision makers, stakeholders and the younger generation in developing resilience and adaptation plans • Promote coordination and networking among the Village Councils and all relevant agencies and stakeholders
Community and Regional Development	• Tailor and generate climate change knowledge products to meet the educational needs of targeted communities • Promote coordination and networking among the councils and all relevant agencies and stakeholders • Engage Hinterland locations and promote synergies between outreach programmes (OCC, REDD+ Secretariat, MSSC) • Help local government agencies access skills, training, knowledge and tools to understand and manage climate change risks • Build climate resilience of communities through effective and climate resilient water, waste management, health care, education, energy, transport and ICT programmes • Restore and develop mangrove forests to increase the resilience of coastal protection • Develop, strengthen and implement law, policies, regulations and national strategies for climate resilience in disaster risk management • Strengthen disaster risk management and response efforts at community, regional and national levels
Ecosystems and	• Improve knowledge on climate vulnerability of ecosystems and biodiversity, particularly the associated impacts on livelihood, economy and society

Sector	Resilience Objectives
Biodiversity	• Create a central repository of all research on biodiversity and ecosystem services (BES) that is freely accessible • Disseminate information through targeted outreach and awareness sessions for various groups of society (e.g. teachers, youth, media, indigenous peoples, farmers, all law enforcement bodies, etc.) • Promote conservation good practice to adapt to the impacts of climate change • Develop, implement and enforce law, policy and regulation for climate resilient ecosystems and biodiversity and mainstream in current laws, policies and regulations, national development strategies, plans, etc. through an inclusive evidence-based process • Enhance and diversify funding for the sector especially in the areas of research and development • Restore and develop mangrove forests to increase the resilience of coastal protection systems • Restore degraded interior ecosystems caused by mining activities
Energy	• Improve knowledge on climate vulnerability of the sector • Develop, implement and enforce law, policy and regulation and national strategies for climate resilience in energy • Increase national capacity to provide renewable energy options, including building research and technical capacity • Increase/strengthen/improve energy security and security of supply • Promote use of 'climate smart' energy practices and technologies • Improve awareness and knowledge of energy conservation and efficiency • Increase access to financial resources for energy sector
Fisheries	• Improve knowledge on climate vulnerability of the sector • Promote adaptation good practice and develop innovative solutions • Provide coastal communities with skills, training, knowledge and tools to understand and manage climate change risks • Adopt an integrated financial risk transfer package that fosters efficient restoration of livelihoods of fisher-folk
Forestry	• Improve knowledge on climate vulnerability of the sector • Enhance monitoring and evaluation of climate impacts on forestry and integrate findings into action plans • Develop, strengthen, implement and enforce laws, policies and regulations for climate resilient forestry • Strengthen and retain human and institutional capacity within the forestry sector • Restore degraded forest ecosystems caused by mining activities
Health	• Improve knowledge on climate vulnerability of the sector, particularly climate-related diseases and appropriate prevention and treatment • Enhance monitoring and evaluation of climate impacts on health • Promote adaptation good practice and develop innovative solutions • Develop national early warning systems for the health sector based on short – medium

Sector	Resilience Objectives
	term climate forecasts and strengthen the capacity of the health sector to respond effectively to the climate-related risks • Develop 'climate smart' health facilities, especially in the interior, that incorporate design features (e.g. renewable energy sources, water harvesting capacity) to ensure effective functioning during times of climate-induced stress • Reduce the exposure of communities to health-related risks associated with flooding • Establish a line item on the national budget for climate change activities for health
Housing	• Improve knowledge on social vulnerability to climate change • Promote land use planning and housing developments to consider the impacts of climate change • Promote adaptation good practice and developing innovative solutions • Improve drainage, and where necessary irrigation systems, within housing areas • Improve waste management systems at a household and community level • Develop, implement and enforce housing-related laws, policies, regulations and national strategies for climate resilience • Promote institutional synergies in the housing sector • Increase access to funding/financial resources for 'climate smart' buildings
Mining	• Increase awareness through targeted training of miners to understand better and manage climate change risks • Reduce the exposure of the mining workforce to health-related risks associated with vector-borne diseases (e.g. use of insecticide treated nets, keeping the immediate environment free of possible breeding sites) • Promote the adoption of climate resilient methodologies through robust R&D interventions • Provide financial assistance to miners to implement climate smart recovery methods (e.g. mercury free extraction), reduce the impact of mining and improve prospecting methods • Review and update mining policies, regulations and relevant codes of practices to ensure effective consideration of climate change adaptation, conservation and reclamation • Strengthen monitoring and enforcement capacities of relevant regulatory agencies (GGMC & GGDMA) to oversee compliance with climate change adaptation measures • Restore degraded interior ecosystems caused by mining activities
Sea and river defence infrastructure	• Upgrade and maintain sea defences • Upgrade and monitor the drainage and irrigation (D&I) system in tandem with the sea defences • Improve knowledge of flood exposure and vulnerable locations to inform investment in sea and river defences • Use climate change information to inform land use planning and infrastructure developments consider the impacts of climate change • Improve understanding of the benefits and challenges of managed retreat • Improve the coordination/collaboration for sharing knowledge between local and regional governmental organisations whose mandates are similar to Guyana's. (i.e.

Sector	Resilience Objectives
	countries that face similar risks with regards to sea level rise) • Increase the institutional capacity to monitor and evaluate climatic impacts with a link to the design of projects through improved technologies and data collection • Improve effectiveness of the policy framework associated with sea and river defence, with a workable link between development and implementation • Foster cooperation between private and public sector entities and funding with key emphasis on the varying climatic conditions
Tourism	• Provide tourism businesses with the skills, training, knowledge and tools to understand and manage climate change risks • Foster coordination among governing bodies and relevant stakeholders within the tourism industry; to contribute information that will support the development of climate resilience strategies • Encourage the development of eco-sensitive ecotourism that has at its core the conservation of the natural resource endowment of Guyana • Develop, implement and enforce law, policy and regulation to integrate climate resilience into tourism operations
Trade	• Improve knowledge of how climate variability and change affect Guyanese trade (imports, exports and domestic trade) and what adaptation options are available • Provide mechanisms to protect Guyanese businesses from climate variability and change, particularly supply chain disruption due to extreme weather events • Introduce measures that encourage climate resilient technologies to be delivered through the market, which may include the provision of incentives for business
Transport	• Improve the coordination and collaboration between local, regional and international bodies and to implement changes in the design of transport systems • Improve the effectiveness of the transport division's policy framework, with a workable link between development and implementation • Foster international cooperation and funding (from private and public sector entities) with a key emphasis on climate change • Maximise the available funds in the agency's budget allocated to capacity building of personnel with emphasis on climate change resilience, adoption of good practice and development of innovative solutions
Water	• Improve knowledge of social vulnerability to climate-induced changes in water resources • Increase availability and accessibility to water resources and supply in the face of a changing climate, particularly for indigenous communities, namely provision of reliable supply, especially during drought, improved quality of potable water and to reduce the risk of saltwater intrusion • Promote integrated water resources management • Build research and technical capacity in context of water resources management • Examine and assess the state of water aquifers, particularly in areas where indigenous communities are reliant on groundwater and where economic activities are conducted (e.g. mining) to ensure the aquifers are not compromised

Sector	Resilience Objectives
	• Improve water management during climate-related disasters, to avoid contamination and associated health issues

3.3.3 Adaptive management approach to prioritising actions

The IPCC defines 'adaptive management' as: *"the process of iteratively planning, implementing, and modifying strategies for managing resources in the face of uncertainty and change. Adaptive management involves adjusting approaches in response to observations of their effect and changes in the system brought on by resulting feedback effects and other variables."*[87] Adaptive management allows the GoG to make decisions and take action now in the absence of complete information about future climate change and its impacts, and results in plans with built-in flexibility. . In practical terms, and to ensure long term effectiveness, the GoG should periodically review, and where necessary, adjust their plans and actions in response to new observations and emerging climate change-related evidence.

To identify priority actions for the next 5 years, it is recommended that sectoral leads draw upon a series of key principles, as presented in Box 2. These principles informed the development of the four CRSAP PCNs.

Box 3: Principles to be used by sectoral leads when prioritising resilience actions

Prioritise actions that address current vulnerability and serious risks. Resilience actions are considered a priority where the current vulnerability is high; and/or the risks are rated as 'high' against one or more of the following criteria:

- Projected impacts of climate change are large;
- Decisions on managing the effects have long lead times or long-term effects;
- There are large uncertainties on the magnitude of future risk, i.e. the scale of future risk is uncertain (but could be large).

Avoid maladaptation. Actions taken to avoid or reduce vulnerability to climate change can negatively affect other systems, sectors or social groups or may inadvertently make climate change more difficult to manage in the future. Examples of maladaptive responses include those that:

- Increase risks in another areas or for other stakeholders;
- Impose higher costs than alternative responses which manage the risk;
- Reduce flexibility to respond to unforeseen climatic conditions;
- Conflict with greenhouse gas emission reduction targets.

Take into account environmental services that help in responding to climate change challenges. Where possible, opportunities for ecosystem based adaptation solutions should be considered.

Emphasise actions that perform well under conditions of uncertainty, namely:

- **No regret adaptation actions**: These are measures that are worthwhile now, delivering net socio-economic benefits which exceed their costs, and that continue to be worthwhile irrespective of the nature of future climate. A sub-set of no-regret measures are so-called 'soft' measures that support understanding, capacity building and improved governance on adaptation.
- **Low regret adaptation actions.** Measures for which the associated costs are relatively low and for which, bearing in mind the uncertainties in future climate change, the benefits under future climate change may potentially be large.
- **'Win-win' adaptation actions.** These are actions which have other environmental, social or economic benefits as well as treating climate change.
- **Flexible** or **adaptive management options**. These are measures that can be implemented incrementally, rather than through the adoption of 'one-off' costly adaptation solutions. For example, delaying measures while exploring options and working with other stakeholders to find the most appropriate solutions may be a viable approach to ensure that the appropriate level of climate resilience is reached when needed. Keeping options flexible and open-ended allows them to be adjusted, following monitoring and evaluation and systematic appraisal of their performance.

Individual actions will need to be delivered as part of a wider suite of actions, covering a range action types. Resilience actions have been linked to the 5 pillars identified in the Second National Communication and cover the suite of potential types of action, including informational, institutional and capacity-building, policy, physical / engineering and financial. It is important to recognise that multiple actions will be needed to address individual risks, and they will also need to be sequenced appropriately. For example, informational actions are often a key first step and pre-requisite for some financial and technical actions.

Where relevant, work in partnership with other stakeholders to develop and implement resilience

actions. Partnership working can help to identify synergies in resilience building objectives and to avoid conflicts. Taking a thematic-based approach may help assess the most effective way to response to the risks identified in this initial assessment. The benefit of this approach is that it allows linkages between risks and areas of collaboration to be more easily identified. It will be important to not take each risk and action in isolation.

3.4 Capacity building actions to enhance Guyana's capacity for planning adaptation and resilience

In addition to developing PCNs and sectoral actions, it is also important for ensure that capacities are built across the country to deliver adaptation measures and build resilience. These actions are cross-sectoral in nature. **Error! Not a valid bookmark self-reference.** presents these recommended actions which are organised according to the five pillars on adaptation and are based on feedback provided by Guyanese stakeholders and by a review of the literature.

Table 8 (next page): Enabling actions to build Guyana's capacity for national adaptation planning

Pillar 1: Information, research & systematic observation	In light of informational capacity gaps identified in section 1.2.3, Guyana should focus on enhancing its collection and analysis of data and information about observed and projected climate variability and change, vulnerability, risk and resilience to enable informed decision making on going forward. This should include robust research, the development of repositories of data (including GIS data), updated projections on future climate variability and change, and the development of protocols for data sharing and access. It may be advisable to create data linkages with external institutions like the CCCCC. In addition, it will be necessary to facilitate the updating of data and information over time. This would be especially useful in the development of an M&E plan. M&E plays a critical role in informing and improving climate resilience focus areas and actions. It provides an understanding of what works (or not) in particular circumstances and why; guides more efficient and transparent investment decisions; and ensures that future resilience building efforts 'build upon' past projects and programmes. A well designed and efficiently executed M&E framework will also demonstrate Guyana's climate finance readiness, providing a strong platform for attracting international climate finance. Finally, It is noted that the CCCCC has developed an M&E framework. Guyana could be guided by this framework to facilitate consistency of reporting across the region which may inform any external reporting process required from, for example, external funders or the UNFCCC.
Pillar 2: Institutional framework & capacity building, education & awareness	Guyana should strengthen the capacity of stakeholders and institutions to use and manage climate information and to deliver and coordinate adaptation activities. Key institutions like Hydromet and the OCC should continue to be strengthened with a view to enhancing the timeliness and accuracy of climate related data, and creating the capacity to generate climate change projections. Institutions should also be strengthened by the introduction of procurement and project management officers that have the capacity to handle technical assistance projects supported by development partners and external climate funds. Building human and institutional capacity should also involve the provision of climate resilience training and awareness-raising at a national, cross-sectoral level. This could possibly be expanded to include climate resilience-related scholarships, internships and professional incentives[88], [89]. Government should engage a wide cross-section of stakeholders on planning, developing and monitoring the CRSAP. Vulnerable groups, including indigenous peoples and women, should be adequately represented. Engagements should adhere to the principle of Free, Prior and Informed Consent (FPIC).
Pillar 3: Policy, legal framework	Guyana should ensure that its long term development planning takes climate change into account. It is also important that revisions to the CRSAP reflect national planning cycles, and thus that the CRSAP is reviewed and updated in line with national development planning activities. At the sectoral level, laws, regulations, policies, plans, programmes, projects and budgets should be reviewed to ensure they are climate-proofed. The objective is to mainstream climate change considerations into national development planning and create a risk management ethic in decision-making. The Caribbean Climate Online Risk and Adaptation TooL (CCORAL), designed for and owned by the Member Countries of CARICOM could be utilised to enable this process.
Pillar 4: Generation & application of technologies	The generation and application of hard and soft technologies to build resilience is highly context specific. Development and/or deployment of appropriate technologies are significantly dependent on strong capacities of the remaining four pillars. Moreover, there should be coordination in delivering solutions. For example, improving sea defence structures should be coordinated with efforts to improve the drainage and irrigation system.

Pillar 5: Use of financing instruments	Financing should address both the sources of financing, as well as financial incentives to allow stakeholders to take measures 'on the ground'. Guyana's approach to accessing finance is described in detail in the financing strategy (section 3.5) however, it will be important that there is a clear mechanism to inform stakeholders of available sources of financing. The development and promotion of financial incentives may be more effective if a thematic, rather than sectoral approach is adopted in implementation. For example, incentives for the purchase of water conservation measures may relate to householders, housing development and construction companies, agribusinesses among others. Additionally, the financial services sector should be engaged regarding access to financial products such as low-interest loans for adaptation.

3.5 Financing strategy

One of the greatest challenges in delivering the CRSAP is access to finance. To date, Guyana's experience to date with climate finance is closely tied to the Guyana REDD+ Investment Fund (GRIF) and the bilateral partnership with the Government of Norway (see Box 3). Recognising this, this strategy focuses on how the GoG can strengthen its capacities on and plan climate finance to implement the CRSAP, with a view to build Guyana's resilience to a changing climate.

Box 4: Guyana REDD+ Investment Fund (GRIF)

The main source of climate finance in Guyana has been via its Memorandum of Understanding (MOU) with the Kingdom of Norway through which Norway pledged to provide eq. US$ 255.50 million between 2010 and 2015 to help deliver 'low carbon, low deforestation, climate resilient development' in Guyana[90]. This funding has been channelled to GRIF, which is the main financing mechanism of the LCDS. 43% (US$ 109.8 million) of Norway's commitments were disbursed between 2010 and 2015; 12.3% (US$ 31.5 million) of the total has been allocated for specific projects[91].

The Overseas Development Institute (ODI) estimates that Guyana has received US$ 12.60 million from the main multilateral climate funds in the last decade in the form of grants, US$ 3.80 million of which has been targeted at climate resilience building activitiesxvi,92. This amount is relatively small in comparison to other Caribbean countries (for example Saint Lucia has received US$ 113 million to invest in early warning systems and other resilience building activitiesxvii). Figure shows the full list of climate funds that Guyana has already accessed, with reference to which sector the funding relates to. Information on the total amount accessed across these nine sources is not available.

[xvi] ODI (2014) reviewed nine international climate funds, namely the Adaptation Fund (AF), the Clean Technology Fund (CTF), the Forest Investment Programme (FIP), the Forest Carbon Partnership Facility (FCPF), the Global Environment Facility (GEF) (with a focus on activities under its fifth replenishment), the Least Developed Countries Fund (LDCF), the Pilot Programme on Climate Resilience (PPCR), the Scaling Up Renewable Energy Programme (SREP) and the Special Climate Change Fund (SCCF).

[xvii] According to ODI (2014), the most successful lower- income countries are Bangladesh, Nepal and Niger, each receiving more than $110 million to invest in early warning systems and other resilience building activities. Morocco, Mexico, Brazil, South Africa and India are also top beneficiaries overall, each receiving over half a billion dollars (largely as loans).

	Agriculture	Amerindian Affairs	Community and Rural Development	DRM	Ecosystems and Biodiversity	Energy	Fisheries	Forestry	Health	Housing	Mining	Sea and River Defence Infrastructure	Tourism	Trade	Transport	Water
Global Climate Change Alliance (GCCA)					■											
Global Environment Facility (GEF) Trust Fund						■										
Forest Carbon Partnership Facility - Readiness Fund (FCPF-RF)								■								
Inter-American Development Bank (IDB)				■												
International Development Association (IDA)													■			
International Climate Initiative (Germany)								■								
Japan's Fast Start Finance												■				■
Norway's International Climate and Forest Initiative									■							
Special Climate Change Fund (SCCF)													■			■

Figure 5: International climate funds that Guyana has accessed; relevance of funding to Guyana's key sectors. Source: Author's own research.

Against this backdrop and based on a review of potential options, the following strategy is proposed:

- Prepare the infrastructure needed to finance the implementation of the CRSAP.
- Integrate climate change into the national budgeting process.
- Secure sources of funding for the implementation of the PCNs.

Table 9 provides an overview of the specific recommendations and intended outcomes for each recommended measure.

Table 9: Summary of specific recommendations and intended outcomes of the financing strategy. (Source: Adapted from UNFCCC, 2008[93]).

Financing strategy measures	Specific recommendations	Intended outcomes
Prepare the infrastructure needed to finance the implementation of the CRSAP	Build the capacity of Guyana to access and plan effective and efficient uses of GCF financing Carry out an institutional assessment of organisations to support the GoG in its process to select one or more of these organisation(s) to become National Implementing Entities (NIEs) to the GCF. Develop project and programme proposals for GCF funding through Multilateral Implementing Entities (MIEs) and Regional Implementing Entities (RIEs). Identify appropriate modalities of access to the AF, by engaging with accredited MIEs and RIEs in the short term to submit potential funding applications and identifying in parallel suitable national institutions to seek accreditation as NIE. Start discussions with other multilateral and bilateral funds with a view to generate interest in financing the implementation of the CRSAP and identify potential funding opportunities. Explore options for the development of a national climate fund to channel a range of climate-related funds. Action is taken to improve the investment risk profile and the attractiveness of Guyana to private sector investment.	Potential sources of finance and most appropriate modalities of access, including funds within or outside the UNFCCC framework, are identified for delivering PCNs and broader resilience-building actions under the CRSAP. Project proposals for delivery of PCNs and broader resilience-building actions under the CRSAP are submitted for full funding application to the GCF. Appropriate modalities to access the AF are identified (direct access via RIEs/NIEs or international access via accredited MIEs). Bilateral and multilateral development partners show interest in funding/supporting the delivery of PCNs and broader resilience-building actions under the CRSAP. Options for developing a national climate fund to channel a range of climate-related funds are identified. Guyana attracts private sector finance for adaptation.

Financing strategy measures	Specific recommendations	Intended outcomes
Integrate climate change into the national budgeting process	Undertake a public expenditure review to investigate how climate change related expenditure is integrated into the national budget and budgetary processes, and provide a baseline for future decisions about financing climate resilience in Guyana. When reviewing the budgeting process, consider integrating a climate proofing tool in the new budgeting process to ensure that government budget decisions (capital and operational costs) fully assess the implications of a changing climate.	Options for strengthening the effective and efficient delivery of climate resilient development through budgets and expenditures are identified. A tool is integrated in the new budgeting process with a view to climate proof national spending.
Secure funding for the implementation of the PCNs	Support full funding applications by lead implementers of the PCNs (namely, NDIA/MoA, MOA, WSG/MoPI and MoPH) by developing and implementing a training course on proposal development. Conduct a more detailed analysis of financing options for each PCN prior to the preparation of funding applications, including co-financing and in-kind assistance from the lead implementer and/or GOG. Monitor progress made in implementing the PCNs, by clearly defining milestones and means of verification.	Full funding applications for all four PCNs are submitted to relevant funds Sufficient resources are secured for delivering the PCNs for immediate implementation.

3.5.1 Prepare the infrastructure needed to finance the implementation of the CRSAP

As described above, Guyana's main source of climate finance has been via its MOU with the Kingdom of Norway, supplemented by access to domestic revenue and a range of bilateral and multilateral external sources. In order to access sufficient finance to implement the CRSAP, it is necessary for Guyana to continue developing or leveraging existing financing options, including existing national budgets and private sector investments, whilst fully exploiting emerging international financing opportunities including funds within or outside the framework of the UNFCCC. It is important to recognise that most climate funds will likely require co-financing from the GoG. As such, securing domestic sources of funding will be critical to the successful financing of the CRSAP.

Recognising that navigating the complex and still evolving global climate finance landscape is challenging for the GoG and its civil servants with day-to-day responsibilities on climate change and funding applications. Annex F provides an overview of 13 dedicated climate funds that could be accessed by the GoG to finance the implementation of the CRSAP. For each of these funds, details are provided on the fund's operating entity, mandate, type of finance provided, eligible organisations, eligible projects/programmes, proposal/application requirements, proposal evaluation criteria, application procedures, ease of access, funding limit for individual projects and its website link.

Funds within the framework of the UNFCCC

With regards to funds within the framework of the UNFCCC, it is recommended that the GoG positions itself to benefit from funds not yet accessed (i.e. the Adaptation Fund, AF), funds that have been already accessed (i.e. Global Environment Facility (GEF)-Small Grant Programme and Special Climate Change Fund, SCCF) and those that will soon become available (i.e. Green Climate Fund, GCF). See Annex F for further information on the modalities of access and application requirements for the AF, the GEF-Small Grant Programme, the SCCF and the GCF.

Particular reference should be made to the GCF as a potential important source of finance for the CRSAP. With developed countries' commitment to mobilize US$100 billion per year by 2020 to address the needs of developing countries[xviii], the GCF was established at the Conference of Parties in Copenhagen to scale up existing funding, while redressing the imbalance between mitigation and adaptation funding, ensuring a geographic balance (with a floor of 50% of the adaptation allocation for particularly vulnerable countries, including Small Islands Developing States (SIDS), and maximizing engagement with the private sector (through a significant allocation to a dedicated Private Sector Facility). The GCF is now the largest global climate fund with over US$ 10.2 billion pledged (as of 5 Oct 2015) and a total of US$ 15 million is already available to immediately provide readiness and preparatory support to countries (capped at US$ 1 million per year for individual countries).

Mr. Joseph Harmon, M.P. and Honourable Minister of State under the Ministry of the Presidency is the National Designated Authority (NDA), the interface between Guyana and the GCF. The NDA provides broad strategic oversight of the GCF's activities within the country and serves as point of

[xviii] Coming from both public and private sources.

communication with the Fund, while seeking to ensure consistency of funding proposals with national objectives and priorities.

While preparing the infrastructure needed for financing the implementation of the CRSAP, the NDA should start engaging as soon as possible with the GCF by following three key steps:

- **Build the capacity of Guyana to access and plan effective and efficient uses of GCF financing:** Readiness support is available to the NDA to undertake its fund-level roles and responsibilities. This will first include strengthening its capacity to successfully engage with the GCF and providing public awareness-raising on GCF operational modalities and requirements amongst national stakeholders.

- **Develop project and programme proposals for funding through Multilateral Implementing Entities (MIEs) and Regional Implementing Entities (RIEs)**. The GCF will finance programmes and projects in the public and the private sectors that contribute toward achieving at least one of its eight strategic impacts. Proposals may be submitted from accredited entities and NDAs at any time using the funding proposal template available on the GCF's website. See the GCF's website for the updated list of accredited implementing entities[xix]. Proposals will be considered against the Fund's investment framework. To ensure country ownership, the Board will only consider funding proposals supported by a letter of no-objection from the NDA, attesting that the proposed project is in line with national strategies. See Annex F for further information on the GCF, its application process and accredited entities. It is important that capacity building and technical backstopping support is provided to key stakeholders involved in the implementation of the CRSAP, including lead implementers of the PCNs to develop robust project proposals. It should be noted that readiness support is available from the GCF to support the development of a pipeline of projects.

- **Carry out an institutional assessment of organisations to support the GoG in its process to select one or more of these organisation(s) as National Implementing Entities (NIEs):** If GoG would like to seek direct access to the GCF, the NDA (or focal point) must start a selection process to consider what institutions in the country are suitable to become the NIE. Readiness support is available for this process (see relevant step above). Once (a) suitable entity or entities has or have been identified, they will need to demonstrate they meet(s) the Fund's fiduciary standards and environmental and social safeguards and submit a completed application through the Fund's Online Accreditation System (OAS) consistent with the GCF's fit-for-purpose accreditation approach. Guidance for NDAs on how to engage with the GCF (including best practice to identify and select a NIE) is available at the GCF website.

[xix] The list is available here: http://www.gcfund.org/operations/accreditation/accredited-entities.html.

Box 5: Importance of establishing a robust process for undertaking selection of appropriate NIEs

Experience accumulated under the direct access modality of the AF has demonstrated the importance of following a systematic process for the selection of suitable NIE candidates which includes:

- The creation of a Selection Committee coordinated by the Designated Authority.
- A shortlist of potential candidates based on a preliminary assessment of their fiduciary standards.
- Identifying how and to what extent existing gaps relating to fiduciary standards in pre-selected institutions could be solved.
- Selection of the most suitable entity and provision of assistance by the Designated Authority to help address gaps and complete the accreditation process.
- Final verification of the entire application by the committee before endorsement.

Source: Adaptation Fund (undated). Guidelines for Designated Authorities to select an NIE, available online at https://www.adaptation-fund.org/system/files/Guidelines%20for%20Designated%20Authorities%20to%20select%20an%20NIE_1.pdf.

With respect to the AF, it is recommended that the GoG also identifies appropriate modalities of access to apply for funding. In the short term accredited MIEs and those institutions that are seeking accreditation as RIEs (such as the Caribbean Community Climate Change Centre (CCCCC) and Caribbean Development Bank (CDB)) should be considered. An assessment of suitable national institutions to seek accreditation as an NIE (as proposed above for the GCF) should also be conducted as a means to attract finance in the medium term. See Annex F for further information on the modalities of access and application requirements for the AF.

Other multilateral and bilateral funds

With regards to funds outside the UNFCCC framework, it is recommended that the GoG starts as soon as possible discussions with other bilateral and multilateral funds outside the UNFCCC framework, with a view to generate interest in financing the implementation of the CRSAP and identify potential funding opportunities. A preliminary list of potential funds could include, but not be limited to the following:

- EU – Global Climate Change Alliance (GCCA).
- World Bank - Global Facility for Disaster Reduction and Recovery (GFDRR).
- Germany - International Climate Initiative (ICI).
- Germany - Kreditanstalt für Wiederaufbau (KfW) general lending activities.
- Japan – Fast Start Finance.
- United States Agency for International Development (USAID).
- Caribbean Development Bank (CDB) - Climate Action Line of Credit (CALC) - not yet operational.

- InfraFund- Inter-American Development Bank (IDB) - not yet operational.

Annex F provides further information on the modalities of access and application requirements, as well as eligible projects or programmes for these various funds.

Explore options for the development of a national climate fund to channel a range of climate-related funds

It is recommended that the GoG explores the development of a national climate fund to support the implementation of the CRSAP, building on the experience accumulated under the GRIF for the implementation of the LCDS and international best-practice. It should encompass various flexible options that can allow coordination and tracking of resources from various sources and funding streams, as well as, performance budgeting to enable cost-effective budget outlays. It is also recommended that climate-related indicators are integrated into the performance assessment framework and that the assessment framework is linked to the CRSAP M&E plan.

De-risk Guyana's investment profile

The CARICOM Implementation Plan for Achieving Development Resilient to Climate Change (March 2012)[94] identifies the assessment and review of the investment risk profile for each CARICOM member state as a priority action required to then improve the risk reward balance and attract private sector investment into adaptation in the region. It is advisable that this is undertaken in Guyana to attract the mainstream private sector into investing in resilience. Countries seen as high-risk on a global comparison, and rated as such by the rating agencies, will continue to experience difficulties in attracting private sector investors and securing competitive debt finance. Attracting finance for resilience should be also be considered within the wider investment challenges Guyana faces in securing finance for development and growth.

3.5.2 Mainstream climate change into the national budgeting process

Climate change considerations are not formally integrated into their budgeting processes and as a consequence climate related expenditures may not always be appropriately flagged. Undertaking a public expenditure review will allow Guyana to investigate how climate change related expenditure is integrated into the national budget and budgetary processes, and provide a baseline for future decisions about financing climate resilience. This public expenditure review will also allow Guyana to better understand whether expenditure is complementary with national strategy on climate change and how expenditure relates to the designated role and function of different institutions responsible for managing the response to climate change. It will assess linkages between national climate change policy; the institutional structures through which policy is channelled; and the resource allocation processes whereby public funding is made available for the implementation of relevant projects, programmes and policies. This will identify best ways to link the CRSAP to national budget, so that actions are fully prioritised and costed.

It will include a review of the following:

- *Budget planning processes*, including how budget allocations are formulated and approved, as well as assessing whether climate considerations are integrated in decision- making;

- *Expenditure trends and categories*, including estimating how much of the existing budget is spent on resilience-building measures and the overall trends in the level of budget allocation to line ministries and other relevant government institutions;
- *Budget financing*, considering the level and trends of domestic resources and external funds against expenditure categories. This may bring opportunities to reallocate, shift and optimise internal revenues for resilience-building, such as changes in relevant policies and laws; and
- *Systems to track climate finance* received. This may help to strengthen alignment with national priorities.

Further information on a methodology used globally to conduct reviews of climate-relevant public expenditures, the UNDP's Climate Public Expenditure and Institutional Review (CPEIR) methodology that has so far been applied in eight countries is provided in Box 5.

Under the new GoG, one of the key priorities is the review of the national budgeting process. Cognisant of this, there is an opportunity for the Ministry of Finance (MoF) to consider integrating a climate proofing tool in the new budgeting process to ensure that government budget decisions (capital and operational costs) fully assess the implications of a changing climate. The Caribbean Community Climate Change Centre (CCCCC) has developed a climate risk management decision support tool for decision-makers in the Caribbean called CCORAL can be used by ministries of finance and line ministries in taking appropriate action in response to a variable and changing climate, apply a risk management approach in decision making and ultimately deliver climate resilient development.

Box 5: Overview of CPEIR

The CPEIR method was developed by UNDP. The five countries with completed CPEIRs are Nepal, Bangladesh, Thailand, Samoa and Cambodia. Future CPEIRs are being planned for Indonesia, Timor-Leste and Vietnam. All completed CPEIRs are available at: http://www.aideffectiveness.org/CPEIR.

Further information on the CPEIR methodology is available in the methodological note at http://www.odi.org.uk/publications/6191-cpeir-methodology-climate-finance-national-public-expenditure.

3.5.3 Secure funding for the implementation of the PCNs

The total investment needed to finance all four PCNs is estimated at US$104.34 - 112.30 million (adjusted for inflation). To secure the necessary funding, capacity building and technical backstopping will be key to support the preparation and submission of robust project proposals focusing on funds presented in

Table 10: shows the sources of funding which the GoG could most easily access in the near- to medium- term to implement the PCNs, however, it is important to note that this list should not been seen as exhaustive and could be extended based on a more detailed analysis of financing options for each PCN. It is recommended that this analysis is undertaken prior to the preparation of funding applications. In addition, it is important to recognise that most of the funds will likely require co-

financing from the lead implementer (project proponent) and/ or GoG. This may be however, in the form of in-kind assistance.

Recognising the significant challenges in Guyana with regards to human resource capacity, it is recommended that a training course on proposal development with technical staff with day to day responsibilities for proposal development and funding application is developed and implemented. The ultimate objective will be to support full funding applications by lead implementers of the PCNs (namely, NDIA/MoA, MoA, WSG/MoPI and MoPH). Procedures should also be put in place to monitor progress made by lead implementers in implementing the PCNs, by clearly defining key milestones and means of verification.

Table 10: Overview of PCN titles, lead implementers, indicative costs (USD$ adj.) and potential sources of funding.

Title	Building Climate Resilient Agricultural Systems	Guyana's Sea Defence Enhancement and Maintenance	Public Health Adaptation to Climate Change	Strengthening Drainage and Irrigation Systems
Lead implementer	MoA	WSG, MoPI	MoPH	NDIA, MoA
Indicative costs	US$13.48-14.18 million (adj.)	US$41.96-46.29 million (adj.)	US$17.35-18.60 million (adj.)	US$31.547-33.227 million (adj.)
Potential sources of funding	IFAD, World Bank, EU – EDF, AF, GEF-Small Grant Programme, GCF, GFDRR, Japan – Fast Start Finance, USAID, SCCF	CDB, EU- EDF, GEF-Small Grant Programme, GCF, EU--GCCA, Japan – Fast Start Finance, USAID, SCCF	USAID, IDB, Guyana REDD+ Investment Fund, AF, GEF-Small Grant Programme, GCF, Japan – Fast Start Finance, SCCF, PAHO for technical support, UNICEF for training materials.	World Bank, EU, Japanese Government through JICA, Indian Government, IDB, FAO, DFID, CIDA, USAID, Petro Caribe, GRIF, AF, GEF-Small Grant Programme, GCF, USAID, SCCF

4 Action Plan

The action plan presents further detail on the content and implementation of the Priority Concept Notes (PCNs) that were introduced in section 3.2 and on the findings of the climate change vulnerability and risk assessment and resilience actions across 15 sectors that were introduced in section 3.3.

Section 4.1 of the action plan presents the four PCNs. All PCNs follow a standard template and provide the following information:

- Summary
- Background and rationale
  - Problem statement
  - Climate impacts, vulnerabilities, risks
  - Rationale
- Project description
  - Project aims and objectives
  - Project activities (broken down into project components)
  - Expected outcomes
  - Expected results
  - Implementation arrangements
  - Stakeholder engagement
  - Economic justification
  - Social impacts
  - Environmental impacts
  - Project sustainability
  - Project risks and mitigation measures
- Summary budget and investment plan
  - Total estimated project costs
  - Possible sources of funding
- Annex(es)

The PCN template was designed to deliver on the requirements on a range of external climate funds.

Each PCN can be used by the lead and partner PCNs implementers to develop the concept notes into full proposals for submission to development partners for bilateral funding or selected funds. As stated in section 3.2, finalisation of funding sources should be done on the basis of using the most readily available sources, consistent with the national government budget. This will facilitate the identification of counterpart resources which are often a feature of development partner requirements. All development partners and climate funds have developed their own concept and proposal templates and it will be necessary to use these when making submissions.

The action plan presents the detailed findings of the climate change vulnerability and risk assessment and identification of resilience actions in the form of sectoral briefing notes. As described in the methodology (section 2), strategic roadmap (section 0) and strategic section on risk and resilience (section 3.3), the CRSAP has used the latest and most robust evidence on climate

vulnerabilities, impacts and risks across Guyana's main sectors to develop a programme of sectoral actions. Section 3.3.3 provides guidance on how to prioritise and implement actions contained in the briefing notes using an 'adaptive management' approach.

4.1 Priority Project Concept Notes (PCNs)

4.1.1 Building climate resilient agricultural systems

Project description:	This project aims to build climate resilience in the agricultural sector by managing drought risk, developing climate proof sustainable farm systems and building the adaptive capacity of the sector.
Location:	Coastal (Regions 5 and 6) and Hinterland Region (Region 8 and 9)
Potential implementing entity:	Ministry of Agriculture (MoA)
Indicative project duration and timeline	2015-2020
Indicative project costs (US$):	US$13.48-14.18 million

4.1.1.1 Background and rationale

Problem statement

The agriculture sector is the mainstay of income and employment in many rural communities that are increasingly threatened by climate change and climate variability. The sector is essential to Guyana in terms of its significance to food security, poverty reduction, employment generation and foreign exchange earnings. The agriculture sector in 2009-2013 contributed on average to approximately 20% to Guyana's GDP and accounted for on average 40% of the county's total export earnings per annum[95]. Agriculture is a critical livelihood activity, both for subsistence and commercial purposes and provides revenue generating income for about 25,000 farming households, of which approximately 90% are concentrated in coastal areas and 10% in the hinterlands[96].

Many farmers lack the technical knowhow, financing and technology needed to respond to and manage the impact of climate change on their farms, livelihood and communities. Additionally, the existing legislative environment and institutional support need to be assessed to ascertain if they enable small farmers' development and knowledge expansion in the wake of climate change. Given the important linkages between agriculture productivity, food security and livelihoods, the potential impacts of climate change on the agriculture sector could have far reaching effects on the society; therefore, addressing the vulnerability of the agriculture sector to climate change is of high priority to the people of Guyana.

Climate impacts, vulnerabilities and risks:

Using historic climate data and the anomalies predicted by the European Centre Hamburg Model (ECHAM) of A2 and B2, it is projected that temperature will increase under both scenarios with B2 exhibiting less variation than A2 (see Annex B for further information on the scenarios used). Similarly, rainfall is projected to increase beyond 2050 but with greater variation in rainfall under A2 than under B2[97],[98]. Evidence for the period 1950-2000 suggests that although precipitation had increased of the period, this increase is driven by a rise in precipitation due to weather events above the 95th percentile[99]. That is, greater intensity in rainfall. Greater intensity and increased variation in projected rainfall patterns increases the likelihood of floods. With increasing temperature and inefficient and insufficient catchments and storages of water, there is increased risk to communities during dry spells and drought events. Empirical evidence suggests that drought conditions in Guyana are mostly likely to occur during or after an El Niño. There is no consensus on the projected frequency with which El Niño events will occur and as such there is great uncertainty about the frequency of droughts in Guyana[100].

Guyana's agriculture sector is highly sensitive to flooding and drought events. With increased intensity of rainfall, Guyana's low-lying coastal agricultural communities become more vulnerable to flooding as demonstrated by the 2005 floods. Heavy rains in the last nine days of December 2004 and early January, 2005, a brief period of dry in the second week of January, 2005, followed by eight days of some of the heaviest rainfall recorded in Guyana since 1888, an anomaly in Guyana's rainfall climatology[xx] coupled with the disrepair of several components of the drainage and irrigation system, led to flooding in the low-lying coastal zones of Guyana. This flooding is one of the most alarming natural disasters to affect Guyana. Damage was experienced across all major sectors in the economy including agriculture, education, environment, health, water, housing, drainage and irrigation and environment. The livelihood and social activities of many households were disrupted for several days during and after the event. Households across Regions 3, 4 and 5 were significantly impacted with reports of water levels of 4-5 feet and areas flooded from as little as 3 days to 5 weeks. In total, 69,560 households were affected, which is 37.4% of the total number of households in Guyana and 58% of Regions 3, 4 and 5. Disaggregated, 10,683 households or 41% of households in Region 3 were affected. 56,312 households or 72% of households in Region 4 were affected; and, 2,567 households or 20% of households in Region 5 were affected[101]. The 2005 floods caused direct damages of US$418.3 million and indirect damages of US$46.8 million, which translates into approximately 60% of Guyana's Gross Domestic Product (GDP in 2004 prices). Damages to the agriculture sector amounted for US$52.6 million[102].

On the other hand, changes in precipitation patterns coupled with rising temperature results in an increase in the number of droughts[103]. In, 1997, a drought, associated with an El Niño event affected approximately 80% of the population with a conservative damage estimate of US$29 million; US$22 million in rice production and US$7 million in sugar production. Losses of livestock and crops such as cassava, coconut and coffee, while not quantified, were important as well as drinking water shortages in several communities across the country[104]. Forest fires also destroyed farmlands. A state of emergency had to be declared by the President of Guyana as the drought resulted in severe

[xx] The unusual weather system produced the heaviest rainfall on record and created a new monthly precipitation maximum of 1108mm versus the normal monthly average of 200 – 250 mm.

water stress on the population and economic activities across the country[105]. Moreover, the 2010 drought also caused severe losses and damage to the sector with overall costs estimated at US$14.7 million. Over 10,000 acres of rice, livestock and other crops were affected. In one Region the delivery of water through pumping and the creation of canals reached a cost of US$ 16,000 per day; pumping saline water to about 150 acres of rice lands[106]. In addition, water shortage impacted several persons located within both coastal and hinterland communities.

With increases in the number of dry spells, drought conditions and changing rainfall patterns, stresses on Guyana's internal water resources, aquifers and rivers is increasing. The problem will worsen under the projected climate change scenarios for Guyana. According to the World Bank, in 2013 Guyana withdrew approximately 60% of its 241 cubic meters of renewable internal fresh water resources; 94.3% of which was used for agricultural purposes, 4.2% for domestic purposes and 1.4% industrial purposes. Moreover, over a six month period in later 2014 to early 2015, Region 9's monthly precipitation was as low as 0.2mm in some areas creating a situation that resulted in the death of livestock and crops, exhaustion of fresh water from wells, and an increase in the pest population.

Table 11: Major droughts and floods in Guyana. Source: EM-Dat, 2015[107]

Type	Date	Total affected	Total damage (US$ Mn)	Total death
Drought	1997	607200	29	-
	2010	-	14.7	-
Flood	1971	-	0.2	-
	2005	274774	465.1	34
	2006	35000	169	-

Table 12: Enabling Guyana's Fresh water resources and usage in 2013. Source: The World Bank (2015)[108]

Fresh water resources and usage	**Quantity**
Renewable internal freshwater resources, total (billion cubic meters)	241
Renewable internal freshwater resources per capita (cubic meters)	301,395.8
Annual freshwater withdrawals, total (billion cubic meters)	144.5
Annual freshwater withdrawals, total (% of internal resources)	0.599585
Annual freshwater withdrawals, industry (% of total freshwater withdrawal)	1.412

Annual freshwater withdrawals, domestic (% of total freshwater withdrawal)	4.242
Annual freshwater withdrawals, agriculture (% of total freshwater withdrawal)	94.33

Based on studies from similar countries and regions and immediate evidence from flooding and droughts, the impact of climate change on livestock and other non-traditional subsectors is most likely to be unfavourable.

Table 13: Enabling: Potential impacts of climate change on Rice and Sugarcane. Source: ECLAC (2011)[109]

Crop	Potential climate change impacts
Rice	• Sea-level rise could increase water salinity in the rice fields. • Temperature increases could reduce rice yields by lowering sterility in rice flowers. • Changes in growing conditions are expected to result in increased weed and pest infestation. • The intensity and frequency of droughts are projected to increase resulting in reduced yields.
Sugarcane	• Increases in temperature at night-time, which affects the ripening process of the crop, while overall increases in the intensity of drought periods affect yields; • Increased rainfall reduces the days available for planting and reaping; • Floods from more frequent and intense rainfall and flooding from the Atlantic, due to over-topping and sea-level rise, reduce the discharge window available for coastal drainage and impact output negatively.

ECLAC summarizes the impact of climate change on agriculture in Guyana as:

"The key threat mechanisms are debilitated plant vitality and increased propagation of pests, as drought periods increase the breeding of vectors through water pooling and soil erosion associated with the increased intensity of hydro events. In addition, climate change is likely to affect crop productivity in specific geographical areas through its impact on growing seasons and crop patterns, to the extent that crop varieties cannot adapt"[110].

Rationale:

It is against this background that this project aims to build climate resilience in the agricultural sector by managing drought risk, developing climate proof sustainable farm systems and building the adaptive capacity of the sector thereby reducing the vulnerability of farmers. By increasing productivity and expanding the market of Guyana's agriculture sector, new employment and income generation opportunities will be created resulting in wider socio-economic benefits. Through the entire agriculture value chain, this project will strengthen technical and institutional capacity,

improve infrastructure management, enhance policy and legislation, and convene research and development while raising awareness within the farming communities.

This project will enable small to medium scale farmers to better cope with the effects of climate change. The main benefits of the project are primarily through avoided damage and loss of productivity due to slow onset events and extreme events (in particular drought and flooding). Additionally, through the promotion of crop diversification and improved strategy and technical management of farms, this project will contribute to achieving Guyana's food security and economic growth goals.

Undoubtedly, continuing and enhancing efforts to address flood risk in the agriculture sector is crucial to the future development of the sector. However, relatively little work has been undertaken on drought to date, and work in this area has become particularly important to the agriculture sector given both recent experiences with drought events and projections that indicate that droughts would become more frequent in the future.

This project also contributes to the delivery of Guyana's National Agriculture Strategy 2013-2020, which recognises that natural disasters, such as droughts and floods, and climate change will affect the achievement of its key objectives and associated result areas, in particular, ensuring food security in Guyana and the accessibility by all citizens to fibre and nutritious food. To achieve these goals, the Strategy identifies twenty-five priorities for success (see Annex A).

In addition, this project aids the achievement of the objectives set out the following policies and strategic plans:

- Guyana's Food and Nutrition Security (2011-2020) which focuses on consolidating food and nutrition security, considering factors affecting Guyana's food availability, stability and access. In terms of availability, major concerns are production and marketing constraints; stability relates to natural disasters and climate variability; while access concerns are characterized by those whose livelihoods survive on a very limited income[111].
- Grow More Food Campaign (2008-present) which builds on the recently completed Agriculture Diversification Program components: (1) Promotion of private sector entrepreneurship in agribusiness; (2) Improving the capabilities of agribusiness export and facilitation services; (3) Strengthening and consolidating agricultural health and food safety services; and, (4) Drainage and irrigation rehabilitation.
- Agriculture Disaster Risk Management Plan (ADRM) (2013-2020) which symbolizes the Government of Guyana and Ministry of Agriculture's commitment to risk reduction. The objectives are to: (1) Strengthen capacities and operating frameworks within the agriculture sector to prevent and mitigate the impacts of disasters, while promoting efficient and effective restoration of livelihoods through a well-coordinated mechanism; (2) Improve decision-making and coordination with respect to DRM among stakeholders at international, national, regional and local levels; and, (3) Articulate a sustainable mechanism for integrated financial resource mobilization that facilitates ongoing implementation of DRM activities. Disaster Risk Management Policy is aimed at, among other things, preventing and/or reducing disaster impacts on families, infrastructure, livelihoods and the environment and increasing resilience of communities in terms of

reducing their vulnerability and increasing their ability to withstand and minimize disaster impact[112].

- The Flood Prevention and Drought Control Plan (2013-2020) which describes actions that are intended to reduce and prevent floods and control and mitigate drought events.
- The National Integrated Disaster Risk Management Plan and Implementation Strategy[xxi], Multi-hazard Preparedness and Response Plan[xxii], and Early Warning System (EWS) Framework[xxiii] - documents that are still in draft[113].

The proposed project will build on and maximise synergies with existing and/or ongoing national initiatives. This will include, in particular:

- Research and development efforts by Guyana Rice Development Board (GRDB) on drought-resistant corps, entomology and monitoring[114].
- Efforts by Guyana's National Agricultural Research and Extension Institute (NAREI) to identify and research selected varieties of crops resilient to various climatic stresses as well as the usefulness of various agricultural techniques and technology such as drip irrigation and hydroponics[115].
- Rural Enterprise and Agriculture Development (READ) project focused on empowering rural households in six Guyanese regions through better access to financial services and training in marketing and enterprise development. Funded at a value of US$6.9 million by The International Fund for Agricultural Development (IFAD), the project ran from 2007 to 2013 and involved small farmers, women, unemployed or underemployed young people, and Amerindian communities. Several lessons learnt can be drawn from this project such as: (1) how to get rural communities, women, youths and indigenous groups involved in marketing and enterprise; (2) how to set-up organizations needed to support small groups meet their objectives[116].
- The Caribbean Water Initiative (CARIWIN), Caribbean drought and precipitation Monitoring Network (CDPMN) aimed at building capacity within the Hydrometeorological Service to enable member states like Guyana better manage drought and flood risk through modelling, monitoring and information dissemination. CDPMN monitors drought and the general precipitation status on two levels: (i) regional, encompassing the entire Caribbean basin and (ii) national using a number of indices and indicators[117]. Efforts are being made by the Hydrometeorological Service (Hydromet) to maintain and strengthen meteorological and hydrological monitoring network and disseminate information to agencies such as National

[xxi] This document identifies strategic actions needed to tackle floods and droughts including: Risk Identification, prevention and mitigation, financial risk management, preparedness and response and recovery.

[xxii] This document focuses on establishing the roles and responsibilities of the different actors for preparedness and response and the mechanisms for early warning, and provides guidelines and procedures for emergency and disaster management.

[xxiii] This document sets the overarching principles of Guyana's EWS, clarifies the structure and mechanisms, establishes decision making, communications, and dissemination procedures and protocols, and provides guidance for implementation.

Drainage and Irrigation Authority and Civil Defence Commission as well as to the farming communities and the wider public aimed at disaster risk management[118].

4.1.1.2 Project description

Project aims and objectives:

This overall aim of this project is to build climate resilience in the agricultural sector by managing drought risk, developing climate proof sustainable farm systems and building the adaptive capacity of the sector hence reducing the vulnerability of farmers, agricultural infrastructure, industries and local communities that are dependent on agriculture. The specific objectives of this project are to:

- Improve water resource management in Guyana's agriculture sector.
- Develop a diversified and integrated approach to agri-business in Guyana, with a focus on developing drought-tolerant species.
- Integrate climate resilience into programmes for developing sustainable farm management systems.
- Enhance the adaptive capacity of Guyana's agriculture sector to a changing climate change.

Project activities:

The project components and corresponding activities[xxiv] of this project are as follows:

Component 1- Water resource management

The objective of this component is to improve water management primarily aimed at building resilience to increased drought conditions in Guyana's agriculture sector. The main activities will be as follows:

- Review existing water harvesting practice and techniques used by large scale agriculture companies in region 9.
- Conduct a detailed assessment of the status and availability of water resources in Region 9 including consideration of how these resources can be accessed by potential agricultural lands.
- Conduct a geo-hydrological study of the aquifers, due to declining aquifer levels.
- Conduct research to identify drought prone areas in region 9 and drought tolerant crop species, including high value/ low volume crops, which could be deployed in these areas.

[xxiv] The components and activities of this project draws on two ECLAC reports (as follows), as well as consultation with the MoA Guyana: (1) United Nations Economic Commission for Latin America and the Caribbean (ECLAC). (2011). An assessment of the economic impact of climate change on the agriculture sector in Guyana. United Nations, and (2) United Nations Economic Commission for Latin America and the Caribbean (ECLAC).(2005). Guyana socio-economic assessment of the damages and losses caused by the January-February 2005 flooding. Santiago. United Nations.

Component 2- Diversified and integrated approach to agri-business:

The objective of this component is to develop a diversified and integrated approach to agri-business in Guyana to reduce the vulnerability of the sector to climate change. The main activities will be as follows:

- Review and update the Agriculture Diversification Strategy based on commercialization of the sector, and on interventions compatible with the National Agricultural Sector Plans. These should include detailed market appraisals of the potential opportunities for Guyana to diversify into organic, and niche crops supplying a wider regional market, and the development of food processing facilities.
- Facilitate distribution of appropriate planting materials (through use of bio-technology and restoration of nurseries).
- Strengthen credit facilities and agrarian extension services.
- Support the development export markets for diversified products. This should build on the existing work undertaken by the New Guyana Marketing Corporation (GMC) and including the elaboration of a market information system.

Component 3- Sustainable farm management systems:

The objective of this component is to integrate climate resilience into programmes for developing sustainable farm management systems. The main activities will be as follows:

- Develop dynamic farm/agricultural management tools that integrate climate change risks into existing and emerging management systems to facilitate adaptation.
- Identify and build on successful strategies and traditional knowledge of adaptation by the agricultural sector to climate change already being implemented.
- Develop, where possible, environmental management systems for agriculture. These should also include an appraisal of and implementation plan for the opportunities arising from changing land use change and management, low-tillage practices, and organic fertilizers.
- Conduct feasibility study of instituting crop insurance[xxv] exploring how crop insurance has been piloted in other countries, for example in Haiti[xxvi].
- Conduct a longitudinal study on the impacts of climate change on the most notable and important pests and diseases affecting agriculture (NAREI, UG, and CARDI). This requires close collaboration with the Guyana Lands and Surveys Commission (GL&SC).
- Provide technical assistance and training in production and climate smart management techniques in the context of the National Agriculture Strategy. These could include cutting edge technologies in areas such as plant breeding, agrochemicals and fertilizer application, organic fertilizers, plant husbandry, and water conservation and management.

[xxv] It was noted during consultation with the MoA that the cost of insurance is high in areas where there is a high risk of flooding. This is an important consideration to take into account in the feasibility study and may primarily target hinterland areas.

[xxvi] It should be noted that Caribbean Catastrophe Risk Insurance Facility (CCRIF) and Caribbean Institute for Meteorology and Hydrology (CIMH) are currently disseminating a small crop insurance scheme which was piloted in Haiti.

- Showcase climate smart management techniques through the establishment of demonstration farms.

Component 4- Capacity-building:

The objective of this component is to enhance the adaptive capacity of Guyana's agriculture sector to a changing climate change. The main activities will be as follows:

- Conduct hazard and vulnerability mapping nationally to identify and prioritize agricultural regions/areas that are most vulnerable to the impacts of climate change, and integrate these considerations into planning and investment programmes for the sector.
- Develop tailor-made (based on the region) training in relation to drought - to be delivered in region 9, e.g., at Bina Hill Institute, St. Ignatius, Aishalton.
- Conduct a comprehensive review of human resource policies within the agricultural sector to include provisions for skills development through training on climate change and climate risk reduction to staff that are at the forefront of the supply chain, job recruitment and compensation packages for key positions that remain vacant.
- Identify and prioritize endogenous capacity constraints within the agricultural sector in terms of urgent and immediate needs for adaptation.
- Assist farmers to establish proper information management systems.
- Review legislation pertinent to the agricultural sector.
- Promote technology transfer to increase the productivity of labour and capital.
- Promote youth involvement in the agriculture sector.

Expected outcomes:

- **Expected outcome 1:** The agriculture sector in Guyana is more resilient to a changing climate.
- **Expected outcome 2:** The agriculture sector in Guyana is able to recover from weather-related extreme events, in particular drought, and develops resilience to meet market needs in the region.
- **Expected outcome 3:** A diversified and integrated approach to agri-business is promoted in Guyana.
- **Expected outcome 4:** Sustainable farm management systems are adopted and integrate climate resilience, including organic farming.
- **Expected outcome 5:** The adaptive capacity of Guyana's agriculture sector to cope with a variable and changing climate is strengthened.

Expected results:

Table 14: Overview of results and indicators

Results	Indicators
Improved water resource management	Better understanding of water harvesting practice and techniques used by large scale agriculture companies in region 9. The capacity for re-charging of coastal aquifers during the rainy periods is quantified. Investment on research and development of drought tolerant crops. Drought prone areas are identified and strategies for coping with drought conditions are promoted (e.g. mulching, shade vegetation, drip irrigation, alternative crops etc.). Training is conducted on drought in region 9.
Diversified and integrated approach to agri-business	A detailed assessment of the status of land and water resources in Guyana. Updated Agriculture Diversion Strategy. Market analysis of niche and organic crops undertaken and an implementation plan prepared and costed. Market analysis of opportunities for food processing to meet national and regional markets an implementation plan prepared and costed. The diversification of the agriculture sector in Guyana is enhanced. Technical assistance and training in production and management techniques is provided. Increased distribution of appropriate planting materials (through use of bio-technology and restoration of nurseries). Improved accessibility to land. Strengthened credit facilities and agrarian extension services. Improved farmers' capability and infrastructure for storage, value added and marketability of food products.
Upgraded sustainable farm management systems	New dynamic farm/agricultural management tools that integrate climate change risks into existing and emerging management systems to facilitate adaptation; and allow farmer level practices to be informed using climate information in planting and harvesting cycles. Diversification of crop selection and planting creating an interest in the sector in 'crop hedging' investment practices. Appraisal of and implementation plan for the opportunities arising from

Results	Indicators
	changing land use change and management, low-tillage practices, and organic fertilizers. Scale up existing projects or strategies of adaptation by the agricultural sector to climate change. New environmental management systems for agriculture. New crop insurance schemes. Identification of the impacts of climate change on the most notable and important pests and diseases affecting the sector. New public funded demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, agrochemicals and fertilizer application (including organic fertilizers), plant husbandry, and water conservation and management.
Increased capacity of the agriculture sector	Mapping of agricultural regions/areas that are most vulnerable to the impacts of climate change. Integration of climate vulnerability and into planning and investment programmes for the sector. Upgraded hydro-meteorological services. Review of human resource policies within the agricultural sector to include provisions for skills development through training on climate change and climate risk reduction to staff that are at the forefront of the supply chain, job recruitment and compensation packages for key positions that remain vacant. Consideration of endogenous capacity constraints within the agricultural sector in terms of urgent and immediate needs for adaptation. Information management systems established at the farm level. Reviewed Acts pertinent to the agricultural sector. Enhanced technology transfer to increase the productivity of labour and capital. Increased youth involvement in the agriculture sector.

Implementation arrangements:

It is expected that the NDIA will be the lead implementing agency for project and could work in close collaboration with the following institutional partners:

- Hydrometerological Service.
- Department of Natural Resources and the Environment (DNRE).
- Ministry of Communities – Guyana Water Incorporated (GWI).
- Ministry of Indigenous Peoples' Affairs (MIPA).
- University of Guyana (UG).
- Guyana School of Agriculture (GSA).
- Office of Climate Change (OCC)/ Project Management Office (PMO).

Stakeholder engagement:

The process of preparing this project concept note was guided by the general framework employed by projects prepared under the Guyana REDD+ Investment Fund (GRIF). Mr. George Jervis, Permanent Secretary (PS), Mr. Khemlall Alvin, Civil Engineer, Mr. Kelvin Thorne, Engineer, and Mr. Cymeon Nedd, READ M&E Officer were consulted on whether the project aligned with the strategic vision for the sector, how project can be tailored to address crucial gaps that exist in the sector. As project development continues outside the framework of the CRSAP preparation, relevant stakeholder groups are likely to be engaged including in the implementation phase, such as farmers' association district councils.

Economic justifications:

Agriculture in Guyana contributes approximately 20% to GDP, employs about 33% of the labour force and generates almost 40% of Guyana's export earnings[119]. With a total land area of 196,850 square kilometres and approximately 8.5% agricultural land, 2.1% arable land and 77.2% forest[120], Guyana's agricultural sector within the overarching principles of Guyana's Low Carbon Development Strategy will continue to play a significant role in the country's growth and development.

The two largest sub-sectors are rice and sugar. These are considered traditional agriculture commodities in Guyana with combined contribution to GDP of 6.8% or 34% of Agriculture GDP over the period 2009-2013[121]. The fisheries industry is also vital to Guyana economy and dietary intake. It contributes on average 2.8% of GDP over the period 2009-2013[122]. The aforementioned three sub-sectors are critical to agriculture in Guyana; however, the conditions associated with a changing climate will have adverse effects on these sectors and by extension Guyana's Economy. ECLAC estimates that under the IPCC A2 and B2[xxvii] scenarios (see Annex B for further information on the scenarios used), the cumulative cost, at a discount rate of 1%, if there is no adaptation in the sugar industry is US$300 million and US$177 million by 2050 respectively. For the rice industry, the cumulative cost if there is no adaptation is US$1,577 million by 2050 under A2 and US$340 million by 2050 under B2. The fisheries sub-sector is projected to accumulate losses of US$33.74 million by 2050 under A2 and gain US$19.68 million by 2050 under B2. The sum projected accumulated cost of

[xxvii] Derived from the PRECIS European Centre Hamburg Model (ECHAM).

climate change to these three sub-sections is over two times the GDP of Guyana in 2008 (US$935 million) by 2050 under A2 and half 2008 GDP under B2[123]. ECLAC did not cover the subsectors of non-traditional agricultural commodities and livestock due to the lack of data; however, it is noted that these sub-sectors in 2008 had about 3,000 enterprises including 50 commercial farms, 3,000 small farmers, and 4 stock feed plants and employed 5,000 persons directly in poultry[124].

It is also useful to consider the impacts of past extreme events on the sector, in particular flooding and drought. The 2005 floods resulted in damages to the sector amounting to US$52.6 million. The sub-sectors hardest hit were sugar, US$11.2 million, and rice, US$8.1 million. Non-traditional Agricultural Commodities sustained damages of US$28.8 million and livestock, US$2.9 million[125]. With overall costs of US$29 million and US$14.7 million respectively[126], the droughts of 1997 and 2010 resulted in damages to the two major subsectors, rice and sugar, resulting in losses in export earnings to the country and income to many households. More than 1500 Amerindian families in Southern Guyana, reliant on agriculture were affected and several rice farmers were forced to leave 35 % of their rice fields uncultivated[127]. Although not quantified, losses to the other subsectors of Livestock and Non-traditional Agricultural Commodities were numerous. During the 1997 drought, forest fires destroyed farmlands and other assets[128].

It is therefore expected that the benefits of this project largely outweigh the estimated costs (**US$13.48-14.18 million**), which is 30.84-32.45% of the estimated costs to Guyana by the 1997 and 2010 drought and 25.62-26.96% of the cost estimated for the 2005 floods. Diversifying the sector, research and development, capacity building in institutions and communities will result in significant avoided loss of crops and revenues. Additionally, several of the expected outcomes and lessons learnt from this project are transferable spatially (regional and international) and temporally (generations).

Social impacts:

This project aims to improve climate resilience of the agriculture sector in Guyana and has a number of intended positive social effects. Potential positive social impacts include:

- Improved food security.
- Improved water security.
- Empowered rural households, including small-scale farmers, women, youth and indigenous groups, through education, employment and other income-generating activities.
- Community and rural area development.
- Poverty reduction.
- New industry growth and development, creating jobs and employment in rural communities.

No negative social impacts are foreseen in the execution of this project.

Environmental impacts:

There are several positive impacts of this project will have on the environment. These are related to:

- Increase in crop diversity.
- Improved water availability and sustainability.
- Improved water and land use management.
- Strengthened environmental management systems for agriculture.

- Natural disaster risk reduction primarily drought risk.

Negative environmental spill over effects include potential increase in the use of pesticides and herbicides, increased deforestation (removal of trees for farming purpose) and soil degradation.

Project sustainability:

As part of the consultation, the limited availability of financial resources for developing procuring and delivering the project (including long term operation costs), was identified as a key challenge to the project sustainability. To address this, it was recommended that the MoA integrates this project into the work plan of current agencies (such as GLDA and NAREI), continuously build capacity of communities and staff, as well as actively collaborate with the University of Guyana.

The need for improved compensation packages for the Ministry's professionals was mentioned as critical to retaining valued technical expertise at the MoA level.

Potential risks and mitigation measures:

There are a number of risks that may impede the achievement of the project's objectives and impacts.

Table 15: Potential risks and mitigation measures

Potential risks	Risk management options
Farmers unable to pay user fees to access services required to mitigate climate change and natural disaster risk.	Enact policies and strategies that: align user fees with farmers' identifiable profit/loss; improve community relations among farmers by forming co-operatives; extend credit lines to farmers on a needs basis; introduce pre-payment schemes; provide guidance and training on financing and management; and, improve the financial literacy of farmers and the wider communities.
Farms location proximity to water sources	Realign farmlands to surface water by: developing agriculture in new localities and/or creating conservancies, canals and trenches to manage water supply. Review land use planning practices to ensure that the most suitable land for agriculture over time is allocated for cultivation and husbandry.
Farms insurability criteria are not well established	Engage financial institutions and other stakeholders to establish criteria for insurance and compensation. Review legislations governing financial institutions such as insurance companies, credit unions and micro-financing companies. Draw on established legislations in other jurisdictions.

Potential risks	Risk management options
Technical resource capacity is low, resulting in projects failing to be implemented and deliver against objectives.	Draw on lessons learnt from previous projects Monitor and evaluate activities of the project through periodic reports.
Financial resource capacity to manage the scale of funding, resulting in efficiencies, poor due diligence and accounting.	Seek funding for institutional capacity building and strengthening within the MoA.

4.1.1.3 Summary budget and investment plan

Total estimated project costs (US $): US$13.48-14.18 million

The budget proposed below provides a high level estimate of the financing required to implement this project. This cost includes estimates for activities included in the project that were added as part of the consultation with the MoA and for which no readily documented source is available. The estimates are also based on assessments undertaken in 2005 and 2011 and have been adjusted for inflation for the aforementioned years to 2014. It is inevitable that costs will change given that there will be a time lag between the proposal and implementation. Thus to minimize costs and maximize returns, a detailed cost-benefit analysis is required. The actual cost of the project is likely to be at a minimum falling within the range estimated above.

Table 16: Total estimated project costs

Components	Duration	US$Mn (est.)[xxviii]	US$Mn (adj.)[xxix]	Source
Water resource management	3 years	US$4.5[xxx]	US$4.60-4.76Mn	ECLAC, 2011a
Develop a diversified and integrated approach to agri-business in Guyana	3 years	US$1.5	US$2.25-2.41Mn	ECLAC (2005)
Integrate climate resilience into programmes for developing sustainable	3 years	US$1.5	US$2.25-2.41Mn	ECLAC (2005)

[xxviii] Cost reported is as was reported in the literature reviewed.

[xxix] Figures are adjusted for inflation. Adjustments are made from the year, if stated, of the quoted amount; otherwise the reporting year is used. Inflation in Guyana for the periods: 2005-2014 was approximately 55% (CPI) to 66% (GDP deflator); 2009-2014, 16% (CPI) to 28% (GDP deflator); and, 2011-2014, 8% (CPI) to 19% (GDP deflator) (World Bank, 2015). Nominal exchange rate, G$: US$, depreciation over the same periods were approximately 3.28%, 1.22%, 1.19%.

[xxx] High estimates based on activities identified by the MOA. Research and Development into drought tolerant crops estimated at US$1 million (2014 prices) per year.

Components	Duration	US$Mn (est.)[xxviii]	US$Mn (adj.)[xxix]	Source
farm management systems.				
Build adaptive capacity to climate change in the agricultural sector	3 years	US$3.3[xxxi]	US$4.38-4.60 Mn	ECLAC (2005)
Total	-	-	**US$13.48-14.18Mn**	-

Possible sources of funding:

Existing sources of funding that have been accessed for similar initiatives include:

- Ministry of Finance (MoF).
- International Fund for Agricultural Development (IFAD).
- World Bank.
- EU – 11th European Development Fund (EDF) which is providing 34M Euro for the MMA Phase II.

Potential new sources of funding could include:

- Adaptation Fund.
- GEF-Small Grant Programme
- Green Climate Fund (GCF)
- GFDRR
- Japan – Fast Start Finance
- USAID
- Special Climate Change Trust Fund (SCCF)

It is however, important to note that this list should not been seen not exhaustive and could be extended based on a more detailed analysis of financing options for the proposed project. In addition, it is important to recognise that most of these funds will likely require co-financing and/or in-kind assistance from the lead implementer (project proponent) and/or GoG.

[xxxi] An additional US$1.15 million (2014 prices) was included to upgrade Hypo-meteorological service and promote youth involvement in the agriculture sector.

PCN Annex A- National Agriculture Strategy twenty-five priorities for success. Source: Guyana's National Agriculture Strategy 2013-2020

Priority 1 is sustaining and expanding Guyana's Agro-Diversity Policy and Program	**Priority 2** is a new focus on Farming Systems and Techniques, Biotechnology and Precision-Agriculture.
Priority 3 which reaffirms that Water Security and, therefore, Water Management is crucial for success;	**Priority 4** is a strengthened focus on Infrastructure Development (other than drainage and irrigation structures) for the agricultural sector.
Priority 5 establishes Soil Health as a major priority in the development of a modern and effective agricultural sector, assuring food security, economic benefits and environmental protection.	**Priority 6** is Plant and Livestock Health and Protection as a platform for modern agriculture practices in Guyana.
Priority 7 commits to an increased Livestock Production as a priority in the agriculture strategy and in the diversification of Guyana's agriculture portfolio.	**Priority 8** Increased Production of Fish Products is important in the diversification of the agriculture profile and in supporting a growth of agriculture in Guyana.
Priority 9 Sustained High Production of Rice is critical to maintaining annual growth increase in the agriculture sector and in maintaining high export earnings from agriculture	**Priority 10** Increasing Sugar Production to 450,000 tonnes per year
Priority 11 Increased Production and Diversification of Crops	**Priority 12** Agro-Processing and Value-Added will become a new growth pole for agriculture in the Agriculture Vision 2020
Priority 13 identifies Marketing as an important area for realizing the vision of an agricultural sector being the vehicle for economic and social prosperity in Guyana.	**Priority 14** recognizes the importance of Transportation, Packaging, Storage and Cargo Space Facilities as crucial elements to support a modern and more effective agricultural sector.
Priority 15 reiterates the imperative of a secured agriculture workforce through Human Resource Development as part of our strategy to accelerate agricultural development in Guyana.	**Priority 16** addresses Food and Nutrition Security and Safety as fundamental imperatives for agricultural development in Guyana;
Priority 17 orients Guyana's Agricultural Sector to build a capacity for Agro- fuels (bio-fuels)	**Priority 18** is Environmental Sustainability through the agricultural sector;
Priority 19 commits Guyana to further develop its Agriculture Risk Reduction and Disaster Management Program	**Priority 20** identifies hydrometeorology and weather forecasting as part of the lives of the farmers.
Priority 21 seeks to make Land Availability, Land Zoning and Land Tenure for Agriculture easier for farmers and entrepreneurs.	**Priority 22** is significant Long-Term Investment in Research and Development as an important pre-requisite to raise productivity, improve profitability and enhance competitiveness.
Priority 23 is a strengthened Organizational Structure	**Priority 24** is a Policies and Legislative Framework
Priority 25 is a Program of Financing Mechanisms for Agriculture.	

PCN Annex B- Overview of the scenarios used in the ECLAC (2011a and 2011b) study

- BAU – The business as usual scenario was developed for the period 2011 to 2050 by applying a two period moving average to the historical disease data.
- A2 - Countries are assumed to operate on the basis of self-reliance and increased heterogeneity with a focus on regional sources of wealth and a slower profile of per capita economic growth and technological change. Additionally, fertility patterns converge slowly across the regions of the world and results in a continuously increasing population.
- B2 - Emphasis is placed in this context on local solutions to ensure economic, social and environmental sustainability. Similar to A2, the population increases continuously but at a comparatively lower rate. Economic development is intermediate and the rate of technological change is less rapid and more diverse than in the alternative A1 and B1 scenarios, neither of which is considered here. The environmental protection and social equity focus is at the local and regional levels.

4.1.2 Guyana's sea defence enhancement and maintenance

Project description:	The aim of this project is to enhance the resilience of Guyana's sea defence systems to a variable and changing climate. This will be achieved through coordinated and complementary actions of mangrove development and restoration and supporting the rebuilding of the most critical sea and river defences in low-lying coastal areas. This will help increase the coverage of and strengthen the existing sea defence against high tide and sea level rise, which in turn will reduce flood risk in coastal communities.
Location:	East Bank Berbice from Logsdale, Brothers, Sisters and up to Mara- Region 6
Potential implementing entity:	Works Services Group (WSG), Ministry of Public Infrastructure (MoPI), Georgetown, Guyana
Indicative project duration and timeline:	2015-2020
Indicative project costs (US $):	US$41.96-46.29Mn

4.1.2.1 Background and rationale

Problem statement

Guyana has a low-lying coastline of approximately 459 km (285 miles) and a land area of approximately 214,970 km2. The land area can be divided into coastal and hinterland with approximately 90% of the total population of 751,223 living on the 15,000 km2 area of low-lying coast (ECLAC, 2011b). The three most populous administrative regions, four of the five major commercial towns and the capital city, Georgetown, home to 191,810 persons, are located on Guyana's coast. The majority of Guyana's coastal zone is below sea level and relies largely on engineered (seawalls and rip raps) and natural (mangroves) sea defence structures to protect the coast from the Atlantic Ocean.

In Regions 2, 3, 4, 5 and 6 sea defences structures protect approximately 244 km of the coastline; 22.81km are in either poor or critical condition (Ministry of Public Works, 2014). Moreover, 578 km2 of mangroves were destroyed between 2001 – 2011 in Regions 1, 2, 3, 4, 5 and 6 (Singh, 2011) causing negative effects on local fisheries and associated livelihoods, as well as leading to higher risk of flooding.

Climate impacts, vulnerabilities and risks:

Climate change is expected to lead to increased flood risk, erosion, saltwater intrusion, loss of arable lands, freshwater shortage and contamination, and potential loss of coastal ecosystems in lower elevation coastal zones, through increases in rainfall intensity and sea level rise. For Guyana, approximately 45% of the coastline is subject to erosion, freshwater resources are becoming increasing susceptible to salt water intrusion and flooding, and wetlands/mangroves are being threatened by sea level rise, increases in sea surface temperature and increases in extreme weather events (ECLAC, 2011b). The impacts of variable climate and climate change on these resources will have adverse consequences for key economic sectors including agriculture, manufacturing, tourism and housing and construction.

Guyana is identified as one of the most vulnerable CARICOM member states (alongside Suriname and Belize), to sea level rise as a majority of its coastal zones are close to sea level. Climate change is causing oceans to expand (thermal expansion), and this together with the melting of glaciers and melting and increased ice loss from Greenland and West Antarctic is increasing sea levels (National Geography, 2014). Studies suggest that by 2050, sea level rise could range from 8.9cm to 40cm and by 2100, this range could increase to 18 cm to 215 cm (see Annex C). More recently, National Geography (2014) suggested that,

> "Core samples, tide gauge readings, and, most recently, satellite measurements tell us that over the past century, the Global Mean Sea Level (GMSL) has risen by 4 to 8 inches (10 to 20 centimetres). However, the annual rate of rise over the past 20 years has been 0.13 inches (3.2 millimetres) a year, roughly twice the average speed of the preceding 80 years." (National Geography, 2014)

These observed and potential rates of sea level rise have and will continue to present challenges for Guyana. Increases in sea levels could have devastating effects on coastal habitats through the flooding of low-lying coastal communities, flooding of arable land and wetlands, contamination of aquifers and rivers associated with salt water intrusion and destructive erosion and loss of mangroves which are habitats for fish, birds, and plants species. Over the long-term, the expected impact of climate will become more costly. Simpson et al (2010) estimates the potential impact of sea level rise on CAIRCOM members using a mid-range sea level rise scenario (1 meter sea level rise) and a higher range scenario (2 meter level rise). They find that a sea level rise scenario of 1 meter could by 2050 cost Guyana US$21,214 million in GDP. At this same level, the total capital stock at risk is valued at US$427 million (this includes roads valued at US$27 million), power plants valued at US$208 million, property valued at US$87 million, dryland valued at US$84 million and wetland valued at US$21 million. At a higher range scenario, by 2050, capital stock at risk increase to US$991 million (Simpson et al, 2010). Similarly, ECLAC (2011b) estimates that a one (1) meter rise in sea level is expected to increase the risk of inundation across all administrative regions with Regions 4 and 6 the most exposed. Over the long term, it is estimated that exposed assets will increase under both A2 and B2 (see Annex A for further information on the scenarios used) by as much as 4 and 5 times 2010 asset exposure levels (i.e. US$3.2 billion) (ECLAC, 2011b).

Guyana's sea and river defence system is therefore critical to adapt the potential adverse effects of climate change. However, an assessment carried out by Dalrymple and Pulwarty (2006) indicates sea level rise are likely to cause significant increases in overtopping discharges for sea defences; increased flood volumes and frequency; enhanced coastal erosion; and, increased rate of shoreline

recession in areas not protected by seawalls. Spring tides in 2013 provide evidence of the vulnerability of low-lying coastal communities to overtopping and flooding. The water topped the sea wall flooding roadways and limiting economic and social activities in the surrounding areas of the breach.

> "On Sunday [April 28,2013], about 05:30h, 1.5 metres of waves riding on top of a high tide of 3.11 metres overwhelmed the sea defence between Liliendaal and Vlissengen Road, causing inundation of the northern half of the Rupert Craig Highway and the subsequent flooding of adjacent areas inclusive of Kitty, Subryanville, Bel Air Park, and Liliendaal" (Guyana Times, 2013)

Closely interlinked is the drainage and irrigation system which is connected to the 136 sluice gates/kokers which are located in the seawall; however, with sea level rise, consequentially limiting the number of low tide days, opening of the sluice gates/kokers to expel water out to sea is becoming increasingly restrictive hence increasing the risk of flooding and further exposing Guyana's population and assets located in low-lying coastal regions. Additionally, blocked drains and disabled pumps exacerbate the problem of water expulsion. Therefore, the functional relationship between the drainage and irrigation system and the sea wall needs to be optimized for both to efficiently preform their critical roles. A fault in one could comprise the integrity of the other and efforts are on the way to address some of the shortcomings of the drainage and irrigation system. This proposal is aimed at enhancing the resilience of the sea defence systems (See Annex B and C for further information on projected air temperature and annual rainfall anomalies for 2071-2100 relative to 1961-1990 for South America and projected global sea level rise.) These effects associated with climate variability and climate change have implication for a wide cross-section of Guyana.

Rationale:

Climate change places Guyana's low-lying coastline at risk from increased rainfall intensity and rising sea levels. In this context, it should be recognised that seawalls and mangroves represent Guyana's first line of defence against high tides. The ability of the sea defence structures to protect the land behind them has historically been reinforced by a wide belt of mangrove forest extending as much as a mile into the intertidal zone and acting as a wave-energy dissipating buffer to threats from storms and high tides.

Despite the significant investments to rehabilitate sections of Guyana's sea defence system, the 2014 survey of Guyana's sea defence structures, which covered 91.2% of the total length, shows that 2.28 km (1%) is in critical condition, 20.53km (9%) is poor and 80.22km (34.4%) is in fair condition (see Table 19 below) (WSG, 2014).

Table 179: Surveyed Sea Defence Structures Length and Conditions by Region. Source: WSG (2014)

Condition	Region 2	Region 3	Region 4	Region 5	Region 6	Total (km)
Good	14.42	19.03	19.95	45.71	30.733	129.84
Fair	33.87	13.45	13.33	3.28	16.29	80.22

Poor	4.70	1.00	3.72	0	11.11	20.53
Critical	0.70	0.16	0.41	0	1.01	2.28
Total (km)	53.69	33.64	37.41	48.99	59.14	232.87

Region 2, 4 and 6 have the weakest points in the line of defence. A one (1) meter rise in sea level is expected to increase the risk of inundation across all administrative regions; however, Regions 4 and 6 have the highest expected exposure (ECLAC, 2011b). The most vulnerable Regions, 2, 4 and 6, account for 64.8% of the sea defence structure. It should also be recognised that in both Regions 2 and 4, the sea defence structure is mainly composed of hard structures (58% and 82% respectively); whereas, Region 6 is mainly composed of soft structures (83%). Although only 11% of the sea defence structure in Region 4 is poor and critical, relative to 10% in Region 2 and 20% in Region 6, Georgetown is located in Region 4 and as such, the value at risk is higher in Region 4 than in Region 2 and 6 (see Annex D for further information on locations of sea defences for Regions 2-6).

Guyana's sea defence system consists of hard (e.g. concrete sea walls) (109.27km) and soft engineering structures (also called managed realignment, e.g. mangroves) (123.67km). Mangroves function as natural breakwaters along the coast and represent one of the most important natural sea defences available for Guyana. Administrative Regions 3 and 4, which are two of the most densely populated areas in Guyana, have experienced significant depletion of mangrove forest. Mangroves also protects the seawall by reducing the impact of wave action on the sea wall, in several places, especially the Low Elevation Coastal Zone (LECZ) for administrative -Regions 1 through 6, which are approximately 0.5m to 1m below the coastal high of Regions 2 to 6. According to ECLAC (2011b), this has resulted in the reduction of breaches associated with wave action.

Mangroves are highly vulnerable to climate change, in particular sea level rise, which could destroy or damage mangroves and with it coastal habitats and fisheries infrastructure such as landing sites. ECLAC (2011a) identifies that climate change could impact fisheries abundance, fisheries areas and species mix, which in turn increases the vulnerability of the subsistence/small scale fishing community resulting from fewer available options for livelihood. In this respect, it is important to note that over the past five years fisheries accounted for about 14% of the country's agricultural sector GDP (Bank of Guyana, 2013). Fish is also the major source of animal protein in Guyana (ECLAC, 2011a).

Against this backdrop, this project will aim to minimise risks of coastal flooding and erosion, by supporting the rehabilitation and reconstruction of sections of the sea wall, as well as restoration of mangrove ecosystems where appropriate. Another important aspect of this project is raising public awareness, especially amongst the fishing communities, by informing and sensitizing the communities about climate change, the possible impacts on their livelihoods, possible ways to adapt and the importance of the mangroves eco-system.

The project is consistent with the priorities for adaptation identified in the Low Carbon Development Strategy (LCDS) for 'Upgrading infrastructure and assets to protect against flooding through urgent, near-term measures'. This project is also consistent with the delivery of national objectives and

targets identified in the Guyana's Sea and River Defence Strategy, which aims at "[reducing] 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."(WSG, 2012). It continues to build on efforts to reconstruct and rehabilitate critical sections of the sea wall as well as promote mangrove restoration and development. Additionally, there are important synergies between this project and the following strategic and policy frameworks: the National Mangrove Management Action Plan 2010-2012, Code of Practice for Mangrove Harvesting and Guyana's National Development Strategy (GCCA, 2012).

The proposed project will build on and maximise synergies with existing and/or ongoing regional and national initiatives. This will include, in particular the EU support to the Sea and River Defence sector including the 8th EDF which focused on rebuilding critical sections of sea walls (WSG, 2012), and the EUR €17.01M programme funded by the 9th EDF for the rehabilitation and reconstruction of sea defences (reconstruction of 1.5 km and rehabilitation and maintenance of 18 km) and the provision of technical assistance for capacity building and institutional strengthening. The current ongoing 10th EDF is providing support through a Budget Support Programme that aims to ensure construction of 8.98 km, rehabilitation of 4.925 km and maintenance of 59.2 km of sea and river defences. Assistance has been provided last year to prepare the Costed Sea and River Defence Sector Policy. The programme has also supported a 2014 Memorandum of Understanding (MoU) on shore zone management between the former Ministries of Public Works, Agriculture and Natural Resources and the Environment. Further technical assistance is planned for this year to prepare a revised Sector Policy, a Sector Strategy and a Coastal Engineering Manual. Looking to the future, the 11th EDF will focus on future sea defences and a new conservancy between Mahaica Mahaicony Abary water catchments. The programme objectives are i) continued enhancement of Guyana's protection against sea damage through integrated coastal management, with benefits to the population and economic activity in low-lying parts of the coastal regions and ii) improving Guyana's upper stream catchment areas management, to strengthen flood control and prevention capacities, through new dams, embankments and drainage canals, strengthening the cost recovery system for rehabilitation and maintenance while increasing water availability for efficient irrigation during dry seasons through irrigation pumping and conservancy systems and protecting its rich biodiversity. Other initiatives include:

- The Global Climate Change Alliance (GCCA) funded EUR€ 4.165m programme 'Sustainable coastal zone protection through mangrove management in Guyana', which aimed at mangrove restoration and development with a view to reduce flood risk associated with climate change and climate variability and improve the protection to coastal zone biodiversity whilst contributing to carbon sequestration through reforestation and forest preservation (GCCA, 2012). Completed in 2010, the project has laid the foundation for further work in this area, by providing several lessons learnt, including the need to: thoroughly analyse identified sites; identify necessary infrastructure support; create the best environment to promote natural regeneration; and, promote community and women's involvement. A new and updated National Mangrove Management Action Plan (NMMAP) has been developed under the Sector Policy Support Programme (SPSP) (GCCA, 2012).

- The Caribbean Development Bank (CDB) - funded US$ 25M 'Sea and River Defence Resilience Project (February 2014 to December 2017)' which involves the reconstruction and improvement of approximately 5.4km of sea and river defences (CDB, 2014).

4.1.2.2 Project description

Project aims and objectives:

The overall aim of this project is to enhance the resilience of Guyana's sea defence systems to a variable and changing climate. This will be achieved through coordinated and complementary actions of mangrove development and supporting the restoration and retrofitting the most critical sea and river defences in low-lying coastal areas. This will help increase the coverage of and strengthen the existing sea defence against high tide, which in turn will reduce flood risk in coastal communities.

The specific objectives of this project are to:

- Support sustainable coastal zone protection through mangrove restoration and development.
- Build on past and ongoing efforts to reconstruct, rehabilitate and maintain critical sections of the sea wall, in particular the EU support to the sea and river defence sector (see section above).
- Develop and implement a public awareness programme, especially among the fishing community, on climate change, the importance of mangrove eco-systems and alternative livelihood programmes.

Project components and activities:

The project components and corresponding activitiesxxxii of this project are as follows:

Component 1- Sustainable coastal zone protection through mangrove restoration and development:

The objective of this component is to promote sustainable coastal zone protection through mangrove restoration and development. The main activities will be as follows:

- Mangrove monitoring, development and research.
- Development and implementation of a re-planting programme for mangroves.
- Review, revise and support the implementation of mangrove conservation programmes, policies and legislation.
- Review and harmonise existing legislation and define functionalities of entities relating to mangroves.

Component 2- Reconstruct, rehabilitate and maintain critical sections of the sea wall:

The objective of this component is to build on past and ongoing efforts to reconstruct, rehabilitate and maintain critical sections of the sea wall. The main activities will be as follows:

- Conduct survey to establish material needs
- Inspection and evaluation of existing sea and river defence structures.

[xxxii] The components and activities of this project draws on ECLAC (2011a), ECA (2009) and consultation with WSG, MoPI.

- Design structures that will be resilient to the projected climatic conditions.
- Reconstruct and rehabilitate selected sections of the sea wall.
- Utilise other defence techniques such as riff-raff and groynes.

Component 3- Public awareness programme, especially among the fishing community:

The objective of this component is to develop and implement a public awareness programme, especially among the fishing community, on climate change, the importance of mangrove eco-systems and alternative livelihood programmes. The main activities will be as follows:

- Disseminate information and garnering feedback through communities/stakeholders involvement.
- Prepare an education campaign to raise awareness on the importance of mangroves and the impacts of climate change.
- Promote participation of fisher folks in mangrove planting and restoration, for instance through promotion of alternative livelihoods (beekeeping, birdwatching, aquaculture).
- Design public awareness materials.

This is linked to the national programme for public awareness of sea and river defence which has not been implemented due to the lack of requisite expertise within the WSG.

Expected outcomes:

- Expected outcome 1: Guyana's sea defence system is more resilient to a changing climate.
- Expected outcome 2: Sea defence systems are restored and retrofitted.
- Expected outcome 3: Mangrove are replanted and restored.
- Expected outcome 4: Coastal communities are protected against coastal flooding.
- Expected outcome 5: The general public is sensitised about the impacts of climate change and the importance of mangrove eco-system to the sea defence mechanism and livelihood, including among the fishing community.

Expected results:

Table 180: Overview of results and indicators

Results	Indicators
Strengthened sea and rive defence structures	Sea defences constructed and rehabilitated in poor and critical areas
New and restored mangrove plantations	Increase in coverage of Guyana's mangrove forest Mangrove stands are monitored regularly and disturbances are reported.
Increased awareness amongst the general public and in particular	General public and fisher folks sensitised on the implications of climate change and the importance of sea defences

Results	Indicators
the fishing community, about the implications of climate change, and the importance of sea defences	

Implementation arrangements:

It is expected that the Ministry of Public Infrastructure (MoPI) will be the lead implementing agency for project and will work in close collaboration with the following institutional partners all of whom are represented on the Sea Defence Board:

- National Drainage and Irrigation Authority (NDIA), Ministry of Agriculture (MoA).
- Fisheries Department, MoA.
- Environmental Protection Agency (EPA).
- Ministry of Local Government and Regional Development (MoLG&RD) including Regional Democratic Councils (RDCs).
- Civil Society Organisations (CSOs) and Non-Governmental Organisations (NGOs).

Stakeholder engagement:

The process of preparing this project concept note was guided by the general framework employed by projects prepared under the Guyana REDD+ Investment Fund (GRIF). Mr. Geoffrey Vaughn, Coordinator of the Work Services Group at the MoPI was consulted on whether the project aligned with the strategic vision for the sector, how project can be tailored to address crucial gaps that exist in the sector. As project development continues outside the framework of the CRSAP preparation, relevant stakeholder groups are likely to be engaged.

Economic justifications:

Significant investments are needed to repair and upgrade Guyana's existing sea defence system, including both hard (e.g. concrete sea walls) and soft structures (e.g. mangroves), with a view to protect US$3.2 billion in exposed physical assets and 90% of Guyana's population located along the low-lying coastline against the adverse impacts of a changing climate, including increased risk of coastal flooding and coastal erosion. In particular, it is important to note that mangroves are valued at US$4,624 million, including direct economic benefits such as fishing, food, fuel; indirect use such as shoreline protection for exposed assets and carbon sequestration[xxxiii]; and, non-use values (ECLAC, 2011b). These total benefits largely outweigh the estimated costs (i.e. US$5.6 million) of Component 1 of this project aimed at restoring and replanting mangroves.

The benefits of restoring and developing mangrove plantations as well as public education for fishing communities are not immediate as mangrove growth and maturity could take years; however in the medium to long run the fisheries industry and other eco-system based products and services industries will benefit. ECLAC (2011a) estimates that without adaptation in the fisheries industry the cost under A2 Climate Scenario, at a discount rate of 1%, is US$ 33.74 million. However, with

[xxxiii] Carbon sequestration is estimated to be 17 metric tonnes of carbon/hectare/year.

adaptation, over the medium to long term, the net benefits are estimated to be valued at US$ 20 million (ECLAC, 2011a).

Assuming a moderate, one (1) meter, rise in sea level the risk of inundation across all Administrative Regions, with Regions 4 and 6 the most exposed, increases. Simpson et al (2010) estimated that a sea level rise scenario of 1 meter could by 2050 cost Guyana US$21,214 million in GDP. Similarly, ECLAC 2011b estimates that exposed assets will increase under both A2 and B2 by as much as 4 and 5 times 2010 asset exposure levels (i.e. US$3.2 billion). Although adaptation measures have been taken by the Government of Guyana, there is still residual vulnerability which increases every year given the state of technology. ECLAC, (2011b) suggests that adaptation measures could reduce, by the year 2100, the average annual vulnerability within the low-lying coastal communities by approximately US$15.54 billion which is approximately 1,424% of (14 times) the estimated GDP in 2010 (ECLAC, 2011b). This proposed project, which is aimed at enhancing the resilience of Guyana's sea defence systems to a variable and changing climate, could cost a minimum in the range US$41.96-46.29 million, which is 1.8-2% of GDP in 2010.

Social impacts:

This project aims to improve climate resilience of the sea defence sector in Guyana and has a number of intended positive social effects. Potential positive social impacts include increased livelihood security of the coastal dependent vulnerable community even during difficult periods such as droughts and marine fisheries off-season. The project will also raise greater awareness about climate change and the importance of mangroves and eco-system products and services. These will lead to greater diversification of income sources in coastal communities especially over the medium to long term.

One potential drawback especially in the early stages of the project, is the loss of revenue to persons who are usually dependent on mangroves to produce goods and services and whose activities will be restricted during this time so as to protect and allow for the growth of the mangrove forests. One way to mitigate this is to employ persons most vulnerable to this restriction to aid the development, restoration and protection of the mangroves. Otherwise, alternative employment opportunities must be provided for these persons. It is therefore imperative that coastal communities are involved in the different components of this project.

Environmental impacts:

Potential positive impacts of this project relate to the reforestation and expansion of the mangrove forest. This contributes to the seafood needs, wild vegetables and fuel wood for cooking purposes for the local community. This may reduce the pressure on other natural resources like corals, sand dunes and terrestrial forests. In addition, they also perform a large number of regulatory ecological functions, which support economic activity, such as nutrient retention, flood control, ground water recharge, microclimate stabilization and shoreline stabilization etc. Over the long term, this in turn lead to the restoration and regeneration/repopulation of breeding grounds and habitat for several fishes, birds, turtle and other plant and animal species.

No negative environmental spill-over effects are foreseen in the execution of this project.

Project sustainability:

As part of the consultation, the following key challenges to the project sustainability were identified:

- Limited availability of financial resources in particular for the long term operational and maintenance costs of structure.
- Inadequate interagency collaboration and coordination.
- Limited human resources at the lower levels.
- Lack of the awareness of the public of the role of sea defences.

A number of measures to address these key challenges were suggested by the WSG, as follows:

- Implementation of a sea defence tax for regular maintenance and upgrade works to the sea and river defence system. This could be in the form of a budgetary allocation the institution(s) responsible for the maintenance and upgrade of the sea defence system.
- Increased remuneration for staff in junior positions to increase human resources.
- Sustained implementation of public awareness by establishing cooperation with local communities, especially with the fishing community, whose livelihood is closely linked to coastal ecosystems sustainability.

The MoPI should also seek additional funding to develop institutional capacity, as well as collaborate with Non-Governmental Organisations (NGOs) to enhance project delivery, including schools and churches in the mangrove restoration and development component.

Potential risks and mitigation measures:

There are a number of risks that may impede the achievement of the project's objectives and impacts.

Table 21: Overview of potential risks and risk management options

Potential risks	Risk management options
Technical resource capacity is low, resulting in projects failing to be implemented and deliver against objectives, including availability of agronomist for mangrove development.	Draw on lessons learnt from previous projects Monitor and evaluate activities of the project through periodic reports.
Financial resource capacity to manage the scale of funding, resulting in efficiencies, poor due diligence and accounting.	Seek funding for institutional capacity building and strengthening within the MoPI.
Sufficient operational funding	Community and other stakeholder involvement are critical in

Potential risks	Risk management options
to maintain sea defence structures once the project has been implemented and initial capital funding has been deployed.	shaping the 'ownership' of the programmes and continuity of their activities. Local and Central Government support may be required to continue some activities. Other future funding sources include community based fund raising activities, volunteerism, the private sector and grants.
Public buy-in regarding the implications of the climate change for the sea defence sector and coastal ecosystems including mangroves.	Launch a public awareness-raising campaign on the implications of climate change on sea defence and mangrove ecosystem. Develop alternative livelihoods for local communities (e.g. beekeeping, aquaculture, birdwatching).

4.1.2.3 Summary budget and investment plan:

Indicative costs: US$41.9-46.29 million

The budget proposed below provides a high level estimate of the financing required to implement this project. The actual costs are likely to have minimum cost falling within the range estimated above. The estimates are based on assessments undertaken in 2009 and 2011 but have been adjusted for inflation for the aforementioned years to 2014. It is inevitable that the cost for this project will change given that there will be a time lag between the proposal and implementation. For costs minimization and returns maximization, a detailed cost-benefit analysis is required as well as periodic reporting for monitoring and evaluation, which is necessary to avoid cost escalation/overruns often associated with infrastructure projects.

Table 22: Indicative cost estimates

Components	Duration	US$Mn (est.)[xxxiv]	US$Mn (adj.)[xxxv]	Source
Mitigate flood risk through sustainable coastal zone protection through mangrove restoration and development.	n/a	US$5.6 Mn	US$5.98-6.59Mn	ECLAC (2011a)
Continue building on efforts to reconstruct, rehabilitate and maintenance critical sections of the sea wall.	n/a	US$30 Mn	US$34.38-37.94Mn	ECA (2009)

[xxxiv] Cost reported is as was reported in the literature reviewed.

[xxxv] Figures are adjusted for inflation. Adjustments are made from the year, if stated, of the quoted amount; otherwise the reporting year is used. Inflation in Guyana for the periods: 2005-2014 was approximately 55% (CPI) to 66% (GDP deflator); 2009-2014, 16% (CPI) to 28% (GDP deflator); and, 2011-2014, 8% (CPI) to 19% (GDP deflator) (World Bank, 2015). Nominal exchange rate, G$: US$, depreciation over the same periods were approximately 3.28%, 1.22%, 1.19%.

Components	Duration	US$Mn (est.)[xxxiv]	US$Mn (adj.)[xxxv]	Source
Develop and implement a sustained public information programme, especially among the fishing community, on impacts of climate change, the importance of mangrove ecosystem and alternative livelihood programmes	n/a	US$1.5Mn	US$1.60-1.76Mn	ECLAC (2011a)
Total	-	-	**US$41.96-46.29Mn**	-

*Cost reported is as was reported in the literature reviewed.
**Figures are adjusted for inflation. Adjustments are made from the year, if stated, of the quoted amount; otherwise the reporting year is used. Inflation in Guyana for the periods: 2005-2014 was approximately 55% (CPI) to 66% (GDP deflator); 2009-2014, 16% (CPI) to 28% (GDP deflator); and, 2011-2014, 8% (CPI) to 19% (GDP deflator) (World Bank, 2015). Nominal exchange rate, G$: US$, depreciation over the same periods were approximately 3.28%, 1.22%, 1.19%.

Possible sources of funding:

Existing sources of funding that have been accessed for similar initiatives include:

- Caribbean Development Bank (CDB) – US $25M.
- EU – 10th European Development Fund (EDF) – EUR € 14M.

In addition, it should be noted that the EU currently provides budgetary support and not project support. However, this may change in the future.

Potential new sources of funding could include:

• Adaptation Fund.

• GEF-Small Grant Programme

• Global Climate Change Alliance (GCCA)

• Green Climate Fund (GCF)

• Japan – Fast Start Finance

• USAID

• Special Climate Change Trust Fund (SCCF)

It is however, important to note that this list should not been seen as exhaustive and could be extended based on a more detailed analysis of financing options for the proposed project. In addition, it is important to recognise that most of these funds will likely require co-financing and/or in-kind assistance from the lead implementer (project proponent) and/or GoG.

- **Annexes:**

ANNEX A- Overview of the scenarios used in the ECLAC (2011a and 2011b) studies

- BAU – The business as usual scenario was developed for the period 2011 to 2050 by applying a two period moving average to the historical disease data.
- A2 - Countries are assumed to operate on the basis of self-reliance and increased heterogeneity with a focus on regional sources of wealth and a slower profile of per capita economic growth and technological change. Additionally, fertility patterns converge slowly across the regions of the world and results in a continuously increasing population.
- B2 - Emphasis is placed in this context on local solutions to ensure economic, social and environmental sustainability. Similar to A2, the population increases continuously but at a comparatively lower rate. Economic development is intermediate and the rate of technological change is less rapid and more diverse than in the alternative A1 and B1 scenarios, neither of which is considered here. The environmental protection and social equity focus is at the local and regional levels.

Annex B: Table MMM: Summary of Global sea level rise projections for 21st Century (Simpson et al 2010)

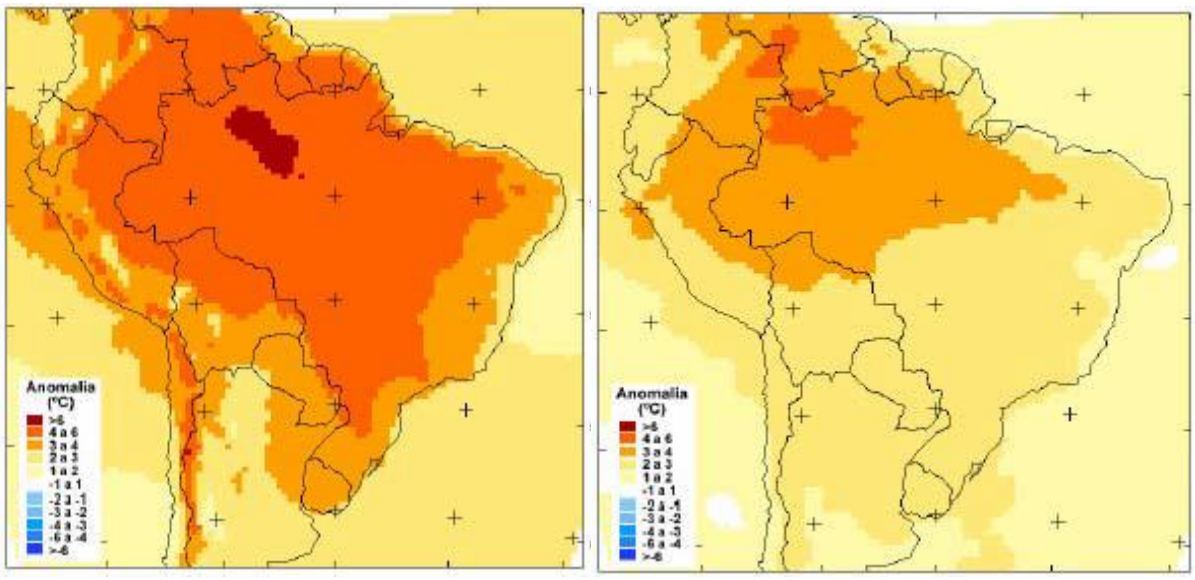
Research	2050*	2100		
Continuation of current trend (3.4mm/yr)	13.6 cm	-	30.6cm	-
IPCC AR4 (2007)	8.9 cm – 23.8 cm	18 cm	-	59 cm
Rahmstorf (2007)	17 cm – 32 cm	50 cm	90 cm	140 cm
Horton et al. (2008)	30 cm (approx.)	-	100 cm	-
Vermeer and Rahmstorf (2009)	40 cm (approx.)	75 cm	124 cm	180 cm
Grinstead et al. (2009)	-	40 cm	125 cm	215 cm
Jevrejeva et al (2010)	-	60 cm	120 cm	175 cm

*Where not specified, interpreted from original sources

ANNEX C- Projected air temperature and annual rainfall anomalies for 2071-2100 relative to 1961-1990 for South America.

Figure 1: Shows the projected air temperature anomalies for 2071-2100 (right) relative to 1961-1990 (left) (degrees Celsius) over South America for A2 and B2 scenarios (a Combination of: Eta CCS, RegCM3 and HadRM3P regional models.)

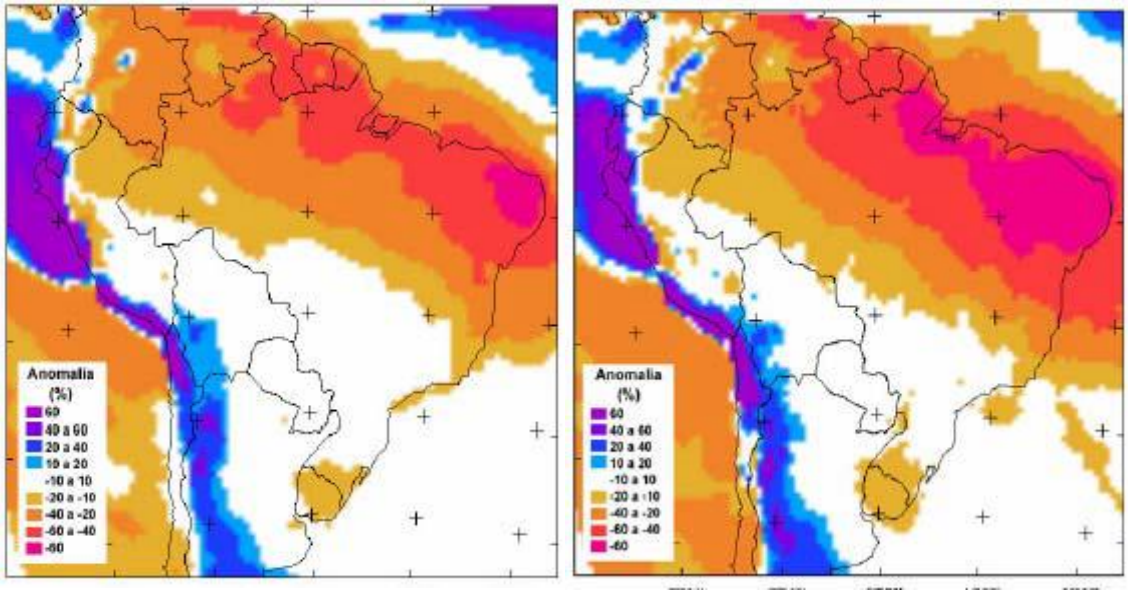
1961-1990 2071-2100



Source: Marengo (2009)

Figure 2: shows the projected annual rainfall (mm/day) anomalies for 2071-2100 (right) relative to 1961-1990 (left) (degrees Celsius) over South America for A2 and B2 scenarios (a Combination of: Eta CCS, RegCM3 and HadRM3P regional models.)

1961-1990 2071-2100



Source: Marengo (2009)

4.1.3 Public health adaptation to climate change

Project description:	The aim of this project is to increase the resilience of Guyana's health sector to a variable and changing climate. This will be achieved through strengthened national disaster risk management (with specific reference to health) and early warning response systems, enhanced access by communities to clean water and sanitation facilities and food hygiene, reduced impacts of water-borne diseases, increased human and physical sectoral capacity and increased public awareness.
Location:	Interior zone (regions 1, 7 and 9) and coastal zone (region 6)
Proposed lead implementing entity:	Ministry of Health
Indicative project duration and timeline	2015- 2018
Indicative project costs (US $):	US$17.35-18.60 million

4.1.3.1 Background and rationale

Problem statement:

Guyana's health sector already faces challenges including a limited number of health care professionals, shortages of equipment and supplies, and poor physical access to health facilities for some of the population. In 2013, there were approximately 15.3 professional nurses, 8.2 physicians and 21.5 health workers per 10,000 people (Ministry of Health Annual Report, 2013). The majority of health care professionals are concentrated in the coastal regions of Guyana.

The Ministry of Health (MoH) has initiated efforts to build resilience to the adverse effects of climate change. However, these efforts would have to be significantly increased to ensure that the sector is resilient to the emerging adverse climate change impacts. Several health facilities (e.g., hospitals, health centres), which are vital to responding to risks in vulnerable communities, are themselves currently vulnerable to climate change impacts, such as flooding, due to their locations. In addition, it is widely accepted that climate change may exacerbate the incidence of vector and waterborne diseases. In general, the sector would significantly benefit from a coherent approach to mainstream climate change considerations into existing policy frameworks.

Climate impacts, vulnerabilities, risks:

Heavy rains in the last nine days of December 2004 and early January, 2005, a brief dry period in the second week of January, 2005, followed by eight days of some of the heaviest rainfall recorded in

Guyana since 1888, an anomaly in Guyana's rainfall climatology[xxxvi] coupled with the disrepair of several components of the drainage and irrigation system, led to flooding in the low-lying coastal zones of Guyana. This flooding is one of the most alarming natural disasters to affect Guyana. Damage was experienced across all major sectors in the economy including agriculture, education, environment, health, water, housing, drainage and irrigation and environment. The livelihood and social activities of many households were disrupted for several days during and after the event. Households across Regions 3, 4 and 5 were significantly directly impacted by the 2005 floods with reports of water levels of 4-5 feet and areas flooded from as little as 3 days to 5 weeks. In total 69,560 households were affected, which is 37.4% of the total number of households in Guyana and 58% of Regions 3, 4 and 5. Disaggregated, 10,683 households or 41% of households in Region 3 were affected. 56,312 households or 72% of households in Region 4 were affected; and, 2,567 households or 20% of households in Region 5 were affected (ECLAC, 2005). The 2005 floods caused direct damages of US$418.3 million and indirect damages of US$46.8 million, which translates into approximately 60% of Guyana's Gross Domestic Product (GDP in 2004 prices).

The 2005 floods illustrated the significant negative effects of current climate variability on Guyana's health sector, in terms of direct damage and losses to the healthcare infrastructure and also, indirectly in terms of increased operational and treatment costs caused. Total costs were estimated at US$0.9 million (G$173.4 million) or 0.11% of GDP (2004 prices), including direct and indirect costs of US$0.3 million (G$52 million) and US$0.6 million (G$120.9 million) respectively. Over 25 health centres in Georgetown, the East Coast and the West Bank Demerara areas were flooded. After the flood, only 60% of the health centres in Georgetown were able to resume regular services, while 80% of health centres on the East Coast were not able to open for regular service, which required that temporary sites were established (ECLAC, 2005).

In terms of projected future change, at a global scale:

> *"Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist (very high confidence). Throughout the 21st century, climate change is expected to lead to increases in ill-health in many regions and especially in developing countries with low income, as compared to a baseline without climate change (high confidence)" (IPCC, 2014).*

In addition, climate change places at risk Guyana's efforts to prevent and reduce the prevalence of climate-induced health diseases, including vector- and waterborne diseases such as malaria, dengue and chikungunya. Greater rainfall intensity increases the number of potential breeding grounds for mosquito species such as the Anopheles gambiae complex, A. funestus, A. darling, Culex quinquefasciatus, and Aedes aegypti, common in the Caribbean and known transmitters of these diseases and rising temperature and humidity aids the hatching, maturity and reproductive capacity of these mosquitoes (Clarke et al, 2013). Further, untreated pools of contaminated water are breeding grounds for the vector species identified above. Therefore, climate change, coupled with poor waste management and sanitation practices and a general lack of knowledge on disease prevention, exacerbates disease incidence and their associated costs to the society. For example,

[xxxvi] The unusual weather system produced the heaviest rainfall on record and created a new monthly precipitation maximum of 1108mm versus the normal monthly average of 200 – 250 mm.

between 2013 to April, 2015, Guyana has had 105 confirmed/probable cases and 5,310 suspected cases of chikungunya (Caribbean Public Health Agency (CARPHA), 2015). Health risks associated with cholera, diarrhoea, gastroenteritis, leptospirosis, typhoid, salmonella, cardiovascular diseases, heat stress, hypothermia and respiratory illnesses are also expected to be exacerbated by climate change impacts (see Table 1 below for further information).

It should be recognised that these diseases represent a significant economic burden for Guyana's economy and society. Prevention has significant benefits not only by improving the length and quality of people's lives, but also reducing the costs which would arise from treatment and lost productivity.

With respect to Guyana, projected future impacts are presented in Table 23 below.

Table 23: Potential health impacts due to climate change. Source: ECLAC (2011a)

Climate-related driver	Health Impact
Direct impact of heat and cold	Cardiovascular disease deaths; heat stress; hypothermia
Temperature effects on food-borne disease	Increased cases of diarrhoea; gastroenteritis; typhoid; Salmonella
Temperature effects on water-borne disease	Increased cases of diarrhoea; gastroenteritis; typhoid; cholera
Temperature, humidity, rainfall effects on vector borne (and rodent-borne) diseases	Increased incidence of malaria; dengue fever; leptospirosis
Effects of extreme rainfall and sea-level rise on flooding	Fatal injuries; non-fatal injuries; mental health effects
Changing patterns of agricultural yield	Malnutrition and under nutrition
Effect of flooding and drought on food and waterborne disease	Increased incidence of cholera; diarrhoea; gastroenteritis
Sea-level rise and reduced snowmelt impacts on freshwater availability	Water-related diseases in resident and displaced/ refugee populations
Drought and flooding, pests, diseases, biodiversity loss, economic disruption, dislocation and migration	Malnutrition and spread of disease in non-immune populations
Changes in air pollution and aeroallergen levels	Deaths and disease cases associated with air pollution e.g. chronic respiratory illnesses and asthma; and allergies
Destruction of health infrastructure in floods and storm	Increases in mortality and morbidity in affected areas
Temperature and precipitation effects on incidence and intensity of forest fires and dust storms	Fatal and non-fatal injuries; respiratory illnesses
Emergence or spread of pathogens via climate change-driven biodiversity loss	New cases of infectious disease

Rationale:

Against this backdrop, this project aims to minimise potential risks of loss of life and productivity, health care and treatment costs associated with the existing health problems that may be exacerbated as a result of a changing climate, including increases in the geographical spread and number of cases of vector- and waterborne diseases, poorer water quality and sanitation conditions and poor food hygiene. In addition, through enhanced human, physical and technical capacity, this project will improve the preparedness and responsiveness of Guyana's health sector to cope with extreme events, such as flooding, which result in significant human injuries, loss of life, loss of property and physical damages to health facilities.

This project is consistent with the delivery of wider national objectives and targets identified in the Health Vision 2020. In particular, the delivery of quality, effective and responsive health services and prevention measures as well as improvement of the physical, mental and social wellbeing of all people (MOH, 2013a). The MoH's vision also covers environmental health, food security and nutrition and health promotion. Strategic actions in these areas are important to mitigate the health impacts of disasters and environmental health crises; improve the adequacy, diversity and quality of diet and reduce the prevalence of malnutrition by strengthening the policy, planning and resource framework; and create a supporting environment for the health sector.

To achieve these objectives the MoH has identified, engaged and is building greater relationship with the communities and other major stakeholders. In 2013, assessments and educational sessions related to waste disposal and safe water practices were done in some regions including in key areas of food safety and hygiene, water purification, child feeding, post-flood sanitization, and medical and solid waste management were trained. In addition, efforts went into drafting legislation for Medical Waste Management and personnel of hospitals were sensitized on the requirements for an effective Medical Waste programme (MOH, 2013a). The MOH also utilized several health programs and media sources such as Pulse Beat, Your Health the Nation's Wealth, Changing Course, Merundoi, Health News and the NAPS newsletter to promote healthy lifestyles and share information. Several of these activities were organized in collaboration with other agencies and stakeholders such as the Ministry of Agriculture, Guyana National Bureau of Standards, Pan American Health Organization (PAHO)/World Health Organization (WHO) and the Caribbean Public Health Agency (MOH, 2012).

This project also has important synergies with the following strategic and policy frameworks:

- Guyana's National Health Sector Disaster Plan, aimed at improving the preparedness and responsiveness of the sector's physical and human capital to prevent loss of life and property and protect the health of the population (MOH, 2009).
- Guyana's Neglected Tropical Diseases (NTDs) Plan aimed at increasing sustainable water, sanitation, and hygiene (WASH) services in an effort to prevention, control, and elimination of five of the NTDs: soil-transmitted helminthiasis (STH), trachoma, schistosomiasis, lymphatic filariasis (LF), and Guinea worm (Ogden et al, 2013).
- Guyana's Water Safety Plan aimed at improving drinking-water quality and the processes of distribution, storage, and handling by optimally preventing, removing, reducing and controlling water contamination and re-contamination sources (CEHI, MoH & GWI, 2009).

- Diarrheal Diseases Malaria Control and Cholera Plans aimed at preventing the contraction and transmission of these diseases.

The proposed project will also build on and maximise synergies with existing and/or ongoing regional and national initiatives. This will include, in particular, efforts to combat Communicable Diseases (CDs), Non-Communicable Diseases (NCDs) and NTDs, as follows:

- The Latin American and the Caribbean Neglected Tropical Disease initiative (Caceres, 2014) -- a partnership that includes the Inter-American Development Bank (IADB), Pan American Health Organization (PAHO) and Sabin Vaccine Institute's Global Network for Neglected Tropical Disease -- aimed at scaling up efforts to control and eliminate NTDs. Guyana was selected to be a part of the project and US$10 million budgeted for the period 2010-2015, to help eradicate and mitigate NTDs. The project recognizes the linkage between sanitation and health and as such it is implementing joint community-based campaigns to educate Guyana's population about treatment, transmission and prevention as well as improve the infrastructure of Georgetown's sewage system to reduce risk factors.
- The Water, Sanitation and Hygiene (WASH) programme (WASH, 2013) -- aimed at combating diarrheal, malaria and others diseases.
- Guyana's Program to Improve Water and Sanitation Infrastructure and Supply, approved for funding at a value of US$31.7 million by a loan for the IDB and supported by Caribbean Investment Fund, European Union, aims to boost efficiency, quality and sustainability of drinking water and sanitation infrastructure in Georgetown and other coastal areas. It involves infrastructure upgrade and expansion of water treatment plants, enhancing access to adequate sanitation, designing and implementing a program to monitor non-registered water, and designing and implementing a public awareness campaign on the use of water and proper hygiene practices (IADB, 2015).

4.1.3.2 Project description

Project aims and objectives:

The aim of this project is to increase the resilience of Guyana's health sector to a variable and changing climate, through strengthened national disaster risk management (regarding health) and early warning response systems, enhanced communities' access to clean water and sanitation facilities and food hygiene, reduced impacts of water-borne diseases, better human and physical sectoral capacity and increased public awareness.

The specific objectives of this project are to:

- Expand the disaster risk management and early warning response systems with regards to the health sector at all levels (community, regional and national).
- Enhance communities' access to clean water and sanitation facilities and improved food hygiene which will in turn reduce climate change related health risks.
- Address the increased risks of water-borne diseases induced by a variable and changing climate.
- Strengthen human and physical capacity to respond to climate impacts on the health sector.

- Increase public awareness of how to minimise the risk of climate-related health impacts and build climate resilience in the health sector.

Project activities:

The project components and corresponding activities[xxxvii] of this project are as follows:

Component 1- Disaster risk management and early warning response systems with regards to the health sector at all levels (community, regional and national):

The objective of this component is to strengthen the disaster risk management and early warning response systems with regards to the health sector at all levels (community, regional and national). The main activities will be as follows:

- Expand Guyana's disaster risk management, early warning and emergency response system with respect to the health sector, including for conditions conducive to the prevalence of certain diseases (respiratory and vector-borne).
- Mainstream climate change into national health disaster management plans and national, regional and community health sectors.
- Enhance the Ministry of Health's environmental surveillance programme and related information system to monitor and assess environmental health-related risks related to climate change and to track the relevance of climate variability and change drivers.

Component 2- Communities' access to clean water and sanitation facilities and improved food hygiene:

The objective of this component is to enhance communities' access to clean water and sanitation facilities and improved food hygiene in preparation for, or after flood periods which will in turn reduce health-related risks. This will require collaboration with the MoA, the CDC and the National Bureau of Standards. The main activities will be as follows:

- Disseminate lessons learnt from Oxfam, Red Cross, the Guyana Citizens Initiative and other relevant agencies, and examine how these efforts can be deployed at a wider scale.
- Develop a sanitation strategy for post-flood clean-up and recovery efforts.
- Create an information exchange mechanism on food hygiene, water and sanitation and post-flood recovery.
- Develop a database to assist in the implementation and sustainability of the sanitation system[xxxviii].

Component 3- Water- and vector-borne diseases induced by a variable and changing climate:

The objective of this component is to reduce the increased risks of water- and vector-borne diseases induced by a variable and changing climate. The main activities will be as follows:

[xxxvii] Efforts in this area should recognise that access to clean water in these communities is an ongoing issue that will need to be also tackled.

- Design and implement bed net and spraying programmes to curb malaria, dengue and chikungunya.
- Review existing Water Safety Plans and pilot initiatives in order to mainstream climate change.
- Expand surveillance of breeding sites.

Component 4- Improving the resilience of critical health infrastructure to climate change:

The objective of this component is to improve the resilience of critical health infrastructure, such as health centres and hospitals to climate change. For new infrastructure, this implies integrating potential vulnerabilities and risks associated with current climate variability and future climate-related impacts in selecting the locations and designs of the facilities. The main activities will be as follows:

- Identify and prioritize infrastructure rehabilitation and retrofitting works for health care facilities.
- Rehabilitate and retrofit health care facilities that are of the highest priority[xxxix.]
- Investments in renewable energy should be explored with respect to the provision of water (e.g. photovoltaic pumps).

Component 5- Capacity-building to respond to climate impacts on the health sector:

The objective of this component is to build and develop human and physical capacity to respond to climate impacts on the health sector. The main activities will be as follows:

- Train staff at Guyana's health centres and hospital(s) in order to re-orient services and build capacity regarding the risks, effects and responses to climate-related extreme events and climate change impacts on health. Initial focus should be placed on health centres in flood prone communities. The climate risk screening tool developed by the Caribbean Climate Change Community Centre (CCCCC) - CCORAL could be used to this end.
- Develop climate change modules for the training of all levels of health professionals.

Component 6- Public education and awareness-raising to build climate resilience in the health sector:

The objective of this component is to create and increase public awareness of how to minimise the risk of climate-related health impacts and build climate resilience in the health sector. The main activities will be as follows:

- Develop and disseminate multimedia public education and awareness materials at the community level.
- Mainstream climate change into the Heath Promotion Strategy Framework.

[xxxix] This should seek synergies with the PAHO's smart hospitals approach (funded by DFID and implemented by CARPHA).

- Prepare a networking strategy, including an education campaign and a strengthened role for social media in health related disaster management. These should be integrated into the Health Promotion Plan.

Expected outcomes:

- **Expected outcome 1:** The disaster risk preparedness and management capacity of the health sector is improved.
- **Expected outcome 2:** The health sector in Guyana is better equipped to recover from weather-related extreme events, in particular flooding.
- **Expected outcome 3:** Communities have better access to clean water and sanitation facilities and improved food hygiene.
- **Expected outcome 4:** The incidence of water- and vector-borne diseases, such as malaria, dengue and chikungunya, is reduced.
- **Expected outcome 5:** Critical health infrastructures are resilient to a variable and changing climate.
- **Expected outcome 6:** Health practitioners in Guyana are trained and prepared to respond to extreme events and climate change.
- **Expected outcome 7:** The general public is sensitised about the risks of climate-related health impacts, including at the community level.

Expected results:

Table 194: Overview of results and indicators

Results	Indicators
Strengthened disaster risk management and early warning response systems with regards to the health sector at all levels (community, regional and national)	Early warning system expanded with respect to the health sector Climate change considerations are featured in (i) the 2009 Health Disaster Management Plan and (ii) the Ministry's disease surveillance programme
Improved access of communities to clean water and sanitation facilities and food hygiene	Lessons learnt from the Oxfam, Red Cross and Guyana Citizens Initiative are shared with stakeholders Sanitation strategy for post-flood clean-up and recovery is developed Information exchange mechanism created

Results	Indicators
Increased resilience of critical health infrastructure	Health facilities prioritised based on need for rehabilitation and retrofit Rehabilitation and retrofit of health care facilities
Increased preparedness and capacity of the health sector in Guyana at all levels (community, regional and national) including through the training and sensitisation of health practitioners	Modules developed for training professionals in the sector in climate change Staff trained at Guyana's health centres and hospitals
Increased awareness amongst the general public about the health implications of climate change	Networking Strategy developed Climate change mainstreamed into the Health Promotion Strategy Framework
Enhanced prevention of water and vector borne diseases which may be associated with adverse climate change impacts	Bed nets distributed Spraying programmes deployed Climate change considerations mainstreamed into existing Water Safety Plans

Implementation arrangements:

It is expected that the MoH will be the lead implementing agency for this project and will work in close collaboration with the following institutional partners:

- Pan American Health Organisation (PAHO). PAHO has assisted previously with the retrofitting some health centres.
- United Nations Children Fund (UNICEF).
- International Federation of Red Cross Crescent.
- Civil Defence Commission (CDC).
- Ministry of Housing and Water (MoH&W).
- Guyana National Bureau of Standards.
- Environmental Protection Agency (EPA).
- Hydrometeorological Unit of the Ministry of Agriculture (MoA).
- Office of Climate Change (OCC).

Stakeholder engagement:

The process of preparing this project concept note was guided by the general framework employed by projects prepared under the Guyana REDD+ Investment Fund (GRIF). Dr. Shamdeo Persaud, Chief Medical Officer (CMO) at the MoH was consulted on whether the project aligned with the strategic vision for the sector, how project can be tailored to address crucial gaps that exist in the sector. As project development continues outside the framework of the CRSAP preparation, relevant stakeholder groups are likely to be engaged.

Economic justifications:

It should be noted that a detailed cost assessment is only available for the following four diseases: dengue, malaria, leptospirosis and gastroenteritis. The benefits of this project largely outweigh the estimated costs. Evidence from the 2005 flooding shows the significant direct costs of US$0.3 million on the health sector, including physical damages to health centres and hospitals. Indirect costs, including cleaning supplies for health facilities, establishment of temporary sites, losses due to increased spending on drugs and medication, losses due to provision of increased public health services and losses incurred due to increased transportation, were estimated at US$0.6 million (ECLAC, 2005).

Table 3 provides an overview of estimated costs for Guyana associated with four vector- and water-borne diseases (namely dengue, malaria, leptospirosis and gastroenteritis) under different climate scenarios (see Annex B for further information on the scenarios used). Using regression analysis, the ECLAC (2011a) assessed the relationship between climate variables (temperature and rainfall) and the aforementioned diseases; whilst controlling for socio-economic conditions and seasonality. For the selected diseases considered, it is predicted that the number of cases will increase over the next four decade for all scenarios, more so under A2 than under B2 and BAU scenarios. This increase in the number of cases will result in increased costs to Guyana. These costs can be categorized into direct costs (prevention and treatment cost) and indirect costs (productivity loss). As shown in Table 3, the projected number of gastroenteritis cases could potentially cost Guyana over US$200 million over the period 2020- 2030. It is striking that a large number of children under 5 years are vulnerable to this disease. With regards to dengue and malaria, the projected combined cost is estimated at over US$6 million; whereas, the project costs associated with leptospirosis are relatively small in comparison.

It is important to note that the costs reported in Table 25 are likely to underestimate the total costs associated with the impacts of climate change as it ignores several other negative health impacts such as cholera, diarrhoea, typhoid, salmonella, cardiovascular diseases, heat stress, hypothermia and respiratory illnesses. Valued at US$17.35-18.60 million, which is approximately 6.40-6.89%, 6.80-7.29% and 7.98-8.55% of the estimated total cost to society up to 2030 for B2, A2 and BAU scenarios respectively. This project is critical to increase the resilience of Guyana's health sector to a variable and changing climate.

Table 25: Cost of diseases to Guyana for 2021-2030 at 1% discount rate. Source: ECLAC (2011a)

Diseases	Scenario	Direct Cost (US$)	Indirect Cost (US$)	Total Cost (US$)
Dengue	A2	3,455,838	86,790	3,542,628
	B2	3,434,122	86,245	3,520,367
	BAU	3,929,938	98,697	4,028,635
Malaria	A2	2,149,350	1,416,384	3,565,734
	B2	2,271,962	1,497,183	3,769,145
	BAU	1,742,104	1,148,016	2,890,120
Leptospirosis	A2	1,510	3,964	5,474
	B2	1,345	3,530	4,875
	BAU	1,448	3,800	5,248
Gastroenteritis (less than 5 years)	A2	27,640,164	3,567,691	31,207,855
	B2	29,092,094	3,755,101	32,847,195
	BAU	23,981,094	3,095,392	27,076,486
Gastroenteritis (5 years and over)	A2	43,298,854	173,567,017	216,865,871
	B2	45,841,039	183,757,578	229,598,617
	BAU	36,641,733	146,881,401	183,523,134

Social impacts:

This project aims to improve climate resilience of the health sector in Guyana and has a number of intended positive social effects. Potential positive social impacts include:

- Reduced risk of contracting communicable diseases (CDs), non-communicable diseases (NCDs) and neglected tropical diseases (NTDs) especially for vulnerable groups such children and elderly.
- Healthier communities and increased productivity of the workforce.

Space-spray application of insecticides may result in negative health effects on the population. Environmental safeguard during planning, execution and post- programme is required to prevent

unwanted residue of insecticide on household goods, food, drinking water etc. The spraying programme may also affect businesses involving the rearing of butterflies or moths, and may also cause traffic disruptions. In addition, a level of public concern inevitably accompanies spraying programmes.

Environmental impacts:

Through information dissemination and training, communities are better able to improve their surroundings to safeguard against contracting and transmission of communicable diseases (CDs), non-communicable diseases (NCDs) and neglected tropical diseases (NTDs). Improved waste disposal and hygiene practices and water sanitation will result in:

- Reduced number of mosquitoes and breeding sites.
- Improved water and air quality.
- Generally a cleaner, safer and healthier environment.

The spraying programme could negatively affect birds and other animals dependent upon caterpillars as their food within the spray zone. The main means for reducing the potential adverse environmental effects of the spraying programme are compliance with various relevant Acts, regulations, policies and plans; a public communications strategy; a contingency plan for emergencies; safe storage, transportation and disposal of insecticides; safeguards for workers, sensitive individuals and sensitive receiving environments; and monitoring the environmental effects of the programme.

Project sustainability:

As part of the consultation, limited availability of internal financial resources at the level of the MoH to cover long term operation costs was identified as a key challenge to the project sustainability. In addition, the institutional capacity in the government can be limited to manage a project of this size. During the consultation, the MoH noted the lack of experience in managing grants above US$1 Mn. The MoH should seek additional funding, outside the scope of this project, to develop institutional capacity, as well as collaborate with Non-Governmental Organisations (NGOS) and other partner organisations to enhance project delivery.

Potential risks and mitigation measures:

There are a number of risks that may impede the achievement of the project's objectives and impacts.

Table 26: Overview of potential risks and risk management options

Potential risks	Risk management options
Technical resource (health care professionals, project managers, administrators,	Draw on expertise from within the region. Expert help can be sought from: other CARICOM Members such Jamaica and Trinidad and Tobago; the Caribbean Public Health Agency and

Potential risks	Risk management options
procurement) capacity is low, resulting in projects failing to be implemented and deliver against objectives.	Cuba. Engaging NGOs and International Organizations such as Doctors without Borders is also a possible option.
Capacity to manage the scale of funding, resulting in efficiencies, poor due diligence and accounting.	Seek funding for institutional capacity building and strengthening within the MoH.
Sufficient operational funding to maintain once projects have been implemented and initial capital funding has been deployed.	Community and other stakeholder involvement are critical in shaping the 'ownership' of the programmes and continuity of their activities. Local and Central Government support may be required to continue some activities. Other future funding sources include community based fund raising activities, volunteerism, the private sector and grants.
Buy-in by the health sector professionals regarding the implications of climate change for health	Host a workshop with stakeholders Long term capacity building through integration into curricula and training courses of health care professionals.
Public buy-in regarding the implications of the climate change for health	Launch a public awareness-raising campaign on the implications of climate change on health.

4.1.3.3 Summary budget and investment plan:

Total estimated project costs (US $): US$17.35-18.60 million

The budget proposed provides a high level estimate of the financing required to implement this project. The actual costs are likely to have minimum cost falling within the range estimated below. The estimates are also based on assessments undertaken in 2005 and 2011 but have been adjusted for inflation for those years to 2014. It is inevitable that the costs will change given that there will be a time lag between the proposal and implementation. Thus, a detailed cost-benefit analysis is required.

Table 27: Indicative cost estimates (US $)

Components	Duration	US$Mn (est.)[xl]	US$Mn (adj.)[xli]	Source
Disaster risk management and early warning response systems with regards to the health sector at all levels (community, regional and national)	3 years	US$4 Mn***	US$6.0-6.40Mn	ECLAC (2005)
Communities' access to clean water and sanitation facilities and improved food hygiene	n/a	US$2.3 Mn****	US$3.45-3.69Mn	ECLAC (2005)
Water- and vector-borne diseases induced by a variable and changing climate+	3 years	US$1.5 Mn	US$1.60-1.76Mn	ECLAC (2011c)
Climate resilience critical health infrastructure	3 years	US$ 3.3 Mn	US$4.95-5.30Mn (LOW)	ECLAC (2005)
Capacity-building to respond to climate impacts on the health sector Public awareness-raising to build climate resilience in the health sector	3 years	US$0.9 Mn	US$1.35-1.45Mn	ECLAC (2005)
Total	-	-	US$17.35-18.60Mn	-

*Cost reported is as was reported in the literature reviewed.
**Figures are adjusted for inflation. Adjustments are made from the year, if stated, of the quoted amount; otherwise the reporting year is used. Inflation in Guyana for the periods: 2005-2014 was approximately 55% (CPI) to 66% (GDP deflator); 2009-2014, 16% (CPI) to 28% (GDP deflator); and, 2011-2014, 8% (CPI) to 19% (GDP deflator) (World Bank, 2015). Nominal exchange rate, G$: US$, depreciation over the same periods were approximately 3.28%, 1.22%, 1.19%.
***Estimated at 20% of the total cost to implement the national Disaster risk management and early warning response system.
****Estimated as difference between the total cost identified by ECLAC (2005) (US$34 million) and the ongoing IDB funded Program to Improve Water and Sanitation Infrastructure and Supply (US$31.7 million).
+This component is for the first three years, subsequently budgetary support or other funds will be required to continue the program. Ceteris paribus, the real cost is expected decline in the future; however, population growth, failures in other sectors such as water and sanitation and agriculture and increase input prices could drive up this cost.

Possible sources of funding:

Existing sources of funding that have been accessed for similar initiatives include:

- Government of Guyana (GoG).
- PAHO for technical support.

[xl] Cost reported is as was reported in the literature reviewed.
[xli] Figures are adjusted for inflation. Adjustments are made from the year, if stated, of the quoted amount; otherwise the reporting year is used. Inflation in Guyana for the periods: 2005-2014 was approximately 55% (CPI) to 66% (GDP deflator); 2009-2014, 16% (CPI) to 28% (GDP deflator); and, 2011-2014, 8% (CPI) to 19% (GDP deflator) (World Bank, 2015). Nominal exchange rate, G$: US$, depreciation over the same periods were approximately 3.28%, 1.22%, 1.19%.

- UNICEF for training materials.
- United States Agency for International Development (USAID).
- Inter-American Development Bank (IDB) for soft loans.
- Guyana REDD+ Investment Fund.

In addition, it should be noted that there are limited public-private partnerships (PPPs) within the sector (to provide infrastructure and service), e.g. Cancer Institute and Caribbean Heart Institute.

Potential new sources of funding could include:

- Adaptation Fund.
- GEF-Small Grant Programme
- Green Climate Fund (GCF)
- Japan – Fast Start Finance
- Special Climate Change Trust Fund (SCCF)

It is however, important to note that this list should not been seen not exhaustive and could be extended based on a more detailed analysis of financing options for the proposed project. In addition, it is important to recognise that most of these funds will likely require co-financing and/or in-kind assistance from the lead implementer (project proponent) and/or GoG.

Annexes:

Annex A- Overview of vector-borne and water-borne diseases in the Caribbean. Source: Peggy Wu et al. (2009)

Malaria is a parasitic disease caused by the bite of an infected Anopheles mosquito. Malaria can reach endemic stages in the presence of climate change, through increased rainfall and the number of formal and informal water sources that are potential breeding sites. Prevention methods include: • Source reduction • Proper solid waste disposal • Prevention of mosquito bites by use of screens, protective clothing, insecticides and insect repellants.
Dengue fever comes in four strains and is spread by mosquitoes in urban areas. The most deadly strain of the dengue fever virus is dengue haemorrhagic fever which damages the circulatory system and internal organs severely. The major breeding sites for the Aedes Aegypti mosquitoes are mostly the artificial water containers commonly found in and around urban areas, particularly residences. Research has shown that the number of months with average temperatures higher than 18°C and the degree of urbanization were found to correlate with increasing risk of dengue fever. Prevention methods include: • Source reduction • Proper solid waste disposal • Prevention of mosquito bites by use of screens, protective clothing, insecticides and insect repellants
The **leptospirosis** infection is associated with the Leptospira bacteria and is transmitted to humans and animals through water contaminated with animal urine that contacts broken skin and the mucous membranes of the eyes, nose and mouth. The disease occurs in both rural and urban areas, and in temperate and tropical climates. Leptospirosis may peak in rainy seasons in countries where it is endemic and reach epidemic levels in cases of flooding. Preventative measures include: • Source control • Interruption of the transmission route • Vaccination
Gastroenteritis is an inflammation of the gastrointestinal tract that often results in diarrhoea, vomiting and abdominal pain. The transmission of gastroenteritis is normally due to the consumption of improperly-prepared foods or contaminated water, or close contact with infected individuals. The primary causes of gastroenteritis are the bacteria Escheria coli and rotavirus. Rotavirus is the most common cause in children while norovirus is the leading cause in adults. Preventative measures often include good sanitation practices and rotavirus vaccination for children.
Cholera is caused by the bacterium Vibrio cholera. People become infected by ingesting food or drinking water that has been contaminated by the faeces of other persons. To prevent the spread of cholera, the following four interventions are essential: • Provision of adequate, safe drinking-water • Proper personal hygiene • Proper food hygiene • Hygienic disposal of human excreta

ANNEX B- Overview of the scenarios used in the ECLAC (2011 a, b and c) studies

- BAU – The business as usual scenario was developed for the period 2011 to 2050 by applying a two period moving average to the historical disease data.
- A2 - Countries are assumed to operate on the basis of self-reliance and increased heterogeneity with a focus on regional sources of wealth and a slower profile of per capita economic growth and technological change. Additionally, fertility patterns converge slowly across the regions of the world and results in a continuously increasing population.
- B2 - Emphasis is placed in this context on local solutions to ensure economic, social and environmental sustainability. Similar to A2, the population increases continuously but at a comparatively lower rate. Economic development is intermediate and the rate of technological change is less rapid and more diverse than in the alternative A1 and B1 scenarios, neither of which is considered here. The environmental protection and social equity focus is at the local and regional levels.

4.1.4 Strengthening drainage and irrigation systems

Project Description	This project aims to increase the resilience of Guyana's drainage and irrigation systems to a variable and changing climate by improving the capacity of the drainage network in critical areas, upgrading the existing drainage and irrigation system, institutional strengthening of the National Drainage and Irrigation Authority (NDIA) and development of a training curriculum on drainage and irrigation. It aligns with the Low Carbon Development Strategy (LCDS) which identified investment in drainage and irrigation infrastructure as one of the key actions that would enable the transition to a low carbon climate resilient economy.
Location:	Georgetown and the immediate surrounding parts of the Demerara Coast
Proposed lead implementing entity:	National Drainage and Irrigation Authority (NDIA)
Indicative project duration and timeline	2015- 2020
Indicative project costs (US$):	US$ 31.55-33.23 million

4.1.4.1 Background and rationale

Problem statement:

Guyana has a low-lying coastline of approximately 459 km (285 miles) and a land area of approximately 214,970 km^2. The land area can be divided into coastal and hinterland with approximately 90% of the total population of 751,223 living on the 15,000 km^2 area of low-lying coast (ECLAC, 2011b). The country's capital, Georgetown, located on the coast, is home to 118,363 persons (ECLAC, 2011b). The intricate nature of Guyana's settlement pattern along the coastline is embedded in history and culture and for many years, Guyanese have learned to live with the flooding risks. However, with increased risks associated with climate change, in particular from flooding, Guyana now needs to significantly increase its capacity to safeguard its economic activities, livelihoods, communities and way of life.

Climate impacts, vulnerabilities, risks:

Projected increasing intensity in rainfall, increasing number of extreme rainfall events, rising sea levels and increased risk of higher storm surges put at risk Guyana's drainage and irrigation infrastructure and institutional structure. This was evident in the flooding events of 2005. Heavy rains in the last nine days of December 2004 and early January, 2005, the heaviest rainfall recorded in Guyana since 1888, an anomaly in Guyana's rainfall climatology,[xlii] coupled with the disrepair of several components of the drainage and irrigation system, led to flooding in the low-lying coastal zones of Guyana. This flooding is one of the most alarming natural disasters to affect Guyana. Damage was experienced across all major sectors in the economy including agriculture, education, environment, health, water, housing, drainage and irrigation and environment. The livelihood and social activities of many households were disrupted for several days during and after the event. Households across Regions 3, 4 and 5 were significantly directly impacted with reports of water levels of 4-5 feet and areas flooded from as little as 3 days to 5 weeks. In total, 69,560 households were affected, which is 37.4% of the total number of households in Guyana and 58% of Regions 3, 4 and 5. Disaggregated, 10,683 households or 41% of households in Region 3 were affected. 56,312 households or 72% of households in Region 4 were affected; and, 2,567 households or 20% of households in Region 5 were affected (ECLAC, 2005). The 2005 floods caused direct damages of US$418.3 million and indirect damages of US$46.8 million, which translates into approximately 60% of Guyana's Gross Domestic Product (GDP in 2004 prices).

Guyana's drainage and irrigation system is a complex network of conservancies, canals, sluice gates/kokers, and pumping station for flood control and water storage and distribution for agricultural and domestic purposes. The conservancies are critical to farming activities of Guyana Sugar Company (GUYSUCO) and small to medium scale farmers as a means of irrigation during the dry season and to protect settlements from flooding. This role is becoming even more critical given the impending impact of climate change through increased drought conditions. In period of high rainfall or increase intensity in rainfall, the conservancies can become full or near capacity. If this occurs, water is released from the conservancies using a gravity dependent drainage system of canals that lead to the sea (water can also be released into the rivers), stopped only by the 136 sluice gates/kokers which are located in the 109.27km of seawall. This system was designed 150 years ago and as such its design did not take into consideration the current sea level rise and the consequential shorter periods of low tides resulting from climate change. The sluice gates/kokers are most effective if the ocean tides are low; however if the tides are high such that the sluice gates/kokers cannot be opened then pumps are used to aid in the expulsion of water to sea. Prior to and during the 2005 floods, several components of the system, such as outflow gates, canals, sluice gates/kokers, and pumping station were in disrepair limiting the ability of authorities to effectively manage water resources and protect the coastal zones through efficient conservation and expulsion channels. In 2004, prior the 2005 floods, the drainage and irrigation sector received financing from the Inter-American Development Bank (IDB) and Economic Commission for Latin America and the Caribbean (ECLAC) approved a US$30 million loan for the rehabilitation of drainage and irrigation infrastructure along the coastline; however, these funds were not sufficient to carry out the major

[xlii] The unusual weather system produced the heaviest rainfall on record and created a new monthly precipitation maximum of 1108mm versus the normal monthly average of 200 – 250 mm.

number of repairs and rehabilitation works needed to upgrade and return the system to a fully functioning efficient and effective drainage and irrigation system. Months after the flooding, it was estimated that approximately US$250-350 million was required to meet the medium to long-run needs of the sector (ECLAC, 2005). Following the 2005 floods an Infrastructure Recovery Task Force was appointed by the President of Guyana to oversee recovery efforts and received over US$3.5 million (ECLAC, 2005). More recent projects are identified in a later section but collectively, these projects are a fraction of the medium to long-run needs of the sector (ECLAC, 2005). While significant recent efforts to address infrastructural and institutional design deficits in Guyana should be recognised, it is useful to note that the ECLAC report on the economic impact of climate change on the coastal and human settlements sector (ECLAC, 2011b) suggested that:

> *"Climate change will increase the risk to coastal human settlements via rising sea levels, increased flood risk, (changing weather patterns & shorter return periods of extreme events) and stronger tropical storms that may further increase their vulnerability and levels of risk. These risks are increasing over time, given that infrastructure design has a five- to ten-year lag before it can support mitigation action or result in risk reduction. Therefore, the existing infrastructure in Guyana is outdated relative to the threat levels associated with climate change today."*

Multiple economic activities, livelihoods and communities are dependent on efficient drainage and irrigation (D&I) systems. These systems are critical for flood control, surface water drainage, but also to provide water for agricultural, domestic and other purposes. In order to carry out the dual role of drainage and irrigation, the systems are operated through the concept of nearly constant water level. A large proportion of Guyana's coastal lands lie below sea level and drainage by gravity is possible only during low-tides, which makes the systems prone to flooding during extreme rainfall events. The losses and damage from the 2005 floods in Georgetown and the surrounding region exposed the system's limitations in terms of handling a greater intensity in rainfall combined with tidal inflow. In the National Adaptation Strategy to Address Climate Change in the Agriculture Sector of Guyana (DPMC, 2009) it was noted that "*Drainage structures were designed to accommodate 38.1 mm of rainfall over a 24 hour period. However, annual rainfall intensities have increased and as such the past and some existing parts of the drainage system are unable to cope with the resulting greater intensity in rainfall causing more frequent flash and prolonged flooding and losses.*"

Damage and losses from the 2005 floods were estimated at approximately 60% of Gross Domestic Product (GDP) or US$450 million (ECLAC, 2005). In 2006, floods cost the country another US$250 million (DPMC, 2009). The sectors most affected were housing, agriculture and commerce. See Annex A for further information on projected air temperature and annual rainfall anomalies for 2071-2100 relative to 1961-1990 for South America.

Rationale:

Against this backdrop, the project will aim to minimise risks of flooding and associated losses and damage to housing, property, agriculture and commerce, resulting from poor D&I systems. The project aligns with the Low Carbon Development Strategy (LCDS) which identified investment in D&I irrigation infrastructure as one of five key actions for supporting adaptation and climate resilience in the country. In addition, the Government of Guyana's Grow More Food Campaign (2008-present) includes D&I rehabilitation as one of its four key components.

The proposed project will build on and maximise synergies with existing and/or ongoing regional and national initiatives. This will include, in particular:

- The Mahaica, Mahaicony, Abary Agricultural Development Authority (MMA/ADA) Phase II (Stabroek News, 2007) aimed at improving agricultural development within the MMA area and providing more efficient drainage and irrigation to surrounding communities; the European Union (EU) has provided €25 million for the feasibility study for MMA Phase II.
- The Agriculture Support Services Programme (ASSP), funded at value of US$0.8 million by an IADB loan, aimed "to raise rural incomes by increasing the efficiency of agricultural production and competitiveness in the sector through the timely availability of irrigation and improved drainage. The program includes rehabilitation of the D&I structures (IADB, 2004).
- The Conservancy Adaptation Project (CAP), valued at US$3.8 million and funded by a grant from the Global Environmental Facility Special Climate Change Fund, was designed "to reduce the Recipient's vulnerability to the catastrophic flooding of its low-lying coastal area due in part to the rise in sea level as a result of global climate change" (World Bank, 2014). The project achievements includes (GFDRR, 2013):
    - A hydraulic engineering foundation, including real- time information on and predictive modelling of the EDWC and East Coast drainage areas.
    - Comprehensive analysis on the stability of the EDWC dam.
    - Increased safety of the EDWC and reduced vulnerability to catastrophic flooding through physical investments.
    - Enhanced government knowledge and capacity to manage the EDWC and coastal drainage systems.
    - A US$ 123m package of investments critical for flood management.

The project must also assess the capacity of existing systems and their operation and management with regard to changes in precipitation.

4.1.4.2 Project description

Project aims and objectives:

The overall aim of this project is to increase the resilience of Guyana's D&I systems to a variable and changing climate by improving the capacity of the network in the most critical areas, upgrading the existing D&I system, institutional strengthening of the National Drainage and Irrigation Authority (NDIA) and development of a training curriculum on drainage and irrigation.

The specific objectives of this project are to:

- Improve the capacity of the drainage network in priority areas identified by the NDIA.
- Upgrade the existing D&I system with a focus on the agriculture sector and local communities dependent on the sector
- Institutional strengthening of the NDIA.
- Develop and implement a curriculum that provides knowledge and training about the D&I system for schools and the wider society.

Project activities:

The project components and corresponding activities[xliii] of this project are as follows:

Component 1- Capacity of the drainage network:

The objective of this component is to improve the capacity of the drainage network focusing on priority areas identified by the NDIA. The main activities will be as follows:

- Upgrade the drainage system by separating urban and agricultural drainage system in: Mon Repos/Annandale, Enterprise/Strathspey/Paradise, Beehive/Clonbrook, and Montrose/Sparendaam by capacity by the procurement of new pumps and construction of additional drainage outlets.
- Improve mechanical drainage by increasing the pumping capacity on the East Coast of Demerara, including a two-phased approach:
    - Phase I: Increasing pumping capacity at Liliendaal, Ogle and Good Hope.
    - Phase II: Increase pumping capacity at Lusignan and Annandale.
- Construction of new canals.

Component 2- Drainage and irrigation in the agricultural sector:

The objective of this component is to build resilience of agricultural sector by improving and upgrading the existing D&I system. The main activities will be as follows:

- Improve the management, maintenance and operation of D&I in the agricultural sector.
- Develop means to increase communication between farmers and D&I system managers.
- Establish additional Water Users Associations (WUAs) in new areas.

Component 3- Institutional strengthening of the NDIA:

The objective of this component is to strengthen the capacity of the NDIA. The main activities will be as follows:

- Review and re-calibrate a hydraulic/hydrologic computer model of the other conservancy areas, with outfall canals, etc. This will help predict the behaviour of any component of the D&I system, given variations in any other component (e.g. those driven by climate variability and change). This will also require a comprehensive network of hydromet stations.
- Provide training, mentoring and inputs to the model until familiarity with the model is entrenched in the NDIA. A sustainability element to this support will be included.
- Set up a functional Geographical Information System (GIS) to better visualise, report and plan for the vast D&I network the NDIA currently manages. This system requires a phased rollout as follows:

[xliii] The components and activities of this project draws on ECA (2009), ECLAC (2005), the ECLAC reports on economic impacts of climate change on Guyana and on the 2004 Guyana Drainage and Irrigation Systems Rehabilitation Project report, as well as consultation with the NDIA.

- Phase I – foundation infrastructure/equipment at the NDIA (server, systems, GPS Units and other equipment, etc.)
- Phase II – Data Collection (geo-tapping, etc. all listed D&I inventory, consultancy to design data collection and entry methodology).
- Phase III – Construction of system and end user applications/interfaces.
- Phase IV – Public and Interagency Access to NDIA GIS using web interface.

- Identify and enrol potential NDIA staff in a Masters level course on flood risk management (including climate change). As part of the course programme, students should undertake a research thesis that is linked to conservancy modelling in Guyana, for instance through joint supervision by university staff and the organisation developing/running Guyana's hydraulic/hydrologic computer model. Upon completion of the course, the graduates will be required to return to Guyana to work for a minimum period of three years. Conduct other capacity building of employees of the NDIA in the areas of hydrology, hydraulics, computer modelling, maintenance and operations.
- Establish a Memorandum of Understanding (MOU) between NDIA and stakeholders to facilitate data sharing, and create a database application for data sharing.

Component 4- Public awareness-raising on drainage systems, with a particular focus on solid waste management and disposal:

The objective of this component is to develop and implement a public awareness-raising programme that provides knowledge and training about the drainage systems, in particular with regard to proper solid waste management and disposal techniques. The main activity will be as follows:

- Review school and teacher training curricula, teacher materials to include information about good practices for households' solid waste management and disposal and raise awareness about the negative impacts of improper waste disposal on drainage systems and flooding risk (for example, during the January 2005 flood when waste-filled canals did not drain as rapidly as expected). Review any existing education and awareness programmes for the general public on solid waste management and drainage, and develop appropriate materials targeted at all citizens with a responsibility for drainage, from individual residential land owners through to Conservancy level managers.

Expected outcomes:

- **Expected outcome 1:** The drainage and irrigation system in Guyana is more resilient to a changing climate.
- **Expected outcome 2:** The capacity of the drainage and irrigation system is increased.
- **Expected outcome 3**: There is regular maintenance of drainage system.
- **Expected outcome 4**: The existing drainage and irrigation system focusing on the agriculture sector is upgraded.
- **Expected outcome 5:** The NDIA has increased institutional capacity.
- **Expected outcome 6:** Synergies are improved among related departments, for example, between the NDIA and the Sea and River Defence Division (SRDD), the Ministry of Local

Government and Regional Development (MoLG&RD)) including Regional Democratic Councils (RDCs) and Neighbourhood Democratic Councils (NDCs), Guyana Sugar Corporation (GUYSUCO) and Central Housing and Planning Authority (CH&PA).

- **Expected outcome 7:** The general public are sensitised about Guyana's drainage systems and in particular, with regard to proper solid waste management and disposal techniques.

Expected results:

Table 28: Overview of results and indicators

Results	Indicators
Increased capacity of the drainage network focusing on the most critical areas	Procurement of new pumps and construction of additional drainage outlets. Construction of new canals.
Upgraded existing drainage and irrigation system in the agriculture system	New procedures for improved management, maintenance and operation of drainage and irrigation in the agricultural sector are set up and implemented. Mechanism developed to facilitate dialogue between farmers and drainage and irrigation system managers. WUAs in new areas are created.
Increased technical capacity at the level of NDIA	Hydraulic/hydrological computer models for other conservancies are recalibrated. NDIA staff are being trained in flood risk management NDIA staff are being trained in the areas of hydrology, hydraulics, computer modelling, maintenance and operations A MOU between NDIA and stakeholders is signed to facilitate data sharing A database application for data sharing is created
Increased awareness amongst the general public and youth, about the drainage and irrigation systems	Public buy-in regarding drainage and irrigation network upgrading and extension
Increased capacity of the drainage network focusing on the most critical areas	Procurement of new pumps and construction of additional drainage outlets. Construction of new canals.

Implementation arrangements:

It is expected that the NDIA will be the lead implementing agency for project and will work in close collaboration with the following institutional partners:

- MoC –NDCs and RDCs.
- GUYSUCO.
- Ministry of Public Infrastructure (MoPI).
- Civil Defence Commission (CDC).
- Ministry of Finance (MoF).
- Guyana Lands and Surveys Commission (GL&SC).
- Regional and Local Governments.
- Conservancy level managers.
- Ministry of Education (MoE).

Stakeholder engagement:

The process of preparing this project concept note was guided by the general framework employed by projects prepared under the Guyana REDD+ Investment Fund (GRIF). Mr. Lionel Wordsworth, Chief Executive Officer (CEO) and Ms. Crystal Conway, Engineer from the NDIA were consulted on whether the project aligned with the strategic vision for the sector, how project can be tailored to address crucial gaps that exist in the sector. As project development continues outside the framework of the CRSAP preparation, relevant stakeholder groups are likely to be engaged.

Economic justifications:

It should be noted that a detailed assessment for the costs and benefits of drainage and irrigation is only available for the agriculture sector (ECLAC, 2011a). To date, there has been little research in other sectors and cross-sectorally. Evidence from the major floods of 2005 shows however, the significant damages of flooding on drainage and irrigation amongst various other key sectors, which amounted to US$6.6 million, including US$5.3 million in indirect costs (out of US$465.1 million in total costs across all sectors). Direct and indirect costs correspond to damages to sluice gates and associated equipment, intake structures and kokers, culverts and canals, the embankment of the Crown Dam, the embankment of the Conservancy Dam and extensive siltation of canals.

The project's benefits are particularly significant to the agriculture sector (where more evidence is available), which contributes to approximately 20% to Guyana's GDP, employs about 33% of the labour force and generates almost 40% of Guyana's export earnings (MOA, 2013). The 2005 floods resulted in damages to the sector amounting to US$52.6 million. The sub-sectors hardest hit were sugar, US$11.2 million, and rice, US$8.1 million. Non-traditional Agricultural Commodities sustained damages of US$28.8 million and livestock, US$2.9 million (ECLAC, 2005).

While this project will not eliminate the impacts of climate change it will help to manage flood-related climate risks. Coupled with other initiatives such as conservancy upgrades and repairs, improved sea defence structures, research and development in agriculture and improved waste and sanitation management, the expected benefits of this project increases significantly.

Social impacts:

This project will provide benefits to a broad cross-section of communities, mainly coastal communities, businesses, farmers and vulnerable groups such as the young and elderly. The project is directed at minimising the risk associated with flooding as well as providing a functioning irrigation network, vital for the agriculture system in the event of higher temperatures and droughts. Since agriculture is closely linked to the livelihood, economy and culture of Guyana, this project will not only directly impact those involved in that sector but also create indirect cross-sectoral benefits.

Environmental impacts:

Potential positive environmental impacts of this project include improved water quality and sanitation; protection of ground water from solid and liquid waste; and reduced pressure on marine ecosystems. These impacts all enhance conditions on the ground ultimately contributing to a cleaner environment. Negative environmental spill over effects include water run-offs resulting from the use of material in the construction of new canals to ensure that is potentially damaging to the environment, as well as, generation of solid waste during the renovation and construction process.

Project sustainability:

As part of the consultation, the cost of operation and maintenance of the drainage and irrigation network, was identified as a key challenge to the sustainability of the project. Some funds are currently provided by the GoG (centrally and through MoLG&RD); received from rates and taxes, and the WUAs in some agricultural areas. It was emphasised that the entire drainage and irrigation network needs to be maintained to function effectively with appropriate decentralisation of asset management at local level (requiring funding through local rates and taxes and community user fees).

It is important to build human capacity and to enhance the physical asset base of the NDIA to address these key challenges. In this respect, it was noted that the NDIA is currently building its capacity to construct canals instead of outsourcing these activities to external contractors and that this has resulted in significant cost savings.

Potential risks and mitigation measures:

There are a number of risks that may impede the achievement of the project's objectives and impacts.

Table 29: Overview of potential risks and risk management options

Potential risks	Risk management options
Technical resource capacity is low, resulting in projects failing to be implemented and deliver against objectives.	Draw on lessons learnt from previous projects Monitor and evaluate activities of the project through periodic reports.
Financial resource capacity to manage the scale of funding,	Seek funding for institutional capacity building and

Potential risks	Risk management options
resulting in inefficiencies, poor due diligence and accounting.	strengthening within the NDIA.
Insufficient operational funding to maintain the drainage and irrigation network once the project has been implemented and initial capital funding has been deployed.	Community and other stakeholder involvement are critical in shaping the 'ownership' of the programmes and continuity of their activities. Local and Central Government support may be required to continue some activities. Explore opportunities for minimizing operational and maintenance costs at the design phase of construction and/or rehabilitation efforts. For example, consideration could be given to using renewable energy to run pumps and pumping stations (providing mitigation co-benefits). New pumps require maintenance less frequently, which is allows NDIA to reallocate financial resources to other maintenance works. Enhancing monitoring capabilities, including through GIS applications, in respect to the avoided costs of maintenance.

4.1.4.3 Summary budget and investment plan:

Total estimated project costs: US$ 31.55-33.23 million

Tables 30 and 31 below provide a high level estimate of the financing required to implement this project, corresponding to component 1, and components 2 and 3 respectively. The estimates are also based on assessments undertaken in 2005 and 2011 (in relation to Table 2) and have been adjusted for inflation for the aforementioned years to 2014. It is inevitable that the costs will change given that there will be a time lag between proposal and implementation. The actual cost of the project is likely to have a minimum falling within the range estimated above. Thus, a detailed cost-benefit analysis is required as well as periodic reporting for monitoring and evaluation, which is necessary to avoid cost escalation/overruns that infrastructure projects often face.

Table 30: Indicative budget provided by NDIA, April 2015, relating to component 1

Item	Cost (US$)
PHASE I: Increase pumping capacity	
Liliendaal	
Additional pumping capacity at Liliendaal	1,130,000
Ogle	
Additional pumping capacity at Ogle	2,328,000
Embankment Raising between pump station and outfall sluice	21,000
Mon Repos/Annandale	
Additional Pumping Capacity at Good Hope	2,019,000
Sub - TOTAL	5,498,000
PHASE II: Increase pumping capacity	
Mon Repos/Annandale	
Additional pumping capacity at Lusignan	2,052,000
Additional pumping capacity at Annandale	2,062,000
Sub – TOTAL	4,114,000
PHASE III:	
Separation of urban and agricultural drainage as follows:	
Mon Repos/Annandale	1,200,000
Enterprise/Strathspey/Paradise	1,600,000
Beehive/Clonbrook	435,000
Montrose/Sparendaam	1,500,000
Sub – TOTAL	4,735,000
TOTAL – Infrastructure Works	**14,347,000**

Table 31: Indicative cost estimates for components 2 and 3

Components	Duration	US$Mn (est.)*	US$Mn (adj.)**	Source
Drainage and irrigation in the agricultural sector	n/a	US$14 Mn	US$16.05 - 17.70Mn	ECLAC (2011a)- Agriculture, ECLAC (2011b) –Coastal

Components	Duration	US$Mn (est.)*	US$Mn (adj.)**	Source
				Zone Management & DPMC (2009)
Institutional strengthening of the NDIA	3	US$1 Mn***	US$1.15-1.18 Mn	ECLAC (2005)
Total costs	-	**-**	**US$17.20 - 18.88Mn**	**-**

*Cost reported is as was reported in the literature reviewed.
**Figures are adjusted for inflation. Adjustments are made from the year, if stated, of the quoted amount; otherwise the reporting year is used. Inflation in Guyana for the periods: 2005-2014 was approximately 55% (CPI) to 66% (GDP deflator); 2009-2014, 16% (CPI) to 28% (GDP deflator); and, 2011-2014, 8% (CPI) to 19% (GDP deflator) (World Bank, 2015). Nominal exchange rate, G$: US$, depreciation over the same periods were approximately 3.28%, 1.22%, 1.19%.
***Estimated by ECLAC (2005) as US$0.3 million but additional activities were included after consultation with NDIA. An additional estimated of US$0.7 million (2014 prices) is included to cover these additional activities.

Possible sources of funding:

Existing sources of funding that have been accessed for similar initiatives include:

- World Bank.
- European Union (EU).
- Japanese Government through the Japanese International Cooperation Agency (JICA).
- Indian Government.
- Inter-American Development Bank (IDB).
- Food and Agriculture Organisation (FAO).
- Department for International Development (DFID).
- Canadian International Development Agency (CIDA).
- USAID.
- Petro Caribe.
- Guyana REDD+ Investment Fund (GRIF).

It should also be noted that co-financing is being investigated for the MMA Phase II project and that GRIF resources have been allocated to the Cunha Canal Rehabilitation Project.

Potential new sources of funding could include:

- Adaptation Fund.
- GEF-Small Grant Programme
- Global Climate Change Alliance (GCCA)
- Green Climate Fund (GCF)
- Caribbean Development Bank (CDB)- European Investment Bank (EIB) Loan Facility
- Japan – Fast Start Finance

- USAID
- Special Climate Change Trust Fund (SCCF)

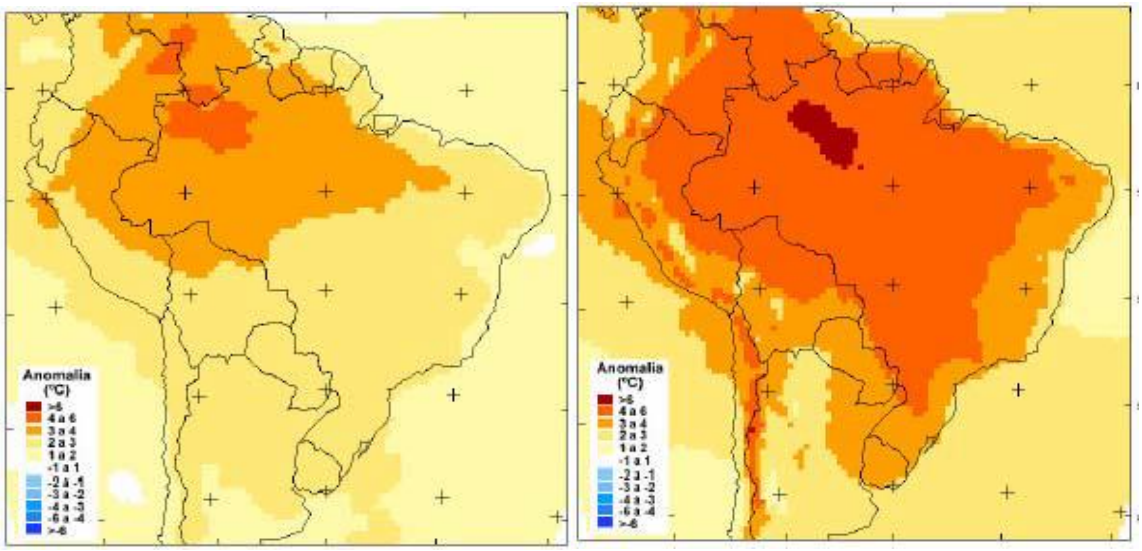
It is however, important to note that this list should not been seen as exhaustive and could be extended based on a more detailed analysis of financing options for the proposed project. In addition, it is important to recognise that most of these funds will likely require co-financing and/or in-kind assistance from the lead implementer (project proponent) and/or GoG.

Annexes

ANNEX A- Projected air temperature and annual rainfall anomalies for 2071-2100 relative to 1961-1990 for South America.

Figure 1: Shows the projected air temperature anomalies for 2071-2100 (right) relative to 1961-1990 (left) (degrees Celsius) over South America for A2 and B2 scenarios (a Combination of: Eta CCS, RegCM3 and HadRM3P regional models.)

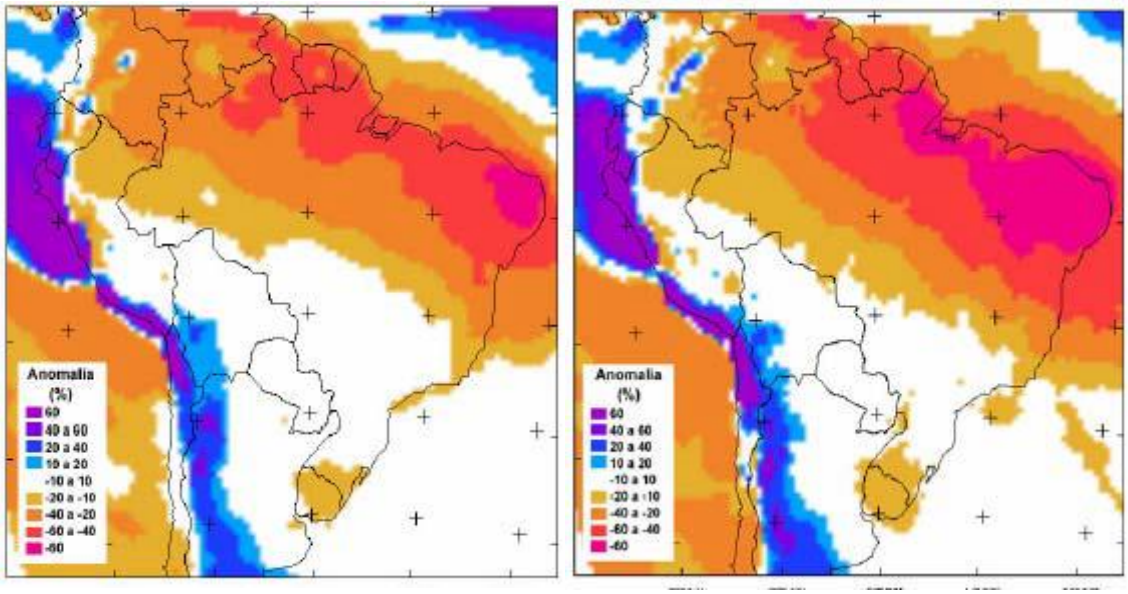
1961-1990 2071-2100



Source: Marengo (2009)

Figure 2: shows the projected annual rainfall (mm/day) anomalies for 2071-2100 (right) relative to 1961-1990 (left) (degrees Celsius) over South America for A2 and B2 scenarios (a Combination of: Eta CCS, RegCM3 and HadRM3P regional models.)

1961-1990 2071-2100



Source: Marengo (2009)

4.2 Sectoral briefing notes

The results from the vulnerability and risk assessment, and identification of climate resilience actions (Track 2) are presented in a series of sector-based briefing notes[xliv]. The intended audiences for these are government ministries and agency staff and other sectoral actors, to provide them with an understanding of the headline climate science messages, risks and opportunities, together with priority resilience actions for their sector. The format and contents of the individual notes mean that they can be removed from the CRSAP and be read as stand-alone short briefings for wider engagement purposes. The individual notes vary in length due to differences in the level of information available across sectors. The briefing notes are structured in two main parts:

- **Current situation**, which contains:
  - **Sector overview** – a short description of the sector's socio-economic profile based on literature review;
  - **Climate vulnerability profile** – a synthesis of the detailed assessment of the sector's climate sensitivity, exposure and adaptive capacity. Sensitivity describes the characteristics of the sector that make it sensitive to climate and weather-related hazards and exposure focuses on the climate variables most relevant to that sector. The narrative on adaptive capacity describes stakeholders' assessments of the informational, human, institutional, financial and policy / regulatory capacity within that sector to support resilience building action. This is based on working sessions at the Vulnerability, Risk and Resilience (VRR) workshop held in Georgetown in April 2015. A summary of the VRR workshop is provided in Annex C.
  - **Climate risks and opportunities** – a risk register and risk matrix containing the risks and opportunities the sector faces. The risks cover the period up to the 2030s and assume that only existing risk management actions are in place (i.e. no additional resilience building measures). A full risk register (across all sectors) is provided in Annex D which contains supplementary information for example about assessment of confidence and pedigree. The scoring of likelihood and consequence is based on a combination of expert judgement and stakeholder consultation, through the VRR workshop.

- **Future vision**, which contains:
  - **Sectoral objectives** – a summary of the objectives for the sector considering climate change and associated challenges to the sector's functioning and contribution to Guyana's socio-economic development. This is based on stakeholder discussions and feedback gathered at the VRR workshop.
  - **Climate resilience actions** – an inventory of actions identified for the sector based on literature review and stakeholder consultation, through the VRR workshop. The actions are

[xliv] Covering: Agriculture; Indigenous Peoples; Community and Regional Development (including disaster risk management); Ecosystems and Biodiversity; Energy; Fisheries; Forestry; Health; Housing; Mining; Sea and River Defence Infrastructure; Tourism; Trade; Transport; and Water. Education was included in the VRR workshop despite not passing the initial sensitivity screening step. The risks and actions for this sector are included in Annex D and E respectively.

grouped against the "five pillars"[xlv], or types of action, consistent with Guyana's Second National Communication[129]. Pillars Four and Five do not contain actions for a small number of sectors; this is a reflection of the state of the evidence base and the need for early actions to focus on building adaptive capacity[xlvi] in these instances. Details of whether the action is an existing one that could be scaled-up[xlvii] or replicated[xlviii] are included, together with information on the action's relevance at the national, sub-national or local scale, and proposed implementing agencies.

[xlv] Pillar 1: Information, research and systematic observation; Pillar 2: Institutional framework and capacity building, education and awareness; Pillar 3: Policy, legal framework and tools to integrate adaptation into development planning; Pillar 4: Generation and application of technologies; and Pillar 5: Financing instruments.

[xlvi] Actions to build adaptive capacity include those that will develop the institutional capacity to respond effectively to climate change, by compiling the information needed and creating the necessary regulatory, institutional and managerial conditions to undertake practical adaptation actions.

[xlvii] Scaled-up' refers to 'activities that attempt to expand an initial intervention' (OECD, 2014).

[xlviii] 'Replicated' is defined as 'activities that explicitly attempt to reproduce a specific intervention in a different location(s)' (OECD, 2014).

4.2.1 Agriculture

A: Current situation

Socio-economic importance

- Agriculture is essential to Guyana in terms of its significance to food security, poverty reduction, employment generation and foreign exchange earnings.
- It is Guyana's largest economic sector. Between 2009 and 2013, the agriculture sector contributed on average approximately 20% to GDP and accounted for on average 40% of the county's total export earnings per annum[130]. Sugar and rice have accounted for over 50% of this contribution since 2000[131]. The agricultural sector is the largest employer, providing over 33% direct employment[132].
- Main agricultural products include sugarcane, rice, edible oils, beef, pork and poultry.
- Sugar is an important agricultural and agro-industry in Guyana, representing 3.8% of GDP and 19% of agricultural GDP in 2013[133]. A significant share of Guyana's sugar is exported, primarily to the Caribbean and the EU[134].
- Rice is an important sector of the economy, growing year by year, contributing approximately 5% of GDP and 13.8% of agricultural GDP[135]. It is exported primarily to the EU and the Caribbean; for instance, Guyana holds 50% of the Jamaican rice market. The rice sub-sector directly supports approximately 20% of the population and is the country's main staple[136].
- Agriculture is also a critical livelihood activity, both for subsistence and commercial purposes and provides revenue generating income for about 25,000 farming households with approximately 90% concentrated in coastal areas and 10% in the hinterlands137. With the exception of sugarcane, farms are predominantly small using less than 15 hectares of land.
- The new administration will place greater emphasis on large-scale private investment in farming, especially in the Intermediate Savannahs and Region 9. Some of the crops identified for diversification in the hinterland areas are corn, soybean, cassava and legumes[138].

Climate vulnerability profile

- The agriculture sector is inherently extremely vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions, plant development and animal health. This vulnerability is exacerbated in Guyana by a number of factors (outlined below), which increase the exposure and sensitivity of the sector to climate impacts.
- The concentration of agricultural activity in The Low Coastal Plain, a narrow strip of land the majority of which is below mean high tide level, increases the exposure of the sector to sea level- and storm surge-related flood damage. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[139]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[140]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[141].
- The agriculture sector is highly dependent on the availability of water, a critical input for plant and animal growth. Surface water resources are currently abundant across the country[142]. However, changes in precipitation patterns, coupled with rising temperatures, may result in an increase in the number of droughts[143]. Temperatures are projected to increase across all seasons, with the warming most pronounced in the dry season of August, September and October[144]. In these months, temperature is projected to increase by a minimum of 0.9°C and a

maximum of 2.5°C by the 2030s; 1.5°C and 5.1°C by the 2060s; and 2.6°C and 6.6°C by the 2090s[145]. Drought conditions and changing rainfall patterns will exacerbate existing stress on Guyana's internal water resources, aquifers and rivers. According to the World Bank, in 2013 Guyana withdrew approximately 60% of its 241 cubic meters of renewable internal fresh water resources, 94.3% of which was used for agricultural purposes[146]. Furthermore, livestock depend on the availability of grazing land, which is sensitive to drought (as well as flooding near the coast).

- The current state of drainage and irrigation systems further increase the sensitivity of the sector to climate impacts. Particularly in rice-growing areas, where drainage and irrigation systems are poorly maintained, droughts and heavy rains already have a negative impact on rice crops[147]. These impacts are likely to become worse given projections across a range of future climate change scenarios, which indicate decreases in seasonal precipitation (up to 6mm for the 2030s, 17mm for the 2060s and 20mm for the 2090s[148]) and increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April[149]. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution; when minimum and maximum values are considered, positive and negative projections of rainfall change are generated.
- Stakeholder consultations highlighted that the capacity of the sector to deal with climate impacts is affected by a number of informational, technological, institutional and regulatory barriers. These include the fact that the majority of agriculture is undertaken by small farmers[150] who lack the technical knowledge, finance and technology to respond to and manage the impacts of climate variability and change. At the institutional level, there is a lack of cooperation and coordination among agencies, creating overlapping responsibilities and gaps. Stakeholders also commented that policy and regulation are poorly enforced, which potentially increases the exposure of agricultural activities to climate impacts (e.g. land-use planning policies and exposure to flooding; water abstraction regulations and exposure to droughts)[151].

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the agriculture sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

The highest magnitude risks identified for the sector are associated with sea level rise and saline water intrusion causing damage to crops (risk ref A1), flooding causing a reduction in the discharge window available for coastal drainage, which could affect sugar cane crop production (risk ref A4) and changes in water levels in the East Demerara Water Conservancy (EDWC), which would have impacts for irrigation (risk ref A6). Drought also appeared as an important risk driver, but given the uncertainty in future precipitation projections, the likelihood of the risk to agriculture yields was scored lower than the risks detailed above. Because the agriculture sector is a major contributor to GDP, any change in production will have significant consequences for the nation's economy and the livelihoods of those working in the sector (risk ref A2 and A3). Furthermore, any changes in yield of staple crops, for example rice, would have detrimental impacts for food security and human health (risk ref A5).

Table 3220: Risk register for the agriculture sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and

consequence are provided in Table 33 and Table 342134 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
A1	Sea level rise causes salt water intrusion with the consequence that agricultural land is damaged (e.g. rice production) and rural livelihoods and commercial enterprises are threatened	Yes	Almost certain	Catastrophic impact	Serious
A2	Incremental climate change and extreme events cause a decrease in agricultural production (e.g. sugar and rice crops) with the consequence that employment, both direct and indirect, is lost	Yes	Likely	Catastrophic impact	Serious
A3	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that revenue is lost at the enterprise, community and smallholder level and rural livelihoods and commercial enterprises are threatened.	Yes	Likely	Major impact	Serious
A4	Increase in extreme rainfall events and sea level rise cause flooding which reduces the discharge window available for coastal drainage with the consequence that the quality and quantity of sugar cane crop production is threatened and rural livelihoods and commercial enterprises are negatively impacted	Yes	Moderate	Catastrophic impact	Serious
A5	Incremental climate change and extreme events causes a decrease in rice paddy production with the consequence that food security is threatened	No	Moderate	Catastrophic impact	Serious
A6	Incremental climate change and extreme events cause water levels in the East Demerara Water Conservancy (EDWC) to fall below feasible levels for irrigation with the consequence that agricultural production declines and rural livelihoods are threatened	Yes	Likely	Major impact	Serious
A7	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that communities face food insecurity and associated human health impacts	Yes	Moderate	Moderate impact	High
A8	Incremental climate change and extreme event particularly increased frequency of droughts, causes water shortages for agricultural purposes (especially rice production) and a decrease in agricultural production with the consequence that rural	Yes	Moderate	Major impact	High

	livelihoods and commercial enterprises are threatened				
A9	Sea level rise causes coastal flooding and erosion with the consequence that agricultural land is damaged or destroyed and coastal livelihoods and food security are threatened	Yes	Almost certain	Minor impact	High
A10	Increase in extreme rainfall events causes flooding with the consequence that agricultural crops are damaged and revenue is lost	Yes	Moderate	Major impact	High
A11	Incremental climate change and extreme events particularly increased frequency of droughts, cause water shortages for agricultural purposes (especially rice production) with the consequence that more water is pumped and energy use (operational expenditure) increases and rural livelihoods and commercial enterprises are threatened	Yes	Likely	Minor impact	High
A12	Incremental climate change and extreme events, particularly increased frequency of droughts, cause water deficits and reduced sugar cane yields with the consequence that rural livelihoods and commercial enterprises are threatened	Yes	Likely	Moderate impact	High
A13	Incremental climate change and extreme events, particularly increased frequency of droughts, cause water deficits and a reduction in livestock productivity with the consequence that rural livelihoods and commercial enterprises are threatened	Yes	Likely	Moderate impact	High
A14	Increase in extreme rainfall events causes water levels in the East Demerara Water Conservancy (EDWC) to rise above safe operating levels with the consequence that flood mitigation systems are breached and extensive flooding of agricultural land occurs	Yes	Moderate	Moderate impact	High
A15	Increase in extreme rainfall events causes a reduction in the "opportunity days" for planting and reaping sugar cane with the consequence that the quality and quantity of sugar cane crop production is threatened and rural livelihoods and commercial enterprises are negatively impacted	Yes	Moderate	Major impact	High
A16	Increase in extreme rainfall events causes flooding due to stress and failure of drainage infrastructure and water management systems with the consequence that agricultural yields are lost	Yes	Moderate	Major impact	High

	(e.g. rice) and rural livelihoods are threatened				
A17	Incremental climate change and extreme events causes a decrease in agricultural production with the consequence that economic growth and poverty reduction efforts are threatened	Yes	Moderate	Moderate impact	High
A18	Increase in extreme rainfall events causes flooding with the consequence that livestock are lost and rural livelihoods are threatened	Yes	Moderate	Moderate impact	High
A19	Decrease in mean annual rainfall causes drought and water shortages for agricultural purposes (especially rice production) with the consequence that irrigation is ineffective and agricultural yields (e.g. rice) are threatened and rural livelihoods are negatively impacted.	Yes	Moderate	Major impact	High
A20	Increase in extreme rainfall events causes flooding of dam roads, which makes agricultural land inaccessible to mechanical combine harvesters with the consequence that harvesting is delayed (e.g. rice), crops are damaged and yields are threatened, negatively impacting rural livelihoods	Yes	Moderate	Major impact	High
A21	Extreme events cause disruption in agricultural production with the consequence that commodity prices increase and food shortages occur, resulting in socioeconomic losses	Yes	Moderate	Moderate impact	High
A22	Increase in extreme rainfall events causes difficulty in accessing (e.g. sugarcane and rice) fields (which is already difficult during the rainy season) due to the poor state of some farm-to-market roads with the consequence that agricultural yields decrease and rural livelihoods are negatively impacted	Yes	Moderate	Moderate impact	High
A23	Increase in extreme rainfall events causes flooding with the consequence that agricultural assets (e.g. land, livestock) in interior communities are destroyed	Yes	Moderate	Minor impact	Medium
A24	Incremental climate change and extreme events cause outbreaks of pests and diseases (e.g. paddy bug, red rice and blast infestation for rice crops) and lost agricultural production with the consequence that revenue is lost at the enterprise, community and smallholder level and rural livelihoods and commercial enterprises are threatened	Yes	Moderate	Minor impact	Medium

A25	Incremental climate change and extreme events cause proliferation of weeds and pest infestation with the consequence that agricultural yields (e.g. rice and sugar) decrease and livelihoods are threatened	Yes	Moderate	Minor impact	Medium
A26	Incremental climate change causes increased humidity and moisture, leading to increased incidences of diseases (e.g. rice blast infestation) with the consequence that agricultural yields (e.g. rice) decrease and rural livelihoods are negatively impacted	Yes	Moderate	Minor impact	Medium
A27	Incremental climate change and extreme events cause wildfire with the consequence that agricultural land (particularly for smallholders in the hinterland) is damaged or destroyed and food security is threatened	Yes	Moderate	Minor impact	Medium

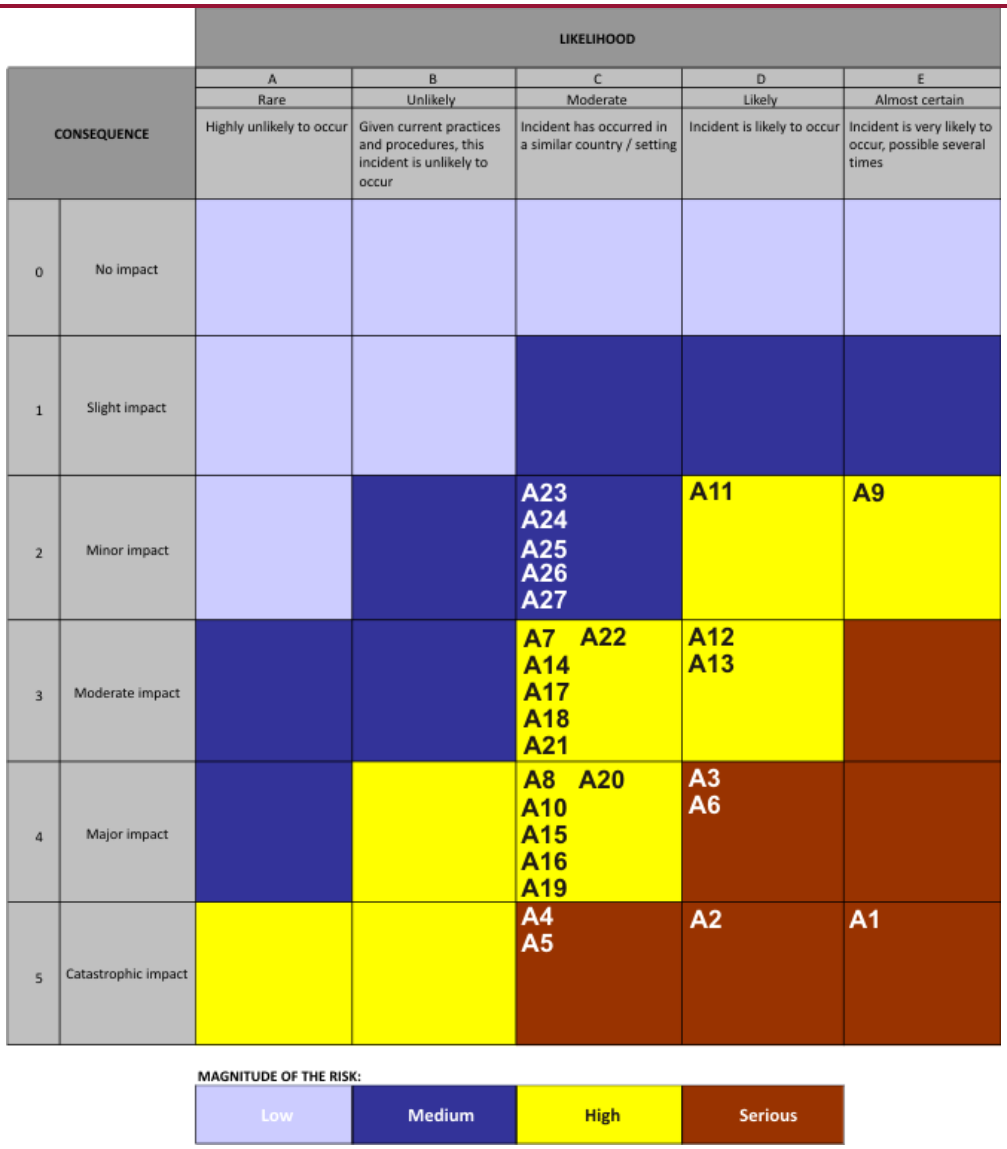


Figure 6: Risk matrix for the agriculture sector.

Table 33: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 3421: Consequence scoring criteria. The descriptors for the agriculture sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Slight losses (less than 10%) of annual production and/or livestock	Minor losses of between 11% and 25% of annual production and/or livestock	Moderate losses of between 25% and 35% of annual production and/or livestock	Major losses of between 35% and 50% of annual production and/or livestock	Catastrophic losses of more than 50% of annual production and/or livestock

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge on climate vulnerability of the sector, particularly the impact of climate change on water resources
- Improve climate modelling and weather forecasting / research, climate data storage and access for a range of user groups (Hydromet services)
- Promote adaptation good practice and develop innovative solutions (e.g. new germplasm, crops and water management best practice, including drip irrigation and protected agriculture)
- Provide farmers with skills, training, knowledge and tools to understand and manage climate change risks
- Upgrade and maintain drainage and irrigation supporting systems
- Embed climate change adaptation responses into agricultural policies and develop appropriate climate change regulations for the sector (e.g. water abstraction quotas and land use planning)
- Enhance monitoring and evaluation of climate impacts on agriculture and on measures to mainstream adaptation

Climate resilience actions proposed for Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
A1	Conduct climate hazard and vulnerability mapping nationally to identify and prioritize agricultural regions/areas that are most vulnerable to the impacts of climate change[152]	▽	N	GL&SC, Hydromet Service MoA
A2	Conduct investigations on the impacts of climate change on the most notable and important pests and diseases affecting the sector[153]	▽	N	MoA, NAREI
A3	Facilitate access to, upgrade and/or develop decision support tools and seasonal forecasts for farmers to improve their ability to manage climate variability at scales relevant to farmers and agricultural managers[154]	▽	L	Hydromet Service, MoA
A4	Establish routine data collection and storage procedure for the conservancies and reservoirs[155]	▽	S	NDIA, Hydromet Service
A5	Establish and improve calibration of hydrological model to synthesize conservancy flows[156]	▽ ...	S	NDIA, Hydromet Service
A6	Undertake studies to analysis groundwater levels (building on a US Army Corps study from 1998[157]) and the potential for groundwater to be used more widely to boost productivity[158]	▽	S	Hydromet Service
A7	Develop and test agricultural techniques that build resilience to a variable and changing climate. This includes integrated pest management and disease control; crop rotation; crops tolerant to saltwater, water logging and drought; use of appropriate greenhouse systems[159]	▽	N	MoA, NAREI, GRDB, GUYSUCO
A8	Identify and build on successful indigenous strategies for climate adaptation of agriculture that are already being implemented[160]	▽ ...	N	MoA, NAREI, MIPA, MoC
A9	Crop-specific measures: develop different crop varieties that are resilient to diseases, drought, floods and salinization, which are related to climate change impacts. Increase	▽	L	MoA, NAREI

	use of climate-responsive fertilizers; and more productive use of pesticides[161,162]			
A10	Conduct demand and feasibility study for introducing crop insurance across Guyana, building on World Bank pre-feasibility study conducted in 2010[163]	*	N	MoA, MoF, Bureau of Statistics
A11	Review, update and implement early warning and information management systems for farmers[164]	▽	N	CDC, GL&SC, NAREI, GUYSUCO, Hydromet, MoA
A12	Conduct a study to determine the feasibility of completing Phases II and III of the Mahaica/Mahaicony/Abary Agricultural Development Authority (MMA/ADA) Scheme[165]	*	S	MoF, MoA, NDIA
A13	Undertake localized vulnerability and risk assessments of agricultural lands, coastal aquifers, and drainage and irrigation systems to address impacts of sea level rise and storm surge[166]	▽	S	NAREI, GL&SC, NDIA, GWI
A14	Undertake detailed topographic, land-use and hydrological mapping of coastal lowlands; assessment of East Demerara Water Conservancy system integrity and hydraulic modelling; and pre-feasibility studies for coastal lowland interventions[167]	▽ …	N	GL&SC, GFC,NDIA, MOA
A15	Develop climate change scenarios and projections at the national and local/sub-national levels, using more accurate data and smaller scales to be relevant to end-users[168]	▽	N, S, L	Hydromet Service, GL&SC, MoA, OCC
A16	Recommended that organisations use local and short-term weather forecasting, regional CIHM 3 month forecasts and drought predictor tool from the CCCCC	*	N, S, L	Hydromet Service, MoA, CCCCC
A17	Develop higher resolution climate models and impact assessments to inform coastal planning and management[169]	▽	N	MoA (outsourced to specialists as required), EPA
A18	Develop a representative hydrometeorological monitoring network across the country (right now it is concentrated in the north and the east, with few inland)[170]	▽	N	Hydromet Service
A19	Explore feasibility and practicalities of CCCCCs providing a hydromet instrument technician to assist with the use of radar data[171]	*	N	Hydromet Service, CCCCC
A20	Develop a centralised repository for climate-related data[172]	*	N	Hydromet Service, MoA

A21	Facilitate research based on spatial variations within sectors[173]	▽	S	MoF, UG, OCC, sectoral ministries, GL&SC,
A22	Promote and facilitate the inclusion of the Bureau of Statistics and non-state actors in conducting research e.g. IICC, WWF, CIG[174]	▽	N	MoF, BoS, IIC, WWF, CIG
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
A23	Showcase best management practices through the establishment of demonstration farms to research and demonstrate cutting edge technologies, in areas such as plant breeding, agrochemicals and fertilizer application, plant husbandry, and water conservation and management[175]	▽	N, L	NAREI, GRDB, GUYSUCO, MoA, Pesticides Board
A24	Develop and implement an awareness raising programme on the impacts and risks of climate change on water and soil resources and encourage sustainable agricultural practices to manage these impacts[176]	▽	N	OCC, GWI, NDIA, UG, GSA, MOA
A25	Facilitate research and development capacity in Guyana with respect to finding solutions to water-related climate impacts[177]	▽	N	MoA, NAREI, GUYSUCO, UG, EPA – Water Quality Unit, Hydromet, FAO, GWI
A26	Include climate resilience as a focus for Guyana's participation in the Global Initiative on Plant Breeding Capacity Building (GIPB)[178]	▽	N	NAREI, GUYSUCO, GRDB, IAST, Crops and Livestock
A27	Conduct training and capacity building programmes for indigenous communities in climate-smart agricultural practices[179]	▽ …	S	NAREI, MIPA, MoA
A28	Develop the necessary capacity within the Ministry of Agriculture and natural resource agencies to respond to climate change[180]	▽	S	MoA, DNRE
A29	Conduct awareness raising campaign among farmers about crop insurance, if such a scheme is put in place[181] (see action A51)	*	N, L	MoA, IPED, OCC
A31	Expand current extension services to farmers to include provision of e-training in agronomic farming practices; and continued improvement and implementation of the 'Six-Point	▽ …	N	NAREI, GUYSUCO, GRDB, GLDA, GSA

	Programme'[182]			
A32	Develop programmes to strengthen institutional capacity of Government to manage water levels in the East Demerara Water Conservancy and to guide interventions aimed at reducing vulnerability to flooding[183]	▽	S	MoA, NDIA, GWI
A33	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation[184]	*	N	MoF, MoA
A34	Train local community members in skills required for monitoring of climate impact[185]	*	N	MoF, NAREI, GFC, IICC, MOA, GSA
A35	Provide training and education to develop technical expertise for improved climatological monitoring and forecasting and downscaling global and regional climate models to specific regions and sectors in Guyana[186]	*	N	MoA, UG, Hydromet Services
A36	Develop and provide a course on water conservation as part of tertiary education[187]	*	N	Guyana School of Agriculture
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
A37	Review, and revise if necessary relevant legislation, such as the Water Commission Act, to integrate climate change considerations[188]	*	N	MoLA, MoC, GWI
A38	Implement and review the 2013- 2018 Agriculture Disaster Risk Management Plan[189], so that opportunities for strengthening climate resilience are identified	▽	N	CDC, MoA
A39	Implement 2013-2020 National Agriculture Strategy, which takes into account climate change as a risk and opportunity for the agricultural sector[190]	▽	N	MoA
A40	Finalise the Draft National Land-Use Policy and the National Land-Use Plan, for Cabinet approval[191]	▽	N	GL&SC, DNRE, MOA
A41	Develop a regional agriculture strategy for the Rupununi region (a region of high ecological value), which will strengthen the region's resilience and work toward sustainable and climate-smart agriculture. This may serve as a model for other regions. The Ministry of Agriculture has already begun the planning process[192]	▽ …	S	MoA, GL&SC, CH&PA, MIPA, NAREI

A42	Conduct a comprehensive review of human resource policies within the agricultural sector to include provisions for skills development through training on climate change and climate risk reduction to staff who are at the forefront of the supply chain, job recruitment and introduction of compensation packages for key positions that remain vacant[193]	*	N	MoA, OCC
A43	Develop and implement policies and other measures to promote investment in the processing of agricultural products, to add value and variety to output for food and other uses, improving food security[194]	▽	N	MoA, GMC, GSA, MITC,
A44	Ensure gender issues are integrated into sectoral projects/ programmes relevant to resilience building[195]	*	N	MoF, Ministry of Social Protection, Ministry of Social Cohesion
A45	Develop a more robust framework for monitoring and evaluation[196]	*	N	MoLA, MOA
A46	Develop a policy paper that will outline an agenda for climate research in Guyana, which will inform policy development and review[197]	*	N	OCC, MOA
A47	Facilitate data sharing among sectors and eliminate existing protocols for sharing information[198]	▽	N	MOA
A48	Enhance collaboration and coordination between the MoA and Ministry of Public Infrastructure (MPI) to promote an integrated approach to Coastal Zone Management, including drainage and irrigation and management of sea and river defence infrastructure[199]	▽	N	MoA, MPI
A49	Research and develop GoG position on GMOs[200]	*	N	MoA
Pillar 4 Actions: Generation and application of technologies				
A50	Reassess and build on Agriculture Market Information Service (AMIS), implemented through the MoA and Digicel, which provides weather information and market information to farmers via mobile phone Short Message Service (SMS)[201]	▽	N	GMC, MoA, Digicel
A51	Upgrade drainage and irrigation system to deal with the expected greater intensity in rainfall; increased drought conditions; and increased flooding and salinity caused by unusually high tides[202]	▽	S	NDIA, GUYSUCO, MMA, other conservancy authorities

A52	Conduct studies and pilot projects on rainwater harvesting and conservation of water for irrigation, e.g. in the Rupununi[203]	*	S	MoA
A53	Develop and implement environmental management systems for agriculture[204]	*	N	MoA, DNRE
A54	Develop dynamic farm and agricultural management tools that integrate climate change risks into existing and emerging management systems to facilitate adaptation[205]	*	N	MoA, NAREI
A55	Assessment to examine the reallocation of agriculture as a flood risk management response[206]	▽ …	N	CDC, MoA, NAREI
A56	Infrastructure, machinery and equipment: existing stock of machines should be modified and replaced with new, specialized machines which can operate under very wet conditions[207]	▽	N	GUYSUCO, GRDB, MoA
A57	Improved existing roads and develop new infrastructure to improve access to market and reduce post-harvest losses (which are over 60% in some parts of the country)[208]	▽	N	MoA, NAREI, New GMC, MPI
A58	Consider development of a crop insurance programme[209]	*	N	MoA, insurance companies
A59	Drainage and irrigation system upgrade and maintenance for flood risk management in Georgetown[210]	▽	L	Municipality of Georgetown, MoC
A60	Maintain and upgrade the East Demerara Water Conservancy which protects Georgetown and most of the East Coast from overflow water[211]	▽	S	MoA, NDIA
Pillar 5 Actions: Financing instruments				
A61	Source financing for research and development programmes, including through use of financial incentives for private sector companies[212]	▽	N	MoA
A62	Develop and provide a financial incentives scheme for farmers, appropriate to each region, to implement climate resilient farming techniques/actions[213]			
A63	Source financing for the development and trial of climate resilient agricultural techniques[214]	▽	N	MoF, MoA, NAREI
A64	Source financing for demonstration farms and educational programmes[215]	▽ …	N	NAREI, MoA, GLDA, MoF, IICA

A65	Source funding for updated, climate-resilient infrastructure and equipment[216]	▽	N	Sea & River Defence Division of MoPI, MoC, MOA, NDIA, MoF
A66	Strengthen primary insurance market, which helps to strengthen resilience within the economy to catastrophic events[217]	▽	N	MoA, insurance companies, IPED
A67	Source financing for the development and dissemination of an appropriate crop insurance product, should it be deemed feasible[218] (see A51)	*	N	MoF, MoA
A68	Secure funds for upgrading coastal irrigation and drainage system and improving sea defences[219]	▽	S	MoF, MoA, MoPI
A69	Source funding for automated weather stations and field staff[220]	▽	N	MoF, MoA

4.2.2 Community and Regional Development

A: Current situation

Socio-economic importance

- All countries need competitive dynamic regions to achieve their economic, social and environmental objectives[221]. Community and regional development is viewed as the general effort to reduce regional disparities by supporting (employment and wealth-generating) economic activities in regions. The vision in Guyana, as stated by the Ministry of Communities (MoC), is for sustainable, cohesive and empowered communities across the country[222].
- Guyana is divided into 10 Administrative Regions and each Region is administered by a Regional Democratic Council (RDC) which is headed by a Chairman. The Regions are divided into neighbourhood councils, known as Neighbourhood Democratic Councils (NDCs). Georgetown and Guyana's other major cities are important generators of wealth, employment and productivity growth and play a leading role in the national economy.
- Guyana's rural hinterland accounts for 95% of the land area and 10% of the population[223] and is home to a number of important economic activities, including agriculture, forestry and mining. However, transport, energy and ICT connections to the hinterland are limited, which will be a constraint to socio-economic development in these regions.
- The communities sector, in both rural and urban locations, is especially important for job creation and provision of services like water, waste management and housing that are essential to a productive and sustainable future.
- The challenge for Guyana is to strike a balance between the interests, capacities and objectives of national and sub-national levels, to ensure that all places contribute to and benefit from economic growth.

Climate vulnerability profile

- Regions and communities in Guyana are vulnerable to climate change. Vulnerabilities differ depending on location (rural vs. urban, coastal vs. hinterland) and physical and socio-economic characteristics of each community/region, for example division of labour between men and women, main sources of livelihood, and access to critical infrastructure such as transport, energy, health facilities and communications.
- Georgetown, where most of the population is concentrated, is highly sensitive to the impacts of flooding due to the city's strained and inadequate drainage infrastructure, leading to various negative impacts such as property damage, loss of life, and deterioration of health due to water-borne illnesses. The city's drainage system depends primarily on 13 sluices, of which 10 are fully functional (as of June 2015)[224]. Pumps are used to drain water off the land when the sluice gates are closed, but not all are currently functional[225]. Flooding is linked to heavy rainfall as well as sea level rise. Management of the EDWC and other conservancies is also critical, especially when there is prolonged heavy rainfall[226]. Climate projections show increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April[227]. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution; when minimum and maximum values are considered, positive and negative projections of rainfall change are generated.
- The concentration of the population along the coast also exposes communities and economic activities to flooding and erosion associated with sea level rise and storm surge. Sea level is

projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[228]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[229]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[230]. These climate hazards have the potential to exacerbate flooding, particularly in Georgetown and coastal communities. The floods of early June 2015 illustrate the vulnerability of Guyana's urban areas to flooding.

- Wastewater management, especially the management of septic effluent along coastal communities[231], and solid waste management also faces challenges, particularly in the absence of opportunities to recycle[232], which increases the sensitivity of communities to climate-related impacts. Improper wastewater and solid waste management contributes to poor sanitary conditions, which may worsen in the event of flooding, and increases the incidence of health problems (e.g. leptospirosis and diarrhoea). For example, many incidences of leptospirosis occurred after flooding in 2005[233].
- Health is therefore a key issue for communities and regions in Guyana, and is the responsibility of the RDCs. Climate factors influence the incidence of water-, vector-, and food-borne diseases[234]. For example, warmer temperatures, higher humidity and more places where water can collect favour malaria transmission. Malaria is present throughout Guyana, including urban areas, though prevalence is higher in rural and hinterland regions (especially Regions 1, 7 and 8), where there is less access to appropriate health infrastructure[235]. Other diseases, such as dengue, gastroenteritis and diarrhoea are also sensitive to changes in climatic conditions.
- Many communities in Guyana are dependent on agriculture for their livelihoods. Agriculture itself is very vulnerable to climate change[236], which increases the sensitivity of the communities which depend upon it. A decrease in agricultural production, as a source of livelihoods and food security, is of particular concern, as Guyana has a high rate of population at risk. In terms of food security, the following risk groups have been identified in Guyana: low-income families, the indigent and homeless population, children 0–5 years of age, adults over age 65, and those infected with communicable diseases or affected by one or more non-communicable chronic diseases[237].
- Gender roles also create vulnerabilities in communities. The division of labour in some communities may lead to different vulnerabilities for men and women.
- The capacity of communities and local governments to adapt to the impacts of climate change was assessed by stakeholders as low to moderate[238]; a number of informational, technological and regulatory barriers exist. Stakeholders commented that policies related to climate resilience exist, yet these need to be revived and enforced, and that there is a particular need to strengthen land use planning. There is also a need to strengthen the connection between policymakers and local people on the ground, to increase communities' participation in decision-making. Information is limited, consisting of traditional knowledge, available Hydromet data and a climate change community manual. Furthermore, due to the hinterland location of certain communities, information is not always readily available (e.g. newspapers and media are not available everywhere) and communication mechanisms need to be tailored to specific communities. Finally, the availability of financial resources to build climate resilience is perceived as low. Although financing is available to various agencies, such as the RDCs and NDIA, for activities that may be classified as resilience building, stakeholders did not refer to this. Institutional capacity was assessed as moderately high and therefore positively contributes to the adaptive capacity of communities. There are a number of institutions in place with mandates to address climate change, including village councils, National Toshaos Council (NTC) executives, GFC, MIPA, regional representation and the OCC. However, there are communication challenges hindering a timely and smooth flow of information between these institutions, which affects the feedback mechanism necessary for participatory decision-

making.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for community and regional development, as detailed in Table 3220 and presented on the risk matrix in Figure .

The majority of risks identified for this sector were deemed high magnitude. However, there were a number of "serious" risks identified (Figure). These are largely linked to risks in other sectors, for example, the impacts of sea level rise on agricultural land is identified as having cascading consequences for regional development and socio-economic growth (risk ref CRD2). Similarly, the impacts of floods and droughts on mining operations could lead to detrimental consequences for the livelihoods and health of rural communities in these areas (risk ref CRD3). These climate risks have the potential to exacerbate regional socio-economic inequalities. The final, more direct, high magnitude risk relates to flood damage to infrastructure, including housing, roads, telecommunications and utilities, and the risk of human injury and death (risk ref CRD1).

Table 3522: Risk register for Community and Regional Development. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk	Likelihood (2030s)	Consequence	Magnitude of risk
CRD1	Increase in extreme rainfall events cause flooding with the consequence that infrastructure, including housing, roads, telecommunications and utilities, are damaged or destroyed and there is increased risk of human injury and death	Yes	Likely	Catastrophic impact	Serious
CRD2	Sea level rise cause coastal flooding and erosion with the consequence that agricultural land is damaged or destroyed and regional development and socioeconomic growth are threatened in coastal areas	Yes	Likely	Catastrophic impact	Serious
CRD3	Extreme events combined with the concentration of population in exposed coastal zones, causes an increased chance of climate-related disasters with the consequence that physical and socio-economic damage and loss of life occur	Yes	Likely	Catastrophic impact	Serious
CRD4	Extreme events particularly floods and droughts, cause detrimental impacts to mining operations and riverine landforms with the consequence that livelihoods and health of rural communities in the hinterland is detrimentally impacted	Yes	Likely	Major impact	Serious
CRD5	Extreme events cause unsuitable living	Not	Moderate	Moderate	High

	and working conditions with the consequence that gender inequality increases, with the disempowerment of women	yet[xlix]		impact	
CRD6	Incremental climate change and extreme events cause a greater number of natural hazard-related disasters with the consequence that lives are threatened (men, women and children)	Yes	Moderate	Major impact	High
CRD7	Extreme events particularly heatwaves, droughts and floods, cause problems with solid waste management and drainage and irrigation with the consequence that waste management systems and practices will need amending and implemented/ enforced	Yes	Moderate	Major impact	High
CRD8	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that rural livelihoods and commercial enterprises are threatened, employment is lost and social problems develop	Yes	Moderate	Major impact	High
CRD9	Incremental climate change and extreme events cause a decrease in agricultural production with the consequence that regional development and socioeconomic growth are threatened	Yes	Moderate	Major impact	High
CRD10	Incremental climate change and extreme events causes a decrease in agricultural production and revenue at the enterprise, community and smallholder level with the consequence that community services (e.g. health, education, infrastructure and transport) are detrimentally affected	Yes	Moderate	Major impact	High
CRD11	Increase in extreme rainfall events causes flooding with the consequence that resources are required for disaster response efforts	Yes	Almost certain	Minor impact	High

[xlix] Based on stakeholder feedback at the VRR workshop

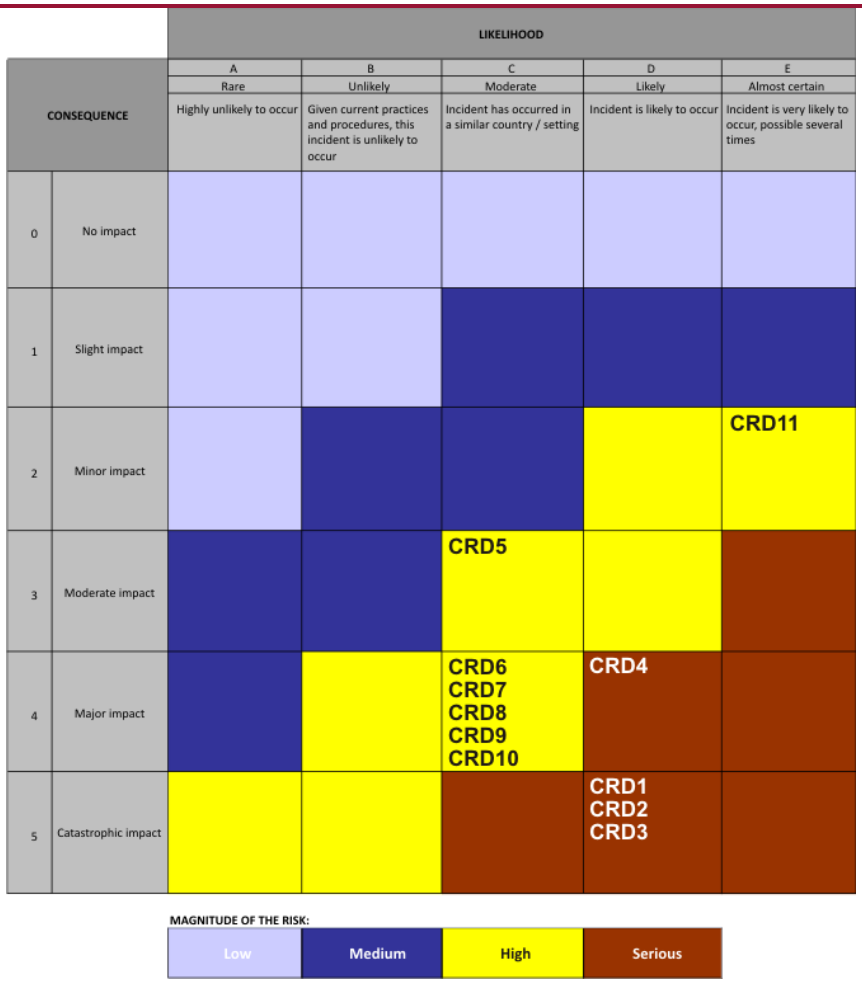


Figure 7: Risk matrix for Community and Regional Development.

Table 36: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 3723: Consequence scoring criteria. The descriptors for Community and Regional Development have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Easily reversed Few households /people affected	Can be fixed, reversible Several households	Can be fixed, reversible with effort/input Many households	Impacts are hard to reverse Livelihoods directly affected	Irreversible Human lives and biodiversity (flora & fauna) are lost

	affected	affected	Human lives and biodiversity (flora & fauna) are threatened	Whole community is affected

B: Future vision

Recommended Sectoral Objectives

- Tailor and generate climate change knowledge products to meet the educational needs of targeted communities
- Promote coordination and networking among the councils and all relevant agencies and stakeholders
- Engage Hinterland locations and promote synergies between outreach programmes (OCC, REDD+ Secretariat, MSSC)
- Help local government agencies access skills, training, knowledge and tools to understand and manage climate change risks
- Build climate resilience of communities through effective and climate resilient water, waste management, health care, education, energy, transport and ICT programmes
- Restore and develop mangrove forests to increase the resilience of coastal protection systems
- Develop, strengthen and implement law, policies, regulations and national strategies for climate resilience in disaster risk management
- Strengthen disaster risk management and response efforts at community, regional and national levels

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
CRD1	Conduct research and studies on climate change in regions not targeted to date, e.g. Region 7[239]. For example, CDC has generated hazard, vulnerability and risk maps for Regions 5 and 6, and they intend to scale this up to other regions[240].	... ▽	S	WWF, CI, UG, CDC, MoA, RDCs, MIPA
CRD2	Review and replicate the risk reduction management centre in Region 9 (which is modelled on the Cuban system) to cover other regions[241]	...	S	CDC
CRD3	Conduct situational analysis, identify needs and justify expansion of outreach activities and climate change capacity building[242]	...	N	CI, OCC, GFC, EPA
CRD4	Conduct feasibility studies on waste management options from a regional perspective[243]	*	N, S	MoC, RD, NDCs, DNRE, EPA, RDCs
CRD5	Undertake reconnaissance surveys of mangrove degradation and vulnerability and identify needs for restoration	...	N	GFC, EPA, MoA, MPI
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
CRD6	Simplify and disseminate climate change materials[244]	▽	N, S, L	OCC, DNRE, MoE, WWF, CI, EPA
CRD7	Include item on sharing climate change information and networking on the agenda of indigenous peoples' representative groups, such as the National Toshaos Council[245]	*	N	MIPA, NTC
CRD8	Train and strengthen climate change technical capacity at regional level[246]	*	N, S	MoC, RD, MoA, MIPA, RDC, MoE
CRD9	Support the Civil Defence Commission (CDC) with early warning/ disaster response systems for communities, using the approach developed in Region 9 as a model and to assess lessons learned[247]	...	N, S	MoC, CDC
CRD10	Provide training on technical expertise required to develop an early warning system and maintain it[248]	▽	N, L	CDC, EPA, UG

CRD11	Extend the volunteer corps[I] used by the CDC in Regions 4, 6 and 9 to cover all regions[249]	▽	S	CDC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
CRD12	Review and enforce laws and policies in relation to the environment, to include climate change[250]	*	N, S, L	MoC, Guyana Police Force, EPA, MoLA, National Task Force
CRD13	Update the draft Disaster Management Policy to integrate climate change[251]	*	N	CDC, MoC, MoPH, GWI
CRD14	Enact & implement national disaster management legislation[252]	*	N	CDC, National Platform for Disaster Risk Management
CRD15	Finalise and implement the Integrated Disaster Risk Management Plan, which is being developed with the Inter-American Development Bank and integrates climate risk[253]	…	S, L	CDC, MoC
CRD16	MoC to provide institutional strengthening support to local democratic organisations, including assessment and recommendations on how to improve their financial sustainability[254]. The current shift towards decentralisation and devolution, and the development of regional development action plans (Region 10 is the pilot) provides a window of opportunity for the integration of climate resilience.	*	N, S	MoC
CRD17	Explore the option of resettlement of exposed communities, as demonstrated in October 2015 when several farmers in the Mahaica Creek area were relocated to the Hope Estate on the east coast of Demerara, due to persistent flooding following unseasonally heavy rainfall and outflow from the conservancy[255].	*	N, S	MoC
Pillar 4 Actions: Generation and application of technologies				
CRD18	Replant mangroves in critical areas[256]	▽	N, S	GFC, EPA, NDIA, MPI, MoA
CRD19	Develop and upgrade warning systems	▽	N	CDC, National

[I] The volunteer corps is split into (1) members with specialized skills, e.g. medical, engineering, GIS, and (2) general members. The skilled volunteer's role is to deliver community-based DRM – lead the process of identifying hazards, risks, actions and delivering actions at the community level. The general volunteers are involved in emergency response.

	and evacuation procedures[257]			Platform for Disaster Risk Management
CRD20	To advance an Integrated Waste Management Strategy, including exploration of waste to revenue[258]	*	N	MoC, National Task Force
Pillar 5 Actions: Financing instruments				
CRD21	Source funding for development and upgrade of early warning systems[259]	▽	N	MoF, CDC
CRD22	Examine the feasibility of contingent capital and cash reserves to provide immediate liquidity in case of a disaster and to create awareness of risk[260]	*	N	MoF, CDC, MoC
CRD23	Source funding for the implementation of the Integrated Disaster Risk Management Plan[261]	*	N	CDC (Ministry of the Presidency)
CRD24	Allocate national budget to Ministry of Communities and maximize on opportunities through projects and initiatives to support building climate resilience for addressing current climate impacts, preparations and recovery	▽ *	N, S, L	MoC

4.2.3 Ecosystems and Biodiversity

A: Current situation

Socio-economic importance

- Biodiversity refers to the degree of variation of life on Earth and includes all animals, plants, fungi, micro-organisms and the genetic variation among these. Biodiversity varies from location to location, with the greatest biodiversity in the tropics[262].
- Guyana's location contributes to its high levels of biodiversity; it is situated in the neo-tropical bio-geographical territory of north-eastern South America and within the Guiana Shield region which forms part of the Amazon Biome. The Amazon Biome, spanning 6.7 million km^2, is the largest remaining tropical rainforest in the world, home to at least 10% of the world's known biodiversity[263]. From coastal mangroves to old growth rainforests, wetlands and savannahs, Guyana's ecosystems support a diverse range of species; as of 2010, Guyana's species status was estimated as 8,000 plant species; 467 fishes; 130 amphibians; 179 reptiles; 814 birds; 225 mammals; 1,673 arthropods; over 1,200 fungi; 33 bacteria; 13 nematodes; 44 algae; 17 molluscs; and an estimated 30 virus[264].
- Guyana's biodiversity provides a basis for climate regulation, poverty reduction, provisioning of freshwater, economic growth and development in areas such as agriculture, forestry and fisheries, payment for forest climate services, and community-based economies. Loss of biodiversity, habitats and ecosystems and any disruption in the provision of ecosystem services would have a negative impact on the economy and the quality of life of all communities[265].
- Guyana's wealth of natural resources, high levels of biodiversity and low rates of deforestation are internationally recognized. One of the government's key objectives over recent years has been to sustainably manage natural resources, with the primary aim of conserving and protecting the environment, and a secondary aim of creating income generating opportunities.

Climate vulnerability profile

- From a global perspective, the Millennium Ecosystem Assessment[266] estimated that approximately 60% of the ecosystem services are already being degraded or used unsustainably (including freshwater, fisheries, air and water purification). Climate change is expected to be the dominant direct driver of biodiversity loss by the end of the century[267]. Ecosystems and biodiversity are vulnerable to a range of climate parameters and hazards, including incremental changes in temperature and rainfall, sea level rise, increases in ocean temperature and pH, water availability, flooding, soil erosion and ground instability, wildfire and pests and diseases. Anticipated impacts of climate change on biodiversity include shifting of ecosystem boundaries, change in natural habitats and sharp increases in extinction rates for some species[268]. For example, warmer springs have led to earlier nesting for 28 migratory bird species on the East Coast of the United States[269]. Furthermore, impacts on one particular species can have a ripple effect on others, for example disrupting food production.
- Terrestrial ecosystems and biodiversity, including vegetation, wetlands, forests, insects, birds and animals, are sensitive to the slow creeping change in temperature and precipitation patterns over the longer-term. In Guyana, mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s[270]. The largest increases in temperature are projected for the southern portion of the country. Trends in annual rainfall are more uncertain, with different models projecting a wide range of possible changes – both decreases and increases in rainfall amounts. However, ensemble median values

of change by the 2060s are consistently negative for all seasons and emissions scenarios. Projections vary between -34% to +20% by the 2090s, with ensemble median values of -18% to -4%[271]. Changes in temperature and water resources, through shifting rainfall amounts and timing, are likely to impact the tolerance thresholds of many species and ecosystems.

- Terrestrial systems are also vulnerable to extreme events. Droughts in particular cause poorer habitat suitability in terms of food, water, cover and useable space, leading to wildlife migration, mortality through starvation, predation, reduced production and recruitment (survival of young ones) and broader environmental degradation. In Guyana, stakeholders commented that El Niño results in conditions similar to heatwaves and prolonged El Niño events may mimic desertification conditions[272]. This puts biodiversity under pressure, with animals experiencing heat stress, for example.
- Forests are also vulnerable to wildfires, which may increase in frequency and intensity in a warmer and potentially drier climate. The projected rise in temperatures and long periods of drought are predicted to lead to more frequent and more intense fires. Fire sensitive areas typically exist in dry evergreen forest predominated by white sandy soils, where lands are cleared for agricultural purposes[273,274]. Fire damaged areas are subsequently vulnerable to erosion from wind and water, leading to sedimentation of waterways.
- Terrestrial ecosystems and biodiversity is also vulnerable to pests and diseases. Many important pest (e.g. mosquitoes, rodents) and diseases (e.g. malaria and leptospirosis) are affected directly or indirectly by weather and climate[275]. Future climate change has the potential to affect the distribution, timing and intensity of pest and disease outbreaks.
- Guyana's freshwater and groundwater resources are vulnerable to saline intrusion from storm surge and sea level rise and contamination from flood events, leading to reduced water quality for species living in or close these environments. In the interior regions where indiscriminate mining practices have changed and/or inhibited water flows, surface water pollution and salinization is currently a critical issue, which may be further exacerbated in a changing climate.
- Guyana's coastline is home to a diverse and important range of ecosystems, including mangrove forests, which offer important natural coastal protection benefits. Coastal ecosystems and biodiversity are vulnerable to sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[276]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[277]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[278]. Coastal flooding and erosion has the potential to damage and destroy coastal ecosystems, including beaches, estuaries and biodiversity. This may in turn lead to problems with water systems, agriculture, infrastructure, fisheries, tourism and other related sectors dependent on the coast. The vulnerability of mangroves to coastal erosion and flooding is a particular concern, given their importance providing land stability in the coastal zone. Stakeholders commenting that young mangroves are susceptible to being uprooted or damaged, which hinders their growth, and man-made infrastructure (such as seawalls) hinders the ability of mangroves to naturally adapt to sea level rise by moving inland[279].
- Marine ecosystems and biodiversity are sensitive to ocean temperature and pH. Climate change-induced changes in water temperature, ocean currents and coastal upwelling may cause changes in the distribution of marine species, which are already experiencing pressures from other non-climate drivers, including over-fishing, pollution, human settlement and development, mining and shipping industry[280]. As such, the impact of climate change on marine ecosystems is incredibly complex, with both positive and negative changes likely. The importance of the fisheries industry in Guyana means that impacts on marine ecosystems and biodiversity will have a significant effect on the productivity and profitability of the industry.

The capacity of key actors in the sector to deal with climate impacts is affected by several key challenges including a number of informational, institutional, financial and regulatory barriers and issues. In terms of information, stakeholders noted that resources exist but they are frequently not coordinated or integrated into decision-making[281]. Specifically, there is a lack of information on the economic value of ecosystems and biodiversity (though it should be noted that the 2013 LCDS Update details the economic value of ecosystem services provided by forests, at around US$5.8 billion[282]). More research is needed to define baselines for evidence-based decision making. There is also little information on ocean ecosystems and health trends and little consideration of how climate change may impact unique indigenous issues, such as political and economic marginalisation and land tenure. Stakeholders commented on the need to improve communication and dissemination of information to different groups, like indigenous peoples and youth, and to incorporate gender and youth angles into research[283]. Institutional capacity was viewed as moderate, with stakeholders acknowledging that there is a lack of coordination and effective communication between institutions[284], however, a Communication and Outreach Team under the LCDS has been established to address this issue. High staff turnover is also an issue, with "brain drain" highlighted by stakeholders. Stakeholders assessed the availability of finance as low. Stakeholders noted that Guyana does not have a strong research base and there is a lack of finance to undertake research[285]. In terms of the policy and regulatory environment, stakeholders commented that although policies exist, many are outdated and need revision, some overlap and there is little to no enforcement[286]. There is a need for more clarity (via legislation) on the use of resources and national sustainable development priorities when more than one government department has responsibilities which can include ecosystems and biodiversity, for example the interplay between forestry, agriculture and mining. It was also noted that policies and legislation must mainstream the economic and non-economic value of ecosystems and biodiversity.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for ecosystems and biodiversity, as detailed in Table 3220 and presented on the risk matrix in Figure .

In this sector, no risks were identified with catastrophic impacts (level 5 consequence in Table 3421); the majority of the risks were clustered around major – moderate impacts (level 4 – 3 consequence in Table 3421). However, the "almost certain" likelihood assigned to several risks creates a number of "serious" risks for the sector. The highest magnitude risks for ecosystems and biodiversity are linked to environmental degradation caused by changes in freshwater and groundwater systems (e.g. flows and salinization) (risk ref E1), flooding, landslides and soil erosion (risk ref E3), sea level rise and increase in storm surges causing coastal erosion or sediment deposition (risk ref E2) and changes in sea surface temperatures impacting ocean ecosystems (risk ref E5). Given the value of ecosystems and biodiversity to a range of interested groups (e.g. indigenous communities, tourism operators, forestry agencies), climate-induced pressure or changes in ecosystems and habitats has the potential create conflicts between different user groups (risk ref E4).

Table 3824: Risk register for ecosystems and biodiversity. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 342140 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
E1	Incremental climate change and extreme events causes changes in freshwater and groundwater systems (e.g. flows and salinization) with the consequence that environmental degradation occurs and biodiversity is threatened and human health compromised, economy, livelihoods	Yes	Almost certain	Major impact	Serious
E2	Sea level rise and increase in storm surge causes coastal flooding and erosion / deposition with the consequence that coastal ecosystems (e.g. mangroves) are damaged or destroyed and environmental degradation occurs	Yes	Almost certain	Major impact	Serious
E3	Extreme events causes flooding, landslide, soil erosion and water contamination with the consequence that environmental degradation occurs, with consequences for rural livelihoods	Yes	Almost certain	Major impact	Serious
E4	Increased pressure or changes in ecosystems and habitats may cause increased tension between different interested stakeholder groups	Potential risk	Almost certain	Major impact	Serious
E5	Increase in sea surface temperatures causes detrimental impacts on ocean ecosystems and functioning with the consequence that environmental degradation occurs	Potential risk	Likely	Major impact	Serious
E6	Incremental climate change and extreme events causes negative impacts on forests and wetlands with the consequence that environmental degradation occurs	Yes	Likely	Moderate impact	High
E7	Incremental climate change causes emergence of pests with the consequence that environmental degradation occurs	No	Moderate	Moderate impact	High
E8	Extreme events cause detrimental consequences for ecosystems and biodiversity with the consequence that the national cultural identity is affected (e.g. land of many waters, coat of arms, animal extinction)	Potential risk	Moderate	Moderate impact	High

E9	Incremental climate change and extreme events particularly increased heatwave duration, causes increase in fire frequency and intensity with the consequence that irreversible environmental degradation and change occurs including agricultural productivity, livelihoods	Yes	Moderate	Minor impact	Medium

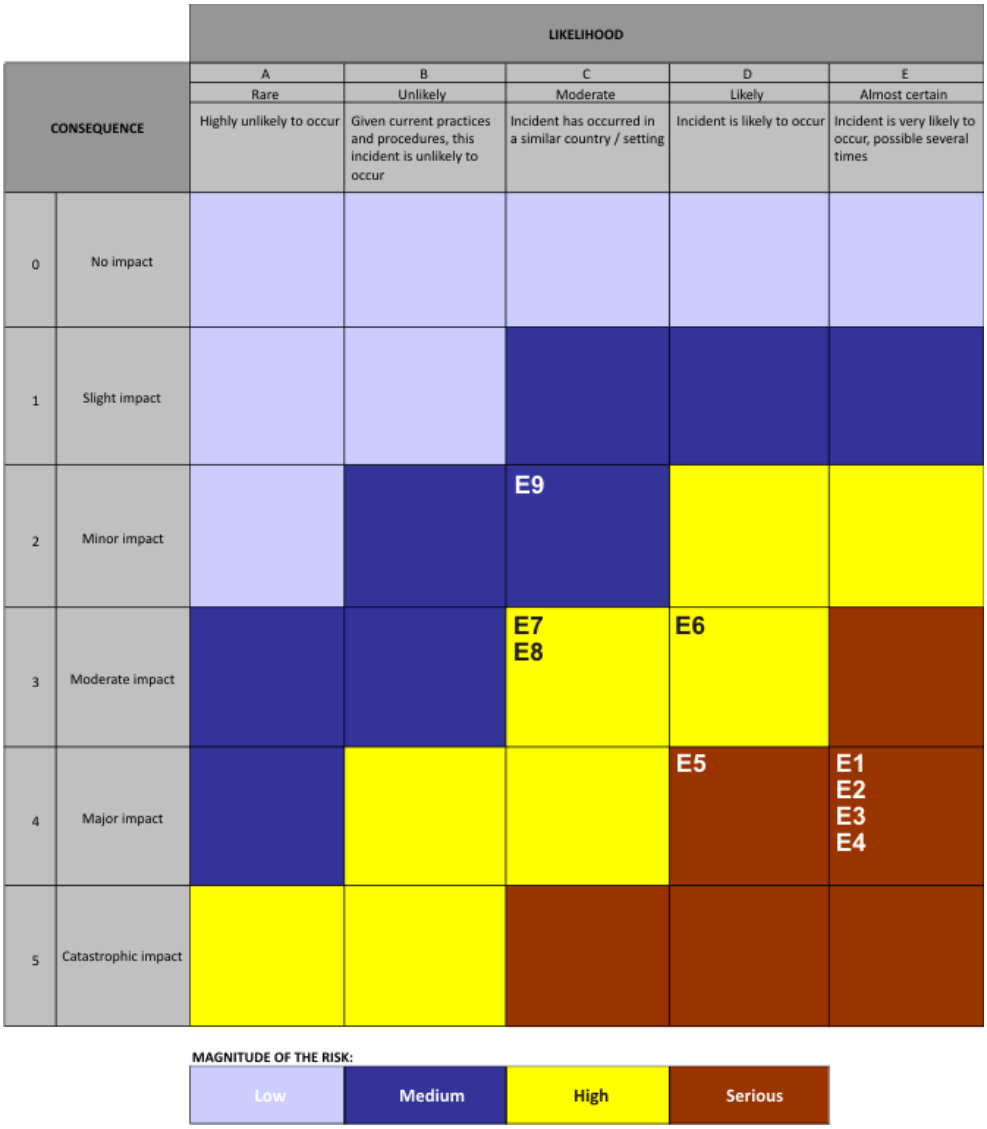


Figure 8: Risk matrix for ecosystems and biodiversity.

Table 39: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain

Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 40: Consequence scoring criteria. The descriptors for ecosystems and biodiversity have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Original biodiversity and ecosystem services interrupted over a short period (0-12 months)	Original biodiversity and ecosystem services negatively impacted and recoverable over a period of 1 to 3 years and impact on productivity negligible (less than 5%)	Original biodiversity and ecosystem services damaged and only recoverable over a period of 3 to 10 years and resulting in a decrease greater than or equal to in 25% in productivity in relevant sectors	Original biodiversity and ecosystem services significantly damaged and only recoverable over a period of 10 to 25 years and resulting in a decrease greater than or equal to 50% in productivity in relevant sectors	Original biodiversity and ecosystem services destroyed beyond and only later replaceable by secondary systems resulting in a decrease greater than or equal 80% in productivity in relevant sectors

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge on climate vulnerability of ecosystems and biodiversity, particularly the associated impacts on livelihood, economy and society
- Create a central repository of all research on biodiversity and ecosystem services (BES) that is freely accessible
- Disseminate information through targeted outreach and awareness sessions for various groups of society (e.g. teachers, youth, media, indigenous peoples, farmers, all law enforcement bodies, etc.)
- Promote conservation good practice to adapt to the impacts of climate change
- Develop, implement and enforce law, policy and regulation for climate resilient ecosystems and biodiversity and mainstream in current laws, policies and regulations, national development strategies, plans, etc. through an inclusive evidence-based process
- Enhance and diversify funding for the sector especially in the areas of research and development
- Restore and develop mangrove forests to increase the resilience of coastal protection systems

- Restore degraded interior ecosystems caused by mining activities

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
Ec1	Research and analysis of past and present climate impacts on the natural environment[287]	▽	N, S, L	OCC, UG, EPA, Iwokrama, CI-Guyana, WWF-Guianas, MoA, DNRE, Hydromet, NAREI, GFC, GGMC, MIPA, MoC, RDCs, NTC
Ec2	Research into natural ecosystems and the natural protection they provide from extreme weather events (e.g. watershed management), and how these will be impacted by climate change[288]	▽	N, S, L (phased approach, from L to N)	OCC, UG, EPA, Iwokrama, CI-Guyana, WWF-Guianas, MoA, DNRE, Hydromet, NAREI, GFC, GGMC
Ec3	Undertake mapping of key areas (threatened, key stone and hotspot areas and species) using GIS and other available technology[289]	*	N	TBC
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
Ec4	Develop a widespread awareness program on the importance of ecosystems and biodiversity and how climate change impacts these systems. Incorporate the importance of evaluating the effectiveness of adaptation action[290]	▽	N, S, L	EPA(EIT DEPT.), MoE, DNRE, MoA, Media, CI, WWF, Iwokrama, OCC, GFC
Ec5	Train local community members in skills required for design and implementation of adaptation measures as well as monitoring and evaluation[291]	▽	N, S, L	Iwokrama, CI, WWF, RDCs, NTC, EPA, EIT, MoA, MoE, GFC, GGMC
Ec6	Strategic packaging and dissemination of knowledge and best practices around climate resilience and the natural environment[292]	▽	N, S, L	DNRE, CI, WWF, MoA, NDC, RDC, NTC, MoE, UG, OCC, GFC
Ec7	Develop and implement a public awareness raising programme about mangrove conservation and restoration[293]	▽	N, S, L	DNRE, MoA – Mangrove Restoration Project, UG,

				sector agencies, GFC, MPI
Ec8	Create a central repository for research. The location should consider the results of a feasibility study that was recently completed to establish a Centre for Biodiversity Studies at UG[294]	*	N, S, L	UG, , EPA, DNRE, MoA, CI, WWF, OCC, Iwokrama, Biodiversity Centre proposed under LCDS
Ec9	Institutional strengthening of relevant agencies to enforce laws, policies and regulations[295]	*	N, S, L	MoC, DNRE, EPA
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
Ec10	Ensure gender issues are integrated into sectoral projects/ programmes relevant to climate resilience[296]	▽	N, S, L	Human Rights Association, MIPA, Women's Associations, CI, WWF-Guianas, EPA, Ministry of Social Protection
Ec11	Develop a more robust framework for monitoring and evaluation[297]	▽	N, S, L	DNRE, MoC, Sector agencies
Ec12	Adopt an Ecosystem-based Adaptation (EbA) approach to environmental management policies and strategies, to build resilience and reduce the vulnerability of ecosystems and people in the face climate change impacts, especially given Guyana's abundance of natural capital[298]	▽	N, S, L	DNRE, CI, MIPA, WWF, MoA, UG, Iwokrama, Sectors agencies
Ec13	Development and implementation of policies and legislation to conserve mangroves[299], building on National Mangrove Management Action Plan 2010-2012.	▽	N, S, L	DNRE, MoA, Mangrove Restoration Project, UG, Legal Affairs, GFC
Ec14	Monitor compliance with environmental impact assessment requirements for coastal mangrove alterations[300]	*	N, S, L	DNRE, MoA, EPA, GFC
Pillar 4 Actions: Generation and application of technologies				
Ec15	Implement climate resilient conservation programmes to protect key ecosystems and biodiversity[301]	▽	N, S, L	DNRE, UG, CI, Iwokrama, sector agencies, OCC, WWF, MoA
Ec16	Develop mangrove monitoring system[302]	▽	N, S, L	MoA-NAREI, Mangrove Restoration Project, UG, DNRE, EPA, GFC

Ec17	Implement mangrove development and restoration programmes, including ecological mangrove restoration methods[303]	▽	N, S, L	MoA-NAREI, Mangrove Restoration Project, UG, DNRE, EPA, GFC
Pillar 5 Actions: Financing instruments				
Ec18	Source financing for research and development, monitoring and conservation/replanting programmes[304]	▽	N, S, L	MoF, Parliament, CI, WWF, DNRE, UG, MoA-NAREI, OCC, PMO, EPA, Iwokrama sector agencies

4.2.4 Energy

A: Current situation

Socio-economic importance

- Access to affordable and reliable energy to provide basic services such as lighting, cooking, heating, cooling, transportation, communication, entertainment and to drive production, is central to all aspects of human welfare[305]. As Guyana continues to grow, demand for energy and associated services will also increase in order to meet social and economic development needs.
- Currently, energy in Guyana is entirely based on fossil fuels, with the majority of its generation capacity derived from plants using heavy fuel oil or diesel. The country is highly dependent on imported energy supplies, which leaves it vulnerable to price volatility. Guyana has significant potential alternative energy sources that it has yet to access[306]. Current energy policy seeks to pursue options to produce energy from hydro, solar, wind and bioenergy sources, as well as encourage energy conservation and energy efficiency activities[307]. In August 2015, it was announced that the large-scale Amaila Falls hydropower project, planned to be constructed on the Kuribrong River, would be abandoned and replaced with smaller regionalised plants[308].
- Electricity coverage in Guyana is 81% while electricity coverage is over 90% in the coastal zone, where 90% of the population is concentrated[309]. The electrification of rural communities in the vicinity of Georgetown is gradually completed by Guyana Power and Light Inc (GPL). Nevertheless, hinterland electrification remains a challenge. Over 80% of the Amerindian population in Guyana lack basic access to electricity[310]. Infrastructure is yet to be developed and energy access is still limited due to the distance from major load centres.

Climate vulnerability profile

- Guyana's energy systems are vulnerable to changes in both the averages and extremes of climate, with the potential to affect electricity demand, supply, and infrastructure.
- Changes in temperature are likely to alter the level, timing, and geographic distribution of electricity demand. In Guyana, mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s[311]. Higher temperatures are likely to increase electricity demand for cooling.
- Guyana's power generation systems are vulnerable to extreme weather events and changes in temperature and precipitation. The country's dependence on imported petroleum fuel for energy generation makes the sector sensitive to weather-related disruption and associated price volatility in the supply chain. Feasibility studies and project design should consider the impacts of future climate change on the operation of any planned alternative energy intervention. Beyond hydropower, the Government plans to examine sources of wind, solar and bioenergy[312].
- The majority of Guyana's energy assets are located on the coast, making them exposed to sea level rise, higher storm surge and flooding. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[313]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[314]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[315].These climate hazards have the potential to damage energy infrastructure and disrupt electricity generation and distribution.
- The geographically patchy transmission and distribution network that extends inland is also

vulnerable to flooding and associated hazards (e.g. landslides).

- The capacity of the energy sector to adapt to the impacts of climate change was assessed by stakeholders as moderate to high[316]. Institutional capacity and the policy and regulatory environment was assessed as moderately high, with a number of relevant policies identified, including NEP, Strategic Plan, Hinterland Electrification Strategy, GEA Act, Upstream Oil & Gas Policy, Electricity Sector Reform Act, and Hydropower Act[317]. However, all of these require improved enforcement. The main barrier identified by stakeholders was poor availability of finance and a high dependence on external funding. This was identified in forecasted energy requirements in GPL's Development and Expansion Plan and budgetary requirements.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the energy sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

The risks identified for the energy sector are spread across the magnitude scale, with the majority of the risks assessed as being medium level. Two serious risks were identified. One relates to the impact extreme temperatures have on transmission and distribution lines, causing reduced efficiency and potential power outages (risk ref E1). The other risk is the potential for flooding to damage critical energy infrastructure, causing energy insecurity (risk ref E2).

Table 41: Risk register for the energy sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
En1	Increase in number of extreme 'hot days' causes transmission and distribution losses due to hotter temperatures with the consequence that effective demand increases and energy security reduces	Yes	Almost certain	Major impact	Serious
En2	Increase in extreme rainfall events causes flooding with the consequence that critical energy infrastructure is threatened	Yes	Likely	Major impact	Serious
En3	Decrease in mean annual rainfall causes reduction in freshwater resources with the consequence that existing and proposed hydroelectric power plants underperform and security of supply is compromised	Yes	Moderate	Major impact	High
En4	Sea level rise causes coastal erosion with the consequence that energy assets on the coast, such as ports for oil import, generation, supply and distribution networks, are negatively impacted	Yes	Unlikely	Moderate	Medium
En5	Incremental climate change and extreme events causes tightening of regulation in fossil fuel producing countries with the consequence that the price of oil is driven	No	Rare	Major impact	Medium

	up, making imported fossil fuels prohibitively expensive, reducing supply and threatening energy security				
En6	Increase in mean annual temperature causes higher air and water temperatures and/or reduced ability to abstract and discharge cooling water with the consequence that thermal power plants experience a loss of productivity	N/A	Moderate	Minor	Medium
En7	Increase in number of extreme 'hot days' and increase in mean annual temperature, causes heat stress for residents and workers with the consequence that use of air-conditioning technology increases, with associated implications for energy demand and grid capacity	Yes	Almost certain	Slight impact	Medium

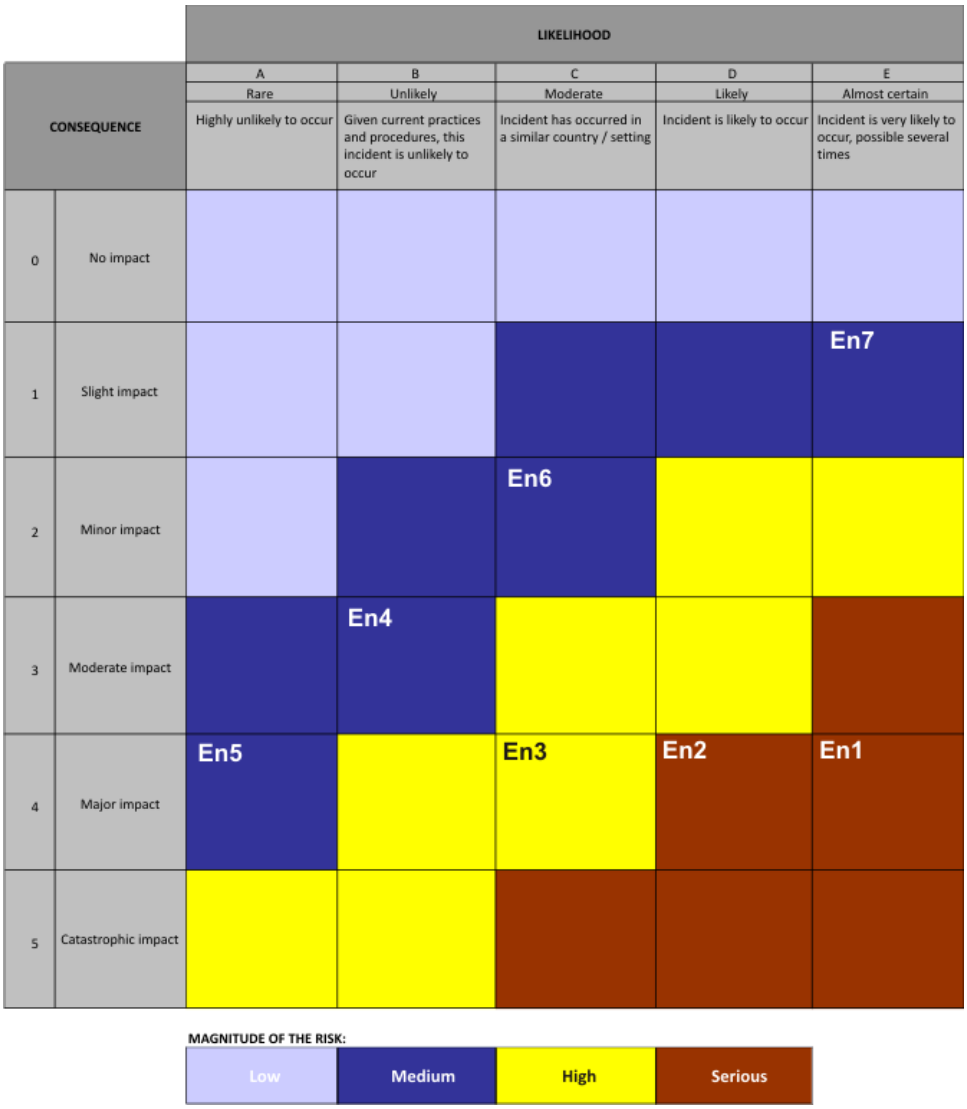


Figure 9: Risk matrix for the energy sector.

Table 4225: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 4326: Consequence scoring criteria. The descriptors for the energy sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Interruption of supply (short durations) which causes heat, discomfort	Power surges lead to destruction of equipment which incurs costs	Interruption of supply (longer duration) Impacts/hindrance to hydropower Increased consumption therefore higher energy costs Loss of productivity (maybe agricultural, commercial)	Security of supply Damage/loss of infrastructure Overdependence on fossil fuels leading to costs/expenditure Increased demand leading to pressure on national grid Technical losses incurred	Prolonged interruption of supply Decreased quality of life

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge on climate vulnerability of the sector
- Develop, implement and enforce law, policy and regulation and national strategies for climate resilience in energy
- Increase national capacity to provide renewable energy options, including building research and technical capacity
- Increase/strengthen/improve energy security and security of supply
- Promote use of 'climate smart' energy practices and technologies
- Improve awareness and knowledge of energy conservation and efficiency
- Increase access to financial resources for energy sector

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
EN1	Undertake analysis of and collect data on past climate impacts on energy sector (operational, performance, maintenance, financial impacts)[318]	▽	N	GEA, GPL, HEU (OPM), IAST, UG, Hydromet, TERI
EN2	Conduct research to understand climate change risks to existing energy infrastructure and future renewable energy infrastructure, particularly hydropower and the potential impact of drought[319]	*	N	OCC, GEA, UG, OPM, GPL, , DNRE OCC-coordinating GEA-implementing
EN3	Conduct research on feasibility of new energy sources, such as wind, solar, biomass (bagasse) and hydropower, as well as electricity generation methods, for example generation from waste[320]	▽	N	GEA, CARICOM, DNRE (EPA), OPM, UG, IAST, TERI
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
EN4	Awareness raising programme across ministries on the impacts of climate change on energy systems and how to manage these impacts[321]	▽	N, S	GEA, OCC, Media, DNRE, MoE, CH&PA
EN5	Encourage training of new professionals in energy research and development; facilitate technical education that focuses on alternative technologies[322]	▽	N	UG, GTI, GEA
EN6	Review the Environmental Protection Agency (EPA) to bring it in-line with new policies and strengthen its enforcement capability[323]	*	N	DNRE
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
EN7	Update national energy policy, strategy and regulatory framework to integrate climate resilience, minimising energy use, increasing efficiency and enabling renewable energy development. This may also include an incentive scheme[324]	* ▽	N	GEA, MoC, MoF, GRA
Pillar 4 Actions: Generation and application of technologies				
EN8	Energy demand reduction programmes, such as replacing electric light bulbs with compact	▽	N, S	GEA, GPL, MoC, OPM, MoPI

	fluorescent light bulbs[325]			(supporting)
Pillar 5 Actions: Financing instruments				
EN9	Source financing to undertake vulnerability and risk assessments as well as feasibility studies[326]	▽	N	MoF, PMO (Ministry of the Presidency)
EN10	Review and revise (if necessary) tax incentives to promote energy efficiency and renewable energy[327]	…	N	GRA, GEA, Ministry of the Presidency, Go-Invest
EN11	Assess climate finance options for energy sustainability through United Nations Framework Convention on Climate Change mechanisms and other related funding avenues[328]	*	N	PMO (OP), MoF, OCC, GEA

4.2.5 Fisheries

A: Current situation

Socio-economic importance

- Agriculture is essential to Guyana due to its contribution to food security, poverty reduction, employment generation and foreign exchange earnings.
- It is Guyana's largest economic sector. Between 2009 and 2013, the agriculture sector contributed on average approximately 20% to GDP and accounted for on average 40% of the county's total export earnings per annum[329]. The agricultural sector is the largest employer, providing direct employment of over 33%[330]. The fisheries sector is one of the five principal sub-sectors of agriculture.
- Between 2009 and 2013, the fisheries sub-sector contributed an average 2.1% to total GDP and in 2013, it accounted for approximately 11% of the agriculture GDP[331]. Fish and shrimp exports amounted to US$63.9M in 2013, which is 4.6% of country's total export[332].
- Approximately 6,500 people are employed in fisheries harvesting and an additional 6,000 persons in processing[333]. In addition, there are indirect livelihood opportunities from fishing related industries, such as boat building[334].
- The fisheries industry consists of three types of activities: (i) marine fisheries, which includes industrial trawler fishery, deep-slope fishery and small-scale artisanal fishery; (ii) inland fisheries, which consists of subsistence activities and an ornamental fish industry and are conducted in rivers, lakes, swamps and flooded plains; and (iii) capture fishery, including aquaculture, which is practiced on the small-scale on the coast in polder areas and in ponds[335].
- While the production and employment in inland fisheries and aquaculture are small compared to those in marine fisheries, there is the potential for significant development[336]. Commercial aquaculture is identified as one of the most promising economic activities with high potential for rapid export and job creation growth[337]. The industry has been experiencing average annual growth of 14% since 1995[338].
- The main exports from the marine fisheries are Shrimp (*Penaeus spp*), Seabob (*Xiphopenaeus kroyeri*) and Whitebelly (*Nematopalaemon schmitti*)[339].
- Marine production has increased from a production of 42.8M kg in 2009 to 49.6M kg in 2013[340]. However, the marine industry faces some current challenges, including the rising costs of inputs such as fuel, feed for aquaculture and piracy attacks on fisher folks.
- In Guyana, fish is a major source of animal protein (estimated at 35.6 kg per capita), which is more than twice the world average of 14 kg per capita, and thus points to the importance of fish to the Guyanese diet[341].

Climate vulnerability profile

- The fisheries sector is vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions and the aquatic environment. The artisanal subsector, the inland fisheries and aquaculture are likely to be particularly vulnerable due to the sensitivity of these environments and livelihoods to even minor environmental changes.
- With the projected increase of temperature and change of rainfall, the main threats to the fisheries sector are the decrease in water quality and disruption of ecosystem dynamics, which cause changes in species distribution, species abundances and the productivity of the marine ecosystems[342].
- Furthermore, while the increased intensity of rainfall could probably lead to an increased rate of

spawning, it would also cause recurrent flooding that could adversely affect aquaculture activities[343].

- Saltwater intrusion can also adversity affect aquaculture production, since certain species would not be able to tolerate saline conditions[344].
- The resultant economic impacts on the fisheries subsector will be a cause of concern given the high level of dependence on the resource (particularly at the subsistence level) and the contribution of the industry to the national GDP and employment[345] .
- Stakeholder consultations examined the informational, technological, institutional and regulatory barriers that would affect the capacity of the sector to deal with climate impacts. These barriers include a lack of data and technical knowledge within the sector, and specifically, the Fisheries Department, to respond to and manage the impacts of climate change and the low levels of formal training of the fisher folk at the artisanal scale. Lack of data and technical knowledge was also highlighted in Guyana's Second National Communication[346]. Stakeholders rated the institutional capacity as weak, despite the established industrial culture of the marine fisheries which has been organised into an Association. Regarding policy and regulation, stakeholders highlighted the existence of the Fisheries Act, a Fisheries Management Plan, and Aquaculture and Inland Fisheries Policy; although there was an identified need for the further development of plans to target other specific subsectors.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the fisheries sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

Only one risks was identified as serious magnitude; the disruption of critical fisheries habitats due to sea level rise (risk ref Fi1). Most of the risks (7) were assigned high magnitude. These risks are associated with changing marine species distribution and abundance (risk ref Fi4), disruption to critical fisheries habitats due to extreme events (risk ref Fi5), and flooding causing destruction of ponds and other fishing infrastructure and pathogen transmission (risk ref Fi2, Fi3 and Fi7). The reduction in fisheries production due to outbreaks of aquatic pests and diseases was rated as low risk, as stakeholders viewed this as an issue that would primarily affect the aquaculture subsector (risk ref Fi12). The potential for inland flooding to produce higher productivity in newly flooded area was identified as an opportunity (risk ref Fi13). In light of the fact that fish is a major protein source for Guyanese, and the current issues faced by the fisher folk, any change in production will have adverse consequences for the livelihoods of those working in the sector (risk ref Fi4), and further, have detrimental impacts for food security (risk ref Fi6).

Table 4427: Risk register for the fisheries sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref:	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of Risk

Fi1	Sea level rise causes changes in the nature and distribution of nursery habitats, with the consequence that fisheries production decreases and revenue is lost	Yes	Likely	Major impact	Serious
Fi2	Increase in extreme rainfall events causes flooding and the transportation of pathogens, with the consequence that fish are killed in the aquaculture subsector and revenue is lost	Unsure	Moderate	Major impact	High
Fi3	Increase in storm surge height causes coastal flooding with the consequence that lives, households and assets, such as ponds and other fishing infrastructure (e.g. landing sites and cooperative buildings) are threatened	Yes	Likely	Moderate impact	High
Fi4	Incremental climate change and extreme events cause decreased water quality and disruption of ecosystem dynamics, changing marine species distribution and abundance with the consequence that revenue is lost at the enterprise, community and individual level and coastal livelihoods and commercial enterprises are threatened	No	Moderate	Moderate impact	High
Fi5	Incremental climate change and extreme events cause disruption to critical fisheries habitats, such as seagrass and mangroves, with the consequence that fisheries production decreases and revenue is lost	Yes	Moderate	Moderate impact	High
Fi6	Incremental climate change and extreme events cause a decrease in fish production with the consequence that food supplies decrease and food security is threatened	Yes	Moderate	Moderate impact	High
Fi7	Increase in extreme rainfall events causes flooding with the consequence such that lives, households and assets, such as ponds and other fishing facilities (e.g. feed storage rooms) are threatened	Yes	Moderate	Moderate impact	High
Fi8	High temperatures and drought causes exceedance of species tolerances, with the consequence that marine fisheries production decreases and revenue is lost	Yes	Moderate	Moderate impact	High

Fi9	Sea level rise causes saline intrusion into freshwater bodies, with the consequence that freshwater aquaculture is negatively impacted and livelihoods and commercial enterprises are threatened	No	Moderate	Minor impact	Medium
Fi10	High temperatures and drought causes exceedance of species tolerances, with the consequence that inland fisheries production decreases and revenue is lost	Yes	Moderate	Minor impact	Medium
Fi11	High temperatures and drought cause a reduction in the size and distribution of inland areas that are fishable, with the consequence that conflicts arise between fisher folk	Yes	Moderate	Minor impact	Medium
Fi12	Incremental climate change causes outbreaks of aquatic pests and diseases with the consequence that fisheries production decreases and revenue is lost	Yes	Unlikely	Slight impact	Low
Fi13	Increase in extreme rainfall events causes flooding with the consequence that some spawning areas increase in size, with the consequence that productivity is higher in the newly flooded areas	Yes			Opportunity

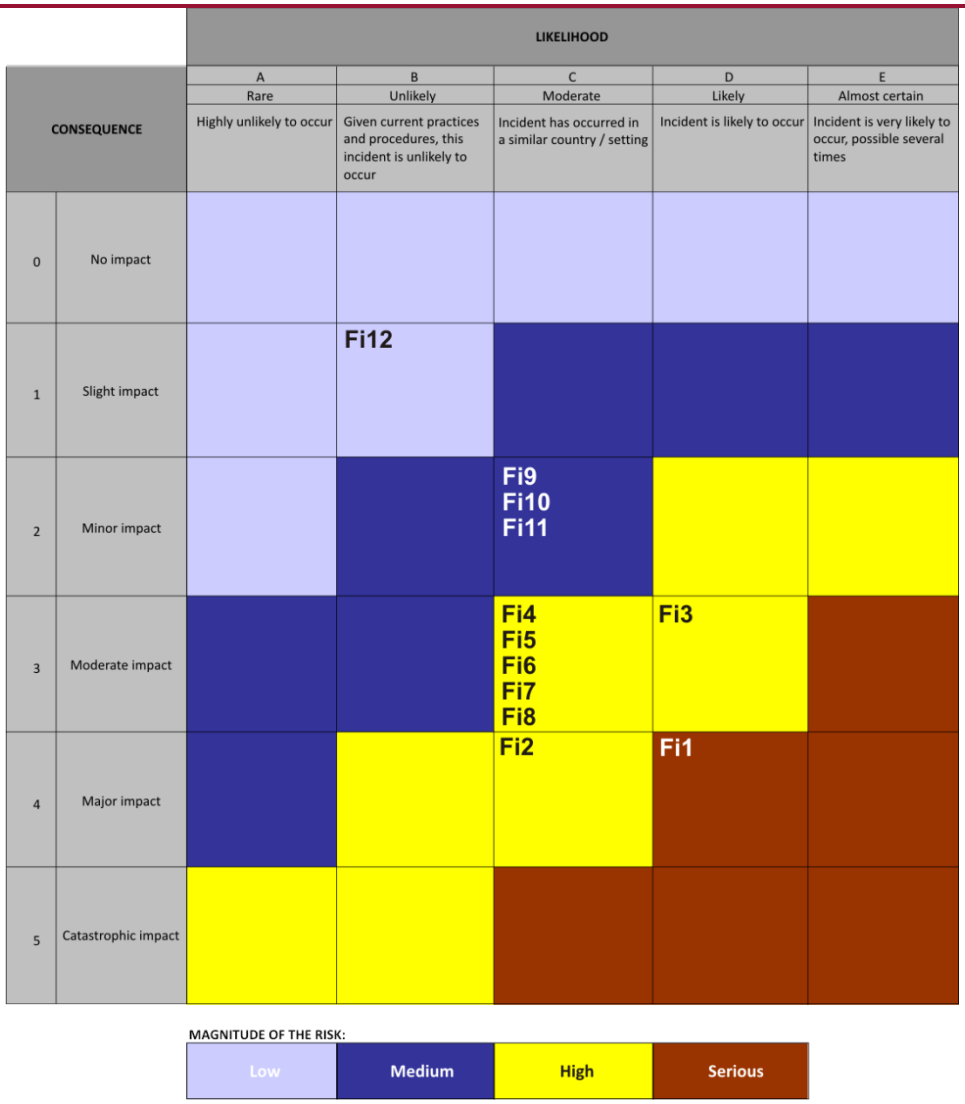


Figure 10: Risk matrix for the fisheries sector.

Table 4528: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 4629: Consequence scoring criteria. The descriptors for the fisheries sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Slight losses of less than 2% of annual production and covered by normal contingency allocations	Minor losses of between 2% and 10% of annual production	Moderate losses of between 10% and 25% of annual production	Major losses of between 25% and 50% of annual production	Catastrophic losses of more than 50% of annual production

NB: The Fisheries Department does not monitor production in the inland fisheries sector

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge on climate vulnerability of the sector
- Promote adaptation good practice and develop innovative solutions
- Provide coastal communities with skills, training, knowledge and tools to understand and manage climate change risks
- Adopt an integrated financial risk transfer package that fosters efficient restoration of livelihoods of fisher-folk

Climate resilience actions proposed for Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
Fi1	Detailed assessment and modelling of the impacts of climate change on fisheries[347]	*	N, S, L	FD, OCC, CRFM
Fi2	Conduct hazard and vulnerability mapping nationally to identify and prioritise regions/areas that are most vulnerable to the impacts of climate change[348]	*	N, S, L	FD, OCC, CRFM
Fi3	Facilitate research and development capacity in Guyana with respect to finding solutions to climate impacts[349]	*	N, S, L	UG, FD, CRFM
Fi4	Conduct research to aid and support sustainable fisheries management goals[350]	...	N	FD, GATOSP, CRFM
Fi5	Develop and trial fisheries techniques that build resilience to a variable and changing climate[351]	*	L	FD
Fi6	Monitor fish catch and effort data[352]	...	N	FD
Fi7	Monitor socio-economic status of fishers in coastal communities[353]	*	N, S, L	FD, UG
Fi8	Assess vulnerability of coastal communities to climate change to determine the suitability of current structure[354]	*	N, S, L	FD, OCC, CRFM
Fi9	Mapping and valuation of coastal ecosystems and habitats, including sea-grass beds, mangrove systems, to document location, state of health and contribution to economic development[355]	*	N, S, L	FD, OCC, CRFM
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
Fi10	Enhance public awareness of climate change impacts on fisheries and facilitate greater fisher safety at sea[356]	*	N, S, L	FD, MARAD, OCC
Fi11	Develop and implement a sustainable public information & dissemination programme on the impacts of climate change on fishing communities and alternative livelihood programmes[357]	*	N, S, L	FD, OCC, EPA
Fi12	Encourage involvement in non-fisheries related economic activity (i.e. tourism)[358]	...	N, S, L	FD, MOA
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				

Fi13	Development and Implementation of policies to increase fisheries sustainability, focusing on efforts to reduce fishing effort and fleet capacity[359]	▽ …	All levels	FD, GATOSP, CRFM
Fi14	Develop Fisheries Management Plan[360] on the basis of the best available information, including climate change, to achieve optimum sustainable use and long-term conservation of fisheries resources[361]	▽ …	National	FD, OCC
Fi15	Establish Fisheries Reserve or expand no catch/take zone in Marine Protected Areas[362]	…	Sub national	FD, DNRE, PAC, EPA
Fi16	Implement an ecosystem approach to fisheries[363]	*	National	FD, FAO
Fi17	Encourage diversification in targeted fish species[364]	▽ …	National	FD
Fi18	Revise and upgrade national fisheries and marine resource management policies, legislation and regulations to incorporate and address ecosystem approach to fisheries, climate change and DRM considerations[365]	▽ …	National	AG, FD, Cabinet
Pillar 4 Actions: Generation and application of technologies				
Fi19	Technological innovations, such as increased capture efficiency, storage, transportation and handling[366]	▽ …	N, S	FD
Fi20	Construct climate-resilient fishing infrastructure[367]	*	N	FD, CRFM
Pillar 5 Actions: Financing instruments				
Fi21	Source financing for research and development programmes, including through use of financial incentives for private sector companies[368]	*	N	MOA, MOF
Fi22	Source financing for the development and trial of climate resilient fisheries techniques[369]	*	N	MOA, FD, MOF
Fi23	Source financing for awareness raising programmes[370]	*	N	MOA, FD, MOF
Fi24	Source funding for updated, climate-resilient infrastructure and equipment[371]	*	N	MOA, FD, MOF
Fi25	Source financing for research and development; monitoring and information programmes[372]	*	N	MOA, FD, MOF
Fi26	Partner with financial institutions to provide	*	N, S, L	FD, MOF,

	competitive loans for the fishing communities to promote risk reduction practices[373]			International donor agencies
Fi27	Set up contingency/DRM funds to be owned and managed by fisher-folk groups and cooperatives[374]	*	N, S, L	FD, MOF, International donor agencies

4.2.6 Forestry

A: Current situation

Socio-economic importance

- Forests occupy approximately 87.5% of the land mass of Guyana[375]. Forests provide a habitat for a large range of animal and plant species, and a number of important ecosystem services, such as soil erosion protection, purification of water supplies and maintenance of environmental stability[376]. Mangrove forest ecosystems are also important, providing a variety of similar functions.
- Forest resources are used for agriculture, harvesting of forest produce, ecotourism, research, conservation and Amerindian reservations[377].
- The forestry sector's contribution to GDP was 4% in 2014[378].
- The sector also provides a significant source of employment for Guyanese people. In 2013, 22,561 people were directly employed in the forestry sector, including sawmilling, timber dealership, plywood and veneer and manicole palm, with almost half involved in logging activity[379].
- Guyana is implementing a Reduced Emissions from Deforestation and Degradation (REDD+) mechanism through which results based payments are earned for reducing deforestation and forest degradation, and for sustainable forest management.
- Guyana's wealth of natural resources, high levels of biodiversity and low rates of deforestation are internationally recognised. One of the government's key objectives over recent years has been to sustainably manage natural resources, with the primary aim of conserving and protecting the environment, and a secondary aim of creating income generating opportunities. Similarly, there is a desire that the negotiations regarding logging concessions should place equal, if not greater emphasis on environmental impact rather than economic gain[380].

Climate vulnerability profile

- Forest ecosystems are vulnerable to a range of climate parameters and hazards, including incremental changes in temperature and rainfall, sea level rise, flooding, soil erosion and ground instability, wildfire and pests and diseases. Anticipated impacts of climate change on biodiversity include shifting of ecosystem boundaries, change in natural habitats and sharp increases in extinction rates for some species[381].
- Forests, and the insects, birds and animals they support, are sensitive to the slow creeping change in temperature and precipitation patterns over the longer-term. In Guyana, mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s[382]. The largest increases in temperature are projected for the southern portion of the country. Trends in annual rainfall are more uncertain, with different models projecting a wide range of possible changes – both decreases and increases in rainfall amounts. However, ensemble median values of change by the 2060s are consistently negative for all seasons and emissions scenarios. Projections vary between -34% to +20% by the 2090s, with ensemble median values of -18% to -4%[383]. Changes in temperature and water resources, through shifting rainfall amounts and timing, are likely to impact the tolerance thresholds of many tree species and associated ecosystems. This may result in some species thriving in a changing climate, whereas others will be unable to cope and may decline in number.
- Forests are vulnerable to wildfires, which may increase in frequency and intensity in a warmer and potentially drier climate[384]. The projected rise in temperatures and long periods of drought

are predicted to lead to more frequent and more intense fires. In 1997/1998, El Niño events produced widespread drought with accompanying forest fires. Fire sensitive areas typically exist in dry evergreen forest predominated by white sandy soils, where lands are cleared for agricultural purposes[385,386]. Fire damaged areas are subsequently vulnerable to erosion from wind and water, leading to sedimentation of waterways.

- Forest ecosystems are also vulnerable to pests and diseases. Warmer temperatures may result in changes in the geographical range of pests, alterations in population growth rates, extension of the development season, and increased risk of invasion by migrant pests[387].
- Guyana's mangrove forests along the coast and river estuaries offer important natural coastal protection benefits. However, there are extremely vulnerable to sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[388]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[389]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[390]. The vulnerability of mangroves to coastal erosion and flooding is a particular concern, given their importance providing land stability in the coastal zone. Stakeholders commenting that young mangroves are susceptible to being uprooted or damaged, which hinders their growth, and man-made infrastructure (such as seawalls) hinders the ability of mangroves to naturally adapt to sea level rise by moving inland[391].
- The forestry sector's dependence on transport systems to deliver forest-related products (including furniture, crafts, utensils, charcoal and firewood) to market makes it vulnerable to weather-related disruption. Transport systems are susceptible to a number of climate parameters, including extreme precipitation change, flooding and landslides. Road connections to the hinterland are poor and there are insufficient all weather access roads connecting forestry areas, in the hinterland, to Georgetown. These roads are vulnerable to flooding and land instability associated with heavy rainfall events. Climate projections suggest that the proportion of rainfall occurring in heavy events may increase (although the trend is weak), particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April[392]. Stakeholders commented that although the majority of transport of forest products utilises road infrastructure, one large concessioner and a few small operators use the Corentyne River for transport and are currently affected by seasonal flow[393].
- The capacity of key actors in the sector to deal with the impacts of climate change was assessed as being moderately high by stakeholders[394]. There is strong institutional capacity, particularly within DNRE, NGOs, and inter-agency committees/projects, for example Land Reclamation, National Toshaos Council, the Multistakeholder Steering Committee (MSSC) under the OCC and the GFC. In terms of information, climate change projections are available regionally and locally, and selected types of information exist, including vulnerability studies for mangroves, adaptation option appraisals for forest communities (e.g. Chainsaw Milling project), and monitoring and evaluation systems through GFC's routine monitoring and MRVS. Stakeholders noted that forestry issues are integrated into the education system, stakeholder consultation occurs, and the Forestry Training Centre Incorporated (FTCI) conducts training and awareness raising activities[395]. The policy and regulatory environment was assessed by stakeholders as strong, with many relevant policies and acts, including the National Forest Plan (2011), National Forest Policy Statement (2011), Revised Forest Act (2009), Environmental Protection Act (1996), Code of Practice for Timber Harvesting, Non-Timber Forest Products (NTFP), Iwokrama Act (1996), Protected Areas Act (2011) and Wildlife Management Authority[396]. Finally, the availability of finance is assessed as moderately high, with stakeholders noting that a variety of sources of funding exist and are used, including

government funds and those available through bilateral/multilateral environmental agreements and international donors, such as WWF and CI[397].

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the forestry sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

The forestry sector faces a range of different magnitude risks, shown by the dispersed nature of risks across the risk matrix (Figure). One "serious" risk was identified: The climate-driven loss of critical ecosystem services provided by the forest, such as soil erosion protection and water catchment management, which will result in broad-scale environmental degradation (risk ref F1).

Table 307: Risk register for the forestry sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
FO1	Incremental climate change and extreme events cause a loss of critical ecosystem services provided by the forest, such as soil erosion protection and water purification with the consequence that environmental degradation occurs	No	Moderate	Catastrophic impact	Serious
FO2	Incremental climate change and extreme events cause forest degradation, negatively impacting forest resources (e.g. wood and minerals) with the consequence that export earnings from forest resources decrease	No	Moderate	Major impact	High
FO3	Sea level rise causes coastal flooding with the consequence that mangrove vegetation is destroyed	Yes	Likely	Moderate impact	High
FO4	Incremental climate change and extreme events can cause changes in the understory species composition of forests	No	Moderate	Moderate impact	High
FO5	Incremental climate change and extreme events, particularly increased frequency of droughts, causes rivers to dry up with the consequence that rivers are no longer navigable (for transport of forest products and equipment) and forestry production decreases and livelihoods(forest concessionaires) are threatened	Yes	Likely	Major impact	High
FO6	Incremental climate change and extreme events will affect accessibility, livelihood options and non-traditional forest products (NTFP) extraction of forest dependent communities/entities	Yes	Moderate	Minor impact	Medium

FO7	Incremental climate change and extreme events, such as drought cause forest fires in dry areas, predominantly where land has been cleared for other land use purposes with the consequence that forests and agricultural land are destroyed	Yes	Likely	Slight impact	Low

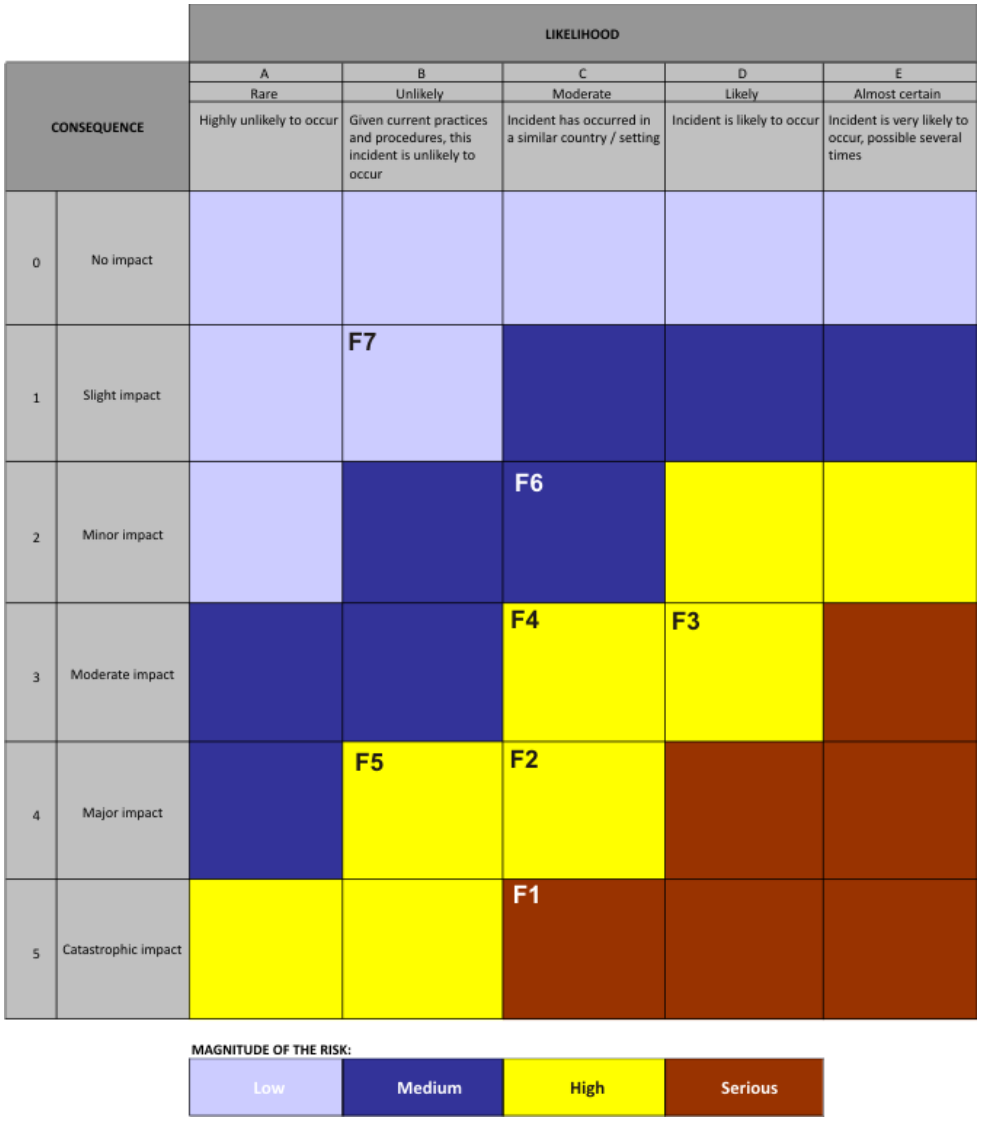


Figure 11: Risk matrix for the forestry sector.

Table 4831: Likelihood scoring criteria. Based on feedback from the OCC, qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain

Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 4932: Consequence scoring criteria. The descriptors for forestry have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Slight losses which are temporary in nature	Short term with recovery in less than five (5) years	Medium term with recovery between 5 to 10 years	Long term with recovery in more than 10 years	Irreversible, permanent loss

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge on climate vulnerability of the sector
- Enhance monitoring and evaluation of climate impacts on forestry and integrate findings into action plans
- Develop, strengthen, implement and enforce laws, policies and regulations for climate resilient forestry
- Strengthen and retain human and institutional capacity within the forestry sector
- Restore degraded forest ecosystems caused by mining activities

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
FO1	Continue research and data collection of vegetation cover and other resources, using remote sensing among other technologies and methodologies, to build up an evidence base of changing trends over time[398]	...	N	GFC, REDD Secretariat
FO2	Undertake research and monitoring of the impacts of climate change on forests to inform decision-making[399]	▽	N, S, L	UG, GFC, Iwokrama, OCC, CI-Guyana, WWF, NRDDB
FO3	Promote research to develop technologies and improve data collection, in order to obtain a better understanding of the impact of future climate change on forests[400]	▽	N, S, L	Iwokrama, MoE, UG, GFC, FAO
FO4	Conduct economic valuation of forest resources (timber and non-timber products and services)[401]	▽ ...	N	GFC, FPDMC, OCC, FTCI, Iwokrama
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
FO5	Develop and implement capacity building programmes to promote education and awareness, both at local levels (e.g. with Amerindian communities that depend on the forests, people that live near mangroves, people related to logging industries, conservationists, park rangers, local authorities, etc.) and national levels (policy-makers, industries, decision-makers, etc.)[402]	▽ ...	N, S, L	GFC, OCC, CI-Guyana, Iwokrama, WWF, NAREI, PAC, NRDDB, KMCRG
FO6	Integrate climate resilient practices into REDD+ training and extension services provided to forest communities, especially Amerindian communities[403]	▽ ...	L	GFC, REDD Secretariat, OCC, Iwokrama, EPA
FO7	Conduct capacity building programmes for communities to develop and maintain alternative income-generating activities, to incentivise conserving forests[404]	▽ ...	S, L	NAREI, OCC, GFC, CI-Guyana, Iwokrama, FAO
FO8	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation[405]	▽ ...	N, S, L	OCC, GFC, DNRE, MoE, conservation NGOs

FO9	Train local community members in skills required for monitoring and evaluation[406]	▽ …	S, L	GFC, MRNE, Iwokrama, CI-Guyana, WWF
FO10	Strengthen coordination among forestry stakeholders and dissemination of information (studies, reports, GIS shape files, research findings)[407]	▽ …	N, S, L	All forestry stakeholders
FO11	Promote and enhance awareness of the importance of freshwater resources to enable and support a climate resilient forest[408]	*	N, S, L	All forestry stakeholders
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
FO12	Implement relevant law, policy and regulation to place to support efforts to build resilience in the forestry sector [409]	* ▽	N, S, L	GFC, EPA, PAC
FO13	Identify and integrate adaptation needs within REDD+ readiness activities, leveraging the synergies between adaptation and mitigation (e.g. sustainable forest management)[410]	▽ …	N, S	GFC, REDD Secretariat, OCC, DNRE
FO14	In line with the GFC's Codes of Practice, develop and utilize management plans to guide protection, conservation, harvesting, processing and marketing of goods and services produced by forests and protected areas, taking into account climate change[411]	▽ …	S, L	GFC, PAC, DNRE, Iwokrama, EPA
FO15	Enact and enforce existing legislation supporting the implementation of sustainable forest management plans[412]	▽	S, L	GFC, EPA, MoLA
FO16	Ensure gender issues are integrated into sectoral projects/ programmes relevant to climate resilience[413]	▽ …	N, S, L	Women and gender equity Commission, Women's Affairs Bureau, Men's Affairs Bureau, GoG and social and civic groups, Ministry of Social Protection
FO17	Develop a more robust framework for monitoring and evaluation of climate change impacts on forest resources[414]	▽ …	N, S, L	GFC, EPA, PAC
Pillar 4 Actions: Generation and application of technologies				
FO18	Map and demarcate forested areas, with boundaries gazetted and made permanent, through GPS aided surveys and technologies such as remote sensing using LIDAR[415]	▽ …	N	GFC, PAC, Iwokrama, GL&SC

Pillar 5 Actions: Financing instruments				
FO19	Increase financial allocation for research and capacity building programmes[416]	▽ …	N, S, L	GoG, international donor/finance community
FO20	Provide economic incentives to protect the forest[417]	▽ …	N, S, L	GoG, international donor/finance community
FO21	Use of payments received for the forests' climate services to develop Guyana's green economy [418]	▽ …	N	GoG, GFC, OCC
FO22	Improve access to financial resources available through bilateral and multilateral agreements[419]	*	N	GoG, OCC

4.2.7 Health

A: Current situation

Socio-economic importance

- Guyana's Health Vision 2020 identifies national objectives and targets related to health, in particular the delivery of quality, effective and responsive health services and prevention measures as well as improvement of the physical, mental and social wellbeing of all people[420]. It also covers environmental health, food security and nutrition and health promotion. The health sector thus makes a significant contribution to the welfare of Guyanese people by providing effective medicines and health care, contributing to the productivity of the population, as well as offering employment opportunities.
- The sector also provides essential services in times of weather and climate-related disasters, such as flooding. A strong health sector is necessary to prevent and reduce the prevalence of climate-related diseases, including vector- and waterborne diseases such as malaria, dengue and chikungunya.
- Overall, a strong and effective health sector contributes to quality of life, helps prevent loss of productivity of the country's workforce, loss of life and reduces health care costs.

Climate vulnerability profile

- The health sector is very vulnerable to climate change, as climatic conditions can exacerbate the severity and occurrence of existing health problems, such as heat stress, respiratory illnesses, vector- and water-borne diseases including malaria, dengue and chikungunya[421]. Furthermore, Guyana's health sector faces a number of challenges (outlined below) that increase its sensitivity and exposure to climate impacts.
- The primarily coastal location of Guyana's health care facilities (e.g., hospitals, health centres), which are vital to responding to risks in vulnerable communities, increases the exposure of the facilities to climate impacts, particularly flooding. The 2005 floods illustrated the vulnerability of Guyana's health sector, in terms of direct damage and losses to healthcare infrastructure and indirect operational and treatment costs. Total costs were estimated at US$0.9 million or 11% of GDP (2004 prices). Over 25 health centres in Georgetown, the East Coast and the West Bank Demerara areas were flooded[422]. These types of impacts are likely to worsen, given future climate change projections across a range of scenarios. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[423]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[424]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[425].
- Guyana has a shortage of health care professionals, which means limited resources to deal with existing health problems. In 2013, there were approximately 15.3 professional nurses, 8.2 physicians and 21.5 health workers per 10,000 people[426]. This shortage has been exacerbated by aggressive recruiting of medical personnel by developed countries[427]. The majority of health care professionals are concentrated in the coastal regions of Guyana. Additionally, health care infrastructure is inadequate, often old and in disrepair, and there are shortages of equipment and supplies[428]. All of these factors increase the health sector's sensitivity to climate change.
- Good health is highly dependent on clean water supply and sanitation, which are sensitive to changes in climatic factors such as temperature and rainfall. While access to basic sanitation

has greatly improved in Guyana, with about 84% of the population using improved sanitation facilities[429], challenges remain. Guyana Water Inc. (GWI), the water and sewerage services public utility, faces operational, financial, and institutional challenges, including deteriorating distribution systems and high levels of non-revenue water, unreliable delivery of water at low pressures and often low quality[430]. Although water resources are abundant, water supply systems are characterised by poor water quality and unreliable service, as water is only unavailable for a few hours a day outside Georgetown[431]. Changes in water quality, which will have significant impacts on health, may be caused by drought due to higher temperatures or flooding due to increases in extreme rainfall[432]. Projections across a range of future climate change scenarios indicate increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution.

- The capacity of the health sector to deal with climate impacts is affected by a number of informational, technological, institutional, financial and regulatory barriers. As noted above, there is already a shortage of health care professionals, who lack the capacity to respond to and manage the impacts of climate variability and change. There is low financial capacity within the sector, which limits the capacity to manage impacts related to climate. There is also limited availability of information on climate change and health, with stakeholders commenting that there is a lack of integration, which does not facilitate the use of available information. In terms of policy and regulation, to date there has been limited implementation despite extensive consultation and discussions, partly due to inadequate enforcement (e.g. low fines for non-compliance)[433].

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the health sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

The risks the health sector faces are spread across the range of likelihood and consequence scales (Figure). The highest magnitude risks are linked to potential water scarcity and the impacts on health (e.g. access to clean drinking water and good sanitation) and inequalities (e.g. gender, education, poverty) (risk ref H2) and the potential for internal and external migration to occur, due to climate-induced changes in living and working conditions (risk ref H3). Both these risks assessed as being moderately likely; however, if they did occur they would have catastrophic consequences for development objectives, including human health. The other high magnitude risk is a cascading consequence from potential declines in agricultural production and revenue, which may cause detrimental consequence from community services, including health and education (risk ref H1). This is because in many geographical locations, agricultural enterprises (such as GUYSUCO) provide a range of community services including health, education, infrastructure and transport facilities[434]. Other risks identified included changes in vector-borne diseases (such as malaria, dengue) driven by potential increases in rainfall (risk ref H7 and H11) and water-borne and food-borne diseases (such as diarrheal diseases) driven by flood impacts on sanitation (risk ref H4 and H5).

Table 50: Risk register for the health sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table51 and Table 3421 respectively.

Ref	Risk description	Current	Likelihood	Consequence	Magnitude

		risk?	(2030s)		of risk
H1	Incremental climate change and extreme events causes a decrease in agricultural production and revenue at the stakeholder and community (e.g. enterprise, community and smallholder) level with the consequence that community services (e.g. health, education) are detrimentally affected	Yes	Likely	Major impact	Serious
H2	Decrease in mean annual rainfall, particularly increase in drought frequency, causes water scarcity with the consequence that human health is negatively impacted (e.g. access to clean drinking water and good sanitation) and inequalities are exacerbated (e.g. gender, educational, poverty)	Yes	Moderate	Catastrophic impact	Serious
H3	Incremental climate change and extreme events causes deteriorating / unsuitable living and working conditions with the consequence that internal and external migration occurs, with associated detrimental human health impacts	Yes	Moderate	Catastrophic impact	Serious
H4	Increase in extreme rainfall events causes breach of river embankments, leading to flooding with the consequence that water sources are contaminated, with detrimental effects on health	Yes	Moderate	Major impact	High
H5	Increase in extreme rainfall events causes overtopping of the East Demerara Water Conservancy, leading to flooding with the consequence that housing and latrines are damaged, with detrimental effects on health (e.g. water-borne diseases and infections)	Yes	Moderate	Major impact	High
H6	Increase in extreme rainfall events causes the overtopping of the East Demerara Water Conservancy, leading to catastrophic flooding with the consequence that lives are lost and public health emergency occurs	No	Unlikely	Catastrophic impact	High
H7	Incremental climate change especially increases in rainfall, cause increases in the incidence of infectious diseases (e.g. malaria, dengue and gastroenteritis) with the consequence that human health is negatively affected	Yes	Moderate	Moderate impact	High
H8	Increase in mean annual temperature particularly increased humidity and heatwave duration, causes heat stress, particularly in urban areas and for outdoor	Yes	Likely	Minor impact	High

	workers with the consequence that human health is negatively impacted				
H9	Extreme events, particularly heatwaves, droughts and floods, cause problems with waste management with the consequence that human health is negatively impacted	Yes	Moderate	Major impact	High
H10	Increase in extreme rainfall events causes flooding with the consequence that resources are directed to disaster response efforts	Yes	Moderate	Moderate impact	High
H11	Incremental climate change, particularly an increase in average annual and seasonal precipitation, causes increased geographic exposure to malaria with the consequence that human health is negatively impacted	Yes	Unlikely	Minor impact	Medium
H12	Increase in storm surge height causes coastal flooding and erosion with the consequence that there is increased risk of human injury and death and communities are displaced	Yes	Unlikely	Slight impact	Low

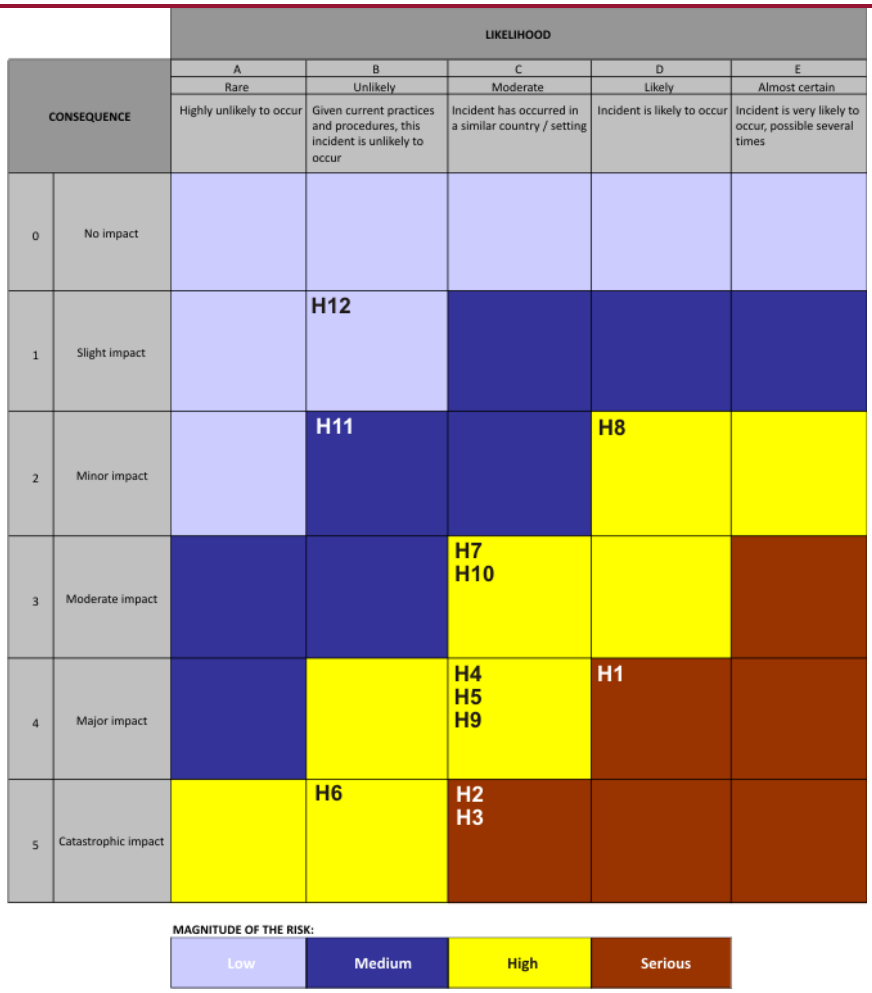


Figure 12 Risk matrix for the health sector.

Table 5133: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 5234: Consequence scoring criteria. The descriptors for the health sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
In a defined area: affecting 5% of the total national population –	Few reported cases in about 2/3 regions	Spread to about 3-5 regions Affecting 15-25%	Spread to 5-6 regions Affecting 25-44%	Spread to 8 or more regions Affecting 45-65%

revenue, health, related issue, social life (education, religion, etc.)	Affecting 10-15% of the total national population	of the total national population	of the national population	of the national population

B: Future vision

Recommended Sectoral Objectives

-
- Improve knowledge on climate vulnerability of the sector, particularly climate-related diseases and appropriate prevention and treatment
- Enhance monitoring and evaluation of climate impacts on health
- Promote adaptation good practice and develop innovative solutions
- Develop national early warning systems for the health sector based on short – medium term climate forecasts and strengthen the capacity of the health sector to respond effectively to the climate-related risks
- Develop 'climate smart' health facilities, especially in the interior, that incorporate design features (e.g. renewable energy sources, water harvesting capacity) to ensure effective functioning during times of climate-induced stress
- Reduce the exposure of communities to health-related risks associated with flooding
- Establish a line item on the national budget for climate change activities for health

Climate resilience actions proposed in Guyana

Ref	Action	Scaled-up (▽), Replicated (...) or New action (*)	National (N), Sub-national (S) or Local level (L)	Implementers (lead underlined)
Pillar 1 Actions: Information, research and systematic observation				
H1	Undertake research into the impact of climate change on public health (especially relating to the threat of malaria)[435]	▽	N, L	MoPH: vector control unit (VCU) and environmental health unit (EHU), surveillance unit, centre for disease control
H2	Strengthen data gathering, processing and	▽	N, S, L	MoPH: vector

	reporting procedures to increase the availability of data for analysis and planning[436]			control, EHU, Stats unit. EPA
H3	Develop and implement early warning monitoring system which pre-empt increases in illness associated with climate factors, such as heat-related illnesses or illnesses associated with flooding[437]	▽	N, S, L	MoPH, MOC
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
H4	Develop and implement capacity building programme for public sector on climate resilient health care practices, such as integrating climate change into risk assessments, considering climate change when developing plans and activities, implementing communication strategies to raise awareness about climate impacts on health[438], [439]	▽ …	N, S, L	EHU of MoPH
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
H5	Integrate climate change considerations into all national policies and plans that relate to human health[440]	▽	N, S, L	MoPH, MOC
Pillar 4 Actions: Generation and application of technologies				
H6	Create and maintain basic public health infrastructure, in terms of training, surveillance, immunisation, vector control, and emergency preparedness and response[441]	▽ …	N, S, L	MCH of CDC, VCU of MoPH
H7	Provide treated bed nets to prevent malaria[442]	▽ …	N, S, L	VCU of MoPH MOC, health centres, MOIA
H8	Implement spraying programmes to prevent malaria, dengue and chikungunya[443]	▽	N, S, L	VCU of MoPH, MOC
H9	Improve water quality and sanitation to prevent gastroenteritis and leptospirosis[444]	▽	N, S, L	GWI, MoC
H10	Implement flood proofing measures for health clinics, especially in Georgetown[445]	▽	N, S, L	MoPH
H11	Improve sanitation and water for flood risk management in Georgetown[446]	▽	N, S, L	GWI, MoPH, M&CC, food and drug dept.
H12	Develop emergency response system[447]	▽	N, S, L	MoPH, CDC, sister agencies
H13	Extend medical care to mobile and remote populations, which may be more vulnerable to climate change[448]	*	N, S, L	MoPH and sister agencies

Pillar 5 Actions: Financing instruments				
H14	None defined yet.			

4.2.9 Housing

A: Current situation

Socio-economic importance

- Improving the housing sector in Guyana has the potential to achieve pro-poor growth, creating new wealth for the emerging working class and small entrepreneurs[449]. It would improve productivity, provide access to financial markets, and fosters asset accumulation in general[450].
- However, Guyana's housing sector faces a number of challenges, resulting from under-population and the spatial configuration of the population. Of the total population, the vast majority (90%) are concentrated on the narrow coastal belt, where population density is more than 115 persons per square kilometre[451]. Guyana's population is predominantly rural, with urban population declining slightly. Urban population was reported as 209,992 in 2002 and in 2012 stood at 191,810 urban dwellers. In comparison, 528,323 and 535,193 persons were reported to reside in rural areas in 2002 and 2012 respectively[452].
- Despite declines in population due to migration, Guyana's CH&PA faces the need to meet a housing deficit totalling 20,000 units for low-income families and an additional 52,000 houses are over 30 years old and require improvement[453]. The challenges facing the housing sector include: providing sites with services such as water, electricity, septic tanks (which is mostly done by home owners, particularly in new housing areas), and road access; introducing pilots for improved access to housing opportunities through a self-build process; and supporting specific priority housing demands, including workforce housing for people who meet priority community needs, such as teachers and nurses[454].
- Finally, the construction sector, of which housing is a key component, is an important economic sector in Guyana. Housing contributes to GDP in two ways: through private residential investment and through personal consumption expenditure. Over the past decade, about 12% of the total annual investment was directed into this sector which generated over 8% of GDP. Additionally, for low income individuals, the government has provided core homes and provided materials for eligible people to improve their houses[455].

Climate vulnerability profile

- The housing sector is vulnerable to a range of climate-related hazards, including sea level rise, storm surge, flooding from extreme rainfall events and heatwaves. These hazards have the potential to directly impact housing infrastructure or the services on which communities rely (e.g. water and sanitation).
- The concentration of the population along the coast exposes communities, houses and supporting infrastructure to flooding and erosion associated with sea level rise and storm surge. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[456]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[457]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[458]. Houses closest to the coast and drainage networks and / or constructed using weak building materials are most vulnerable to flood-related damage. It is common for lower-income and deprived groups to live in high risk zones and in poorer quality housing. These groups frequently have limited resources and capacity to change their exposure, by moving or improving the quality of the building, or deal with the impacts of an event and the post-event

recovery. These factors increase their vulnerability to the impacts of climate change.

- Coastal communities also have a high level of dependence on coastal aquifers for domestic water supply. This renders the population extremely vulnerable to the effects of salt water intrusion as a result of sea level rise.
- Exposure to flooding is also linked to heavy rainfall events and overtopping of drainage and irrigation systems. The 2005 flood caused much damage to the housing sector, approximately 275.6 million USD[459], with stakeholders noting that 61 shelters had been established to house the worst hit victims of the flood[460]. Stakeholders also commented that the Linden/Lethem Road infrastructure was washed away, which resulted in the relocation of the residents in informal settlements along the Lamaha Railway Embankment in Georgetown. Water supply, sanitation and drainage infrastructure is sensitive to floods and any compromise of these systems has the potential to create health risks for local communities (e.g. leptospirosis and cholera).
- The housing sector is also vulnerable to high temperatures. The frequency of days and nights that are considered 'hot' in current climate are projected to increase substantial in all climate scenarios. Annually, projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s[461]. Overheating in houses has the potential to create health risks for residents, including heat exhaustion or heat strokes, which in severe cases, can be fatal. Vulnerability to these risks depends on the style and condition of the housing stock (e.g. use of air-conditioning), and the demographics of residents (e.g. elderly, young and sick are more vulnerable to heat-related health conditions).
- The capacity of the housing sector to deal with climate impacts is affected by a number of institutional, informational, financial and policy and regulatory barriers[462]. Stakeholders commented that the CH&PA are understaffed and lack technical expertise on climate resilience[463]. In terms of information, climate projections and flood maps are available and monitoring and evaluation systems are now being developed; however they do not integrate climate change considerations. Financial resources are assessed as limited, with public sector housing budgets not containing specific reference to climate change objectives and private sector developments not incorporating climate resilient design because it is not specified in legislation (e.g. Building Codes). Stakeholders viewed the policy and regulatory environment as weak, noting that the housing policy, National Land Use Policy, Town and Country Planning Act and Building Code should be finalised, enacted and implemented[464]. Overall, stakeholders felt that the housing is not yet considered a priority in the context of climate change[465]; unless this is addressed, the sector will become increasingly vulnerable to the impacts of extreme weather and climate change.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the housing sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

The housing sector faces a range of different magnitude risks, shown by the dispersed nature of risks across the risk matrix (Figure). The highest magnitude risks are related to housing infrastructure damage, personal injury and community displacement resulting from flooding of rivers and drainage canals, specifically in Georgetown, (risk ref Ho1 and Ho2) and sea level rise and storm surge (risk ref Ho3).

Table 5335: Risk register for the housing sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
HO1	Increase in extreme rainfall events causes flooding with the consequence that housing infrastructure is damaged or destroyed and communities are displaced	Yes	Almost certain	Catastrophic impact	Serious
HO2	Increase in extreme rainfall events causes flooding of Georgetown due to overflowing drainage canals with the consequence that houses and other infrastructure are damaged or destroyed and communities are displaced	Yes	Almost certain	Major impact	Serious
HO3	Sea level rise and increase in storm surge height, causes coastal flooding and erosion with the consequence that households and lives are threatened	Yes	Almost certain	Moderate impact	Serious
HO4	Sea level rise causes coastal flooding with the consequence that mangrove vegetation is destroyed reducing its ability to protect the coast	Yes	Likely	Moderate impact	High
HO5	Sea level rise causes saline intrusion with the consequence that materials used for building houses will degrade at an accelerated rate	Yes	Moderate	Minor impact	Medium
HO6	Increase in extreme rainfall events causes waterlogging of coastal areas with the consequence that houses in coastal areas are damaged and existing poor waste disposal practices are compounded, with detrimental impacts on human health	Yes	Moderate	Minor impact	Medium
HO7	Sea level rise causes erosion with the consequence that housing foundations are weakened	Yes	Unlikely	Minor impact	Medium

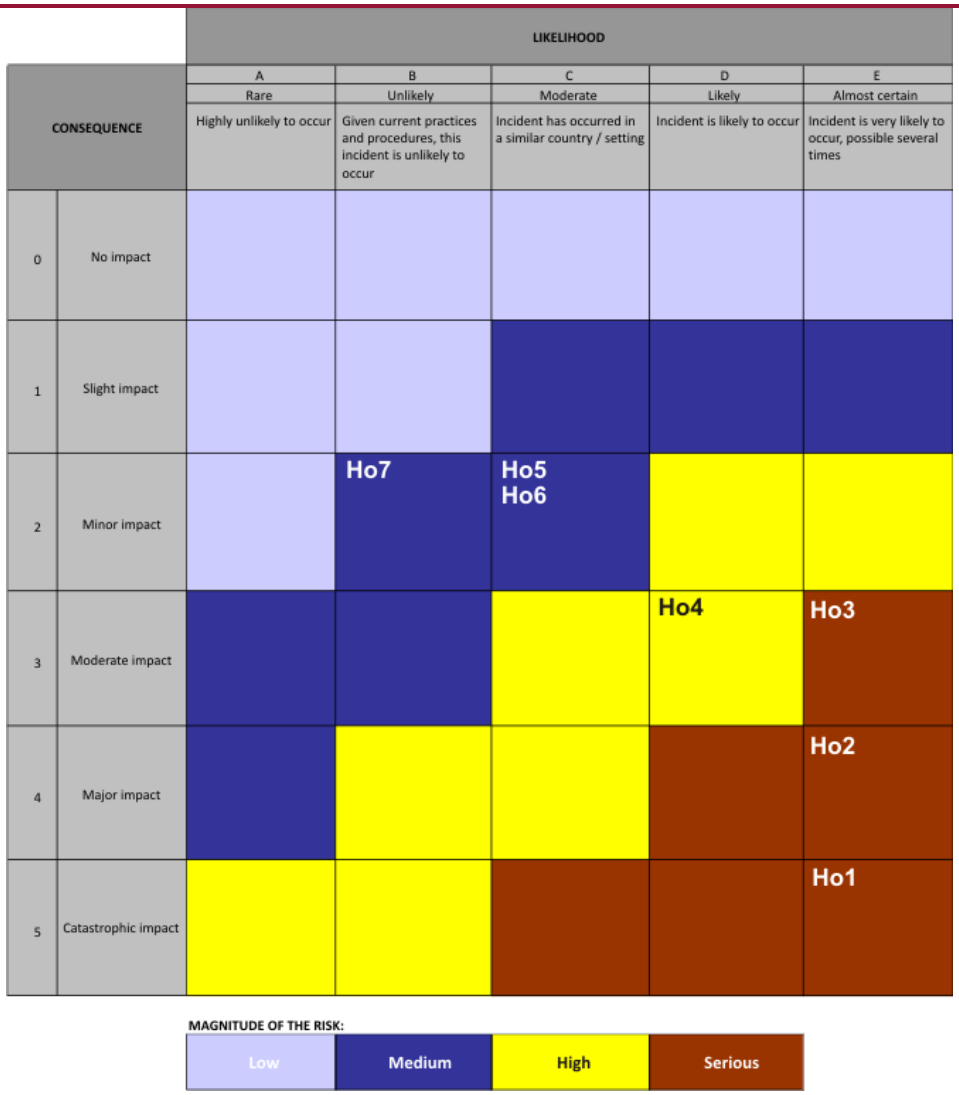


Figure 13: Risk matrix for the housing sector.

Table 5436: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 5537: Consequence scoring criteria. The descriptors for the housing sector have been defined in collaboration with in-country stakeholders. (E) relates to economic consequences, (S) relates to social consequences.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Temporary inundation Swelling of ceilings/doors Loss of aesthetic quality at household and community levels	Damage to building materials (E) e.g. sand and cement Damage to buildings/weakening of foundation Cost of repairs (E) Health impacts	Destruction of ecosystems e.g. Mangroves for provision of building materials	Inundation of bottom stories, flat houses (S) (E) Cost of relocation, retrofitting	Displacement of households/communities (S)

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge on social vulnerability to climate change
- Promote land use planning and housing developments to consider the impacts of climate change
- Promote adaptation good practice and developing innovative solutions
- Improve drainage within housing areas
- Improve waste management systems at a household and community level
- Develop, implement and enforce housing-related laws, policies, regulations and national strategies for climate resilience
- Promote institutional synergies in the housing sector
- Increase access to funding/financial resources for 'climate smart' buildings

Climate resilience actions proposed in Guyana

Ref	Action	Scaled-up (▽), Replicated (...) or New action (*)	National (N), Sub-national (S) or Local level (L)	Implementers (lead underlined)
Pillar 1 Actions: Information, research and systematic observation				
Ho1	Conduct vulnerability assessment/ surveys and hazard mapping to assess physical, social and economic impacts of recent events on housing, and to identify flood risk areas, particularly in Georgetown[466]. SIDS and other countries prepare hazard maps for risk analysis but Guyana does not currently[467, 468],	▽ ...	S	CH&PA, GL&SC, EPA, NDIA, OP, GFC, DNRE, CDC

Ho2	Research on best practice land use policy and housing development processes to support climate resilient housing[469]	*	N, S, L	CH&PA, GLSC, DNRE
Ho3	Research on best practice climate resilient building processes[470]	▽	N, S, L	CH&PA, CDC, OCC, GEA
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
Ho4	Conduct an awareness raising programme for the public on potential climate change impacts on housing and management of impacts[471]	*	N, S, L	CH&PA. Media, OCC, CDC, DNRE
Ho5	Promoting social and economic research, environmental education and public awareness, and community involvement programmes that address the complex issues of settlements, with the aim of improving the surroundings and quality of life[472]	▽ *	N, S, L	MIPA, CH&PA, EPA, DNRE, (RDCs) Local, Government, National Task Force
Ho6	Awareness raising programme on climate resilient housing development and land use policies[473]	*	N, S, L	CH&PA, Media, DNRE, GEA, CDC, GLSC
Ho7	Capacity building and training programmes on climate resilient building design for architects, engineers etc.[474]	*	N, S, L	UG, GTI, Other educational institutions
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
Ho8	Ensure gender issues are integrated into sectoral projects/ programmes relevant to climate resilience[475]	*	N, S, L	Local Government
Ho9	Develop a more robust framework for the effectiveness of adaptation actions[476]	▽	N, S, L	CH&PA, Legal Affairs, CDC
Ho10	Integrate climate change into (Draft) National Land Use Policy and Plan to provide guidelines on appropriate areas for new developments[477]	*	N	CH&PA, OCC, GLSC
Ho11	Design housing development processes to control/phase out development in flood risk areas, using information from climate change impact studies[478]	*	N, S, L	CH&PA, GLSC, private housing developers
Ho12	Develop lands, infrastructure and urban areas in the interior[479]	▽	S	GLSC, CH&PA, Public works, GPL, GWI
Ho13	Develop building codes to integrate climate resilience and encourage the design of a robustly built environment[480,481]. For example, encouraging people to not concrete their yards to ensure sufficient infiltration of water to reduce flood risk[482].	▽	N	Guyana Bureau of Standards, CH&PA, NDCs, (Local Government)

	Some building codes are already in existence; for example, a building code for the construction of 3 and 4 storey buildings incorporates climate resilience by ensuring that the building's foundation can withstand inundation.			
Ho14	Develop guidance for retrofitting existing housing developments to integrate climate resilience[483]	*	N, S, L	GEA, CH&PA, GPL, CDC, National Task Force
Pillar 4 Actions: Generation and application of technologies				
Ho15	Build shelters on higher ground either on the coast (Enmore, Mahaicony) or inland (Linden), to house people in the event of inundation due to storm surges[484]	▽	N, S, L	CH&PA, CDC, RDC, NDC
	Ensure that emergency shelters (e.g. churches, schools) are climate resilient and self-sufficient in water and energy[485]	*	N	CDC
Pillar 5 Actions: Financing instruments				
Ho16	Source financing for research and development and awareness raising programmes[486]	*	N	MoF, CH&PA
Ho17	Provide appropriate economic incentives to encourage compliance with new building codes, in collaboration with insurance and financial sectors[487]	*	N	MoF (GRA), Insurance companies, CH&PA, lending institutions
Ho18	Increase access to funding/financial resources for 'climate smart' buildings and to support building resilience in the housing sector.	*	N	MOF, CH&PA

4.2.10 Indigenous Peoples

A: Current situation

Socio-economic importance

- There are nine indigenous tribes settled across the ten administrative Regions of Guyana, which are part of the many ethnic groups that make up the people of Guyana[488].
- Indigenous populations constitute about 9% of Guyana's total population, or approximately 69,000 people. Each tribe has its own cultural identity, language, heritage and traditional economic activities, often integrated with the natural environment[489].
- There are an estimated 187 villages, communities or settlements belonging to indigenous peoples. These communities are often in remote locations and concentrated in the hinterland, primarily within regions 1, 2, 7, 8 and 9. Combined, indigenous tribes have ownership of about 13.9% of Guyana's lands[490].
- These communities are at various stages of integration with the national economy. Their access to the natural environment and ownership of forestland make indigenous peoples well suited to the conservation and sustainable management of forests, as recognised in the LCDS[491].

Climate vulnerability profile

- The livelihoods of many indigenous peoples are inherently vulnerable to climate change, due to a number of factors that increase sensitivity and exposure, including dependence on ecosystem services and agriculture, and isolation from main infrastructure and transportation networks.
- Many indigenous peoples' communities are found in the forested interior of Guyana, and are highly dependent on the provisioning ecosystem services provided by the forest, which are sensitive to climate change. Many indigenous peoples' communities use forest resources as a source of food, medicine, building materials, fibres, tannins and dyes[492]. Forests are sensitive to climate variability and change, for example higher temperatures leading to higher incidences of drought, which may cause wildfires, in turn damaging or destroying forests, savannah and indigenous peoples' farms. Projections across a range of future climate change scenarios indicate that the frequency of days and nights that are considered 'hot' in current climate will increase substantially. Annually, projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s. Nights that are considered 'hot' for the annual climate of 1970-99 are projected to occur on 33-90% of nights by the 2060s and 46-99% of nights by the 2090s[493].
- Many indigenous peoples' communities are also found along waterways (e.g. Santa Mission, Orealla, Siparuta, Moraikabai, St. Cuthbert's Mission) and on the low coastal plain. Riverine communities are sensitive to increased rainfall, as they are already vulnerable to flooding during rainy seasons. Climate projections show increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April[494]. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution. Communities located close to the coast may be exposed to sea level- and storm surge-related flood damage. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[495]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[496]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least

140,000 hectares by the 2070s[497].

- Many indigenous peoples' communities are heavily dependent on small-scale agriculture, particularly for the provision of their main staple, cassava. Agriculture itself is sensitive to climate change[498] due to the close connections between climatic conditions, plant development and animal health, which in turn increases the sensitivity of indigenous peoples' communities.
- Many indigenous peoples' communities are located in the hinterland and are isolated from the majority of the population and infrastructure. This physical isolation enhances their vulnerability to weather and climate-related disruption due to challenges in emergency response (e.g. transporting food aid on damaged roads)[499]. Some communities are self-sufficient with limited reliance on advanced technologies. Stakeholders commented that poor communication and transportation infrastructure exist, which increases sensitivity to weather and climate-related events, as their ability to communicate or relocate during a weather or climate-related event such as extreme weather or heat wave is limited.
- Capacity to deal with climate impacts to indigenous peoples is affected by a number of barriers - informational, technological, institutional and regulatory, among others[500]. There is also a need for empowerment at the local level and for community members to be able to contribute to policy processes. Information is also limited, consisting of traditional knowledge, available Hydromet data and a climate change community manual. Furthermore, due to the hinterland location of many indigenous peoples' communities, education opportunities are limited or not readily accessible. As a result, language and concepts related to climate change are not readily understood. Finally, the availability of financial resources to build climate resilience is perceived as low. Although financing is available to various agencies, such as the RDCs and NDIA, for activities that may be classified as resilience building, stakeholders did not refer to this.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for indigenous peoples, as detailed in Table 3220 and presented on the risk matrix in Figure .

The risks identified for indigenous people are clustered towards the higher magnitude end of the scale; over half the risks identified were deemed serious, with the remainder viewed as high magnitude. The highest magnitude risks for indigenous peoples' communities are linked to decreases in agricultural production due to changes in water resource availability, with consequences for livelihoods (risk ref AA1), food and health (risk ref AA2 and risk ref AA6). Other high magnitude risks were linked to sea level rise and flooding impacting livelihoods (risk ref AA3), and potentially resulting in relocation of coastal and riverine communities (risk ref AA4). Riverine communities, such as Chenapou, are already vulnerable to flooding during the rainy season[501]. Furthermore, many of the villages in the North Pakaraimas are at risk when it rains because mountainous roads become dangerous in the wet[502]. Finally, the potential impacts associated with wildfires were deemed serious, namely destruction of forests, savannah and indigenous peoples' farms, and health risks associated with the increased dust (risk ref AA5). Fire sensitive areas typically exist in dry evergreen forest predominated by white sandy soils, where lands are cleared for agricultural purposes[503,504].

Table 5638: Risk register for indigenous peoples' communities.The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
IP1	Incremental climate change and extreme events particularly increased frequency of droughts, causes water shortages for agricultural purposes, with implications for traditional agricultural methods (e.g. slash and burn) and a decrease in agricultural production with the consequence that indigenous peoples' livelihoods, reliant on agriculture, are threatened	Yes	Almost certain	Catastrophic impact	Serious
IP2	Increase in extreme rainfall events causes flooding with the consequence that agricultural yields are lost (e.g. cassava crops rot), leading to a food deficit and detrimental impacts on health (e.g. mosquito invasion and malaria; contamination of drinking water)	Yes	Almost certain	Catastrophic impact	Serious
IP3	Sea level rise and extreme events causes flooding in the Low-lying areas of the coastal region of Guyana with the consequence that the livelihoods of indigenous communities, which live along the waterways, are threatened	Yes	Likely	Major impact	Serious
IP4	Sea level rise causes flooding with the consequence that coastal indigenous peoples' village livelihoods are threatened and relocation may be necessary, with recognition of ancestral land rights	Yes	Likely	Major impact	Serious
IP5	Incremental climate change and extreme events (droughts) causes wildfire with the consequence that forests, savannah and farms are destroyed, wildlife die or migrate, health is threatened (e.g. through increased dust, restricted access to potable water), and productive time is lost in search of water	Yes	Likely	Major impact	Serious
IP6	Incremental climate change and extreme events causes decline in farm productivity, traditional hunting and fishing with the consequence that people are more reliant on store bought food, with associated socio-economic and health implications (e.g. weight, diabetes, caries, etc.)	Yes	Likely	Major impact	Serious
IP7	Increase in number of extreme 'hot days' causes water shortages and heat	Yes	Likely	Moderate impact	High

	stress with the consequence that health and sanitation in general communities is detrimentally affected, with the occurrence of heat stress, skin rashes and psychological stress				
IP8	Increase in extreme rainfall events causes flooding with the consequence that rural homes and other buildings are destroyed and communities are displaced	Yes	Moderate	Moderate impact	High
IP9	Incremental climate change and extreme events cause disruption in the regular season of wild forest fruits that wild animals and birds feed upon, impacting their food chain with the consequence that wild animals and birds now search for food on farms, compounding stress on already struggling farms	Yes	Moderate	Major impact	High
IP10	Extreme events causes disruption to communication and transport infrastructure with the consequence that remote indigenous peoples' communities are disconnected and operating costs in these areas increase.	Yes	Likely	Moderate impact	High
IP11	Incremental climate change causes detrimental impacts on indigenous peoples' land and resources with the consequence that their livelihood, identity and culture are affected	Yes	Likely	Moderate impact	High
IP12	Incremental climate change and extreme events particularly increased frequency of droughts, causes lower water levels in freshwater lakes, ponds and rivers with the consequence that fish are more easily caught, with a positive impact on livelihoods	Yes			Opportunity

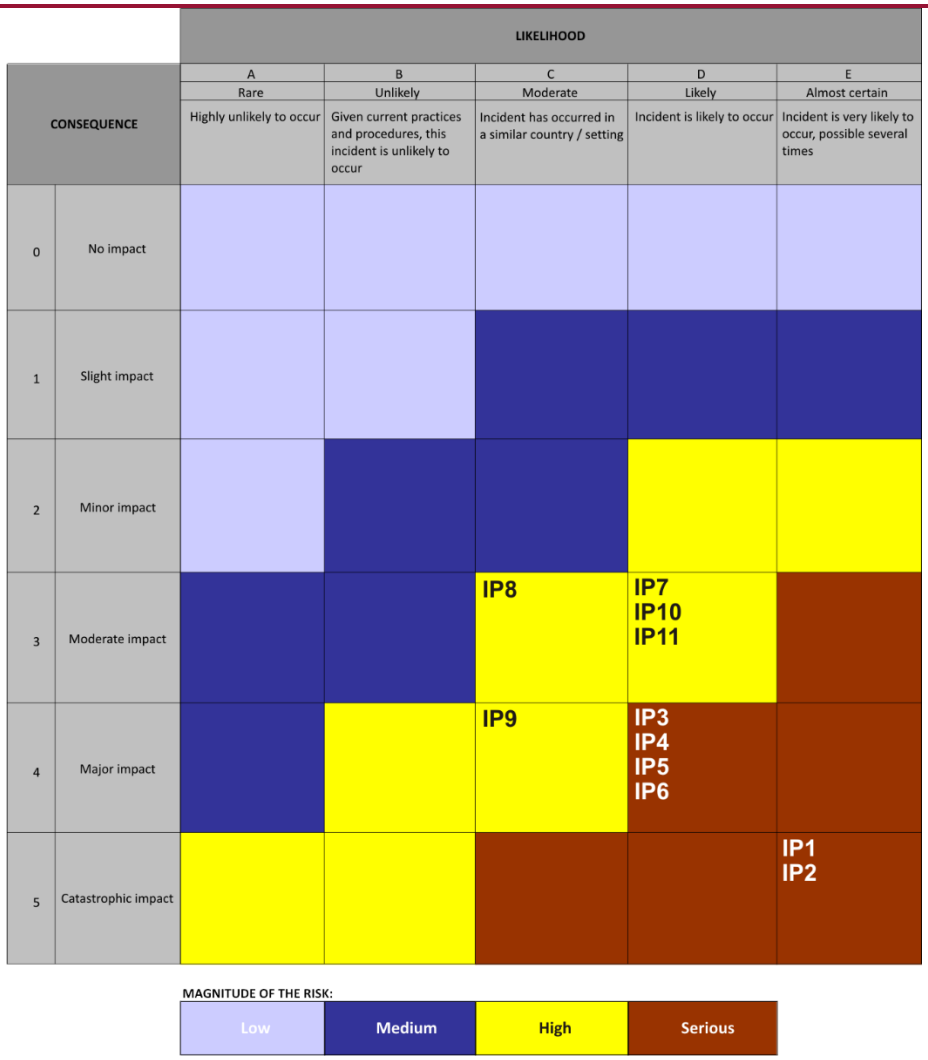


Figure 14: Risk matrix for Indigenous Peoples.

Table57: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table58: Consequence scoring criteria. The descriptors for Indigenous Peoples have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Impacts are easily reversed	Impacts can be fixed/ reversible	Impacts can be fixed/ reversible, but would	Impacts are hard to reverse	Irreversible impacts Human lives and

Few households/ people affected	Several households affected	take effort/ input Many households affected	Livelihoods directly affected Human lives and biodiversity (flora & fauna) are threatened	biodiversity (flora & fauna) are lost Whole community is affected

B: Future vision

Recommended Sectoral Objectives

- Improve food security and health, expanding the use of renewable energy, adding value to agricultural goods and developing ecotourism
- Increase and improve potable water security and access, particularly for remote satellite communities
- Improve early warning systems for extreme events, particularly for remote satellite communities
- Use traditional and scientific knowledge to inform decision makers, stakeholders and the younger generation in developing resilience and adaptation plans

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined, where known)**
Pillar 1 Actions: Information, research and systematic observation				
IP1	Examine how traditional knowledge can be further researched and documented (with the consent from the relevant indigenous peoples' groups and individuals). .	▽	N, S, L	NTC, MIPA
IP2	Implement mechanisms to ensure that traditional knowledge is captured in the adaptation planning stage, particularly via the National Toshaos Council (NTC) and other indigenous peoples' representative groups	▽	N, S, L	NTC, MIPA
IP3	Promote the wider use of 3 month weather forecasts[505]	▽	S, L	MIPA, NTC, Hydromet
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
IP4	Conduct awareness raising and capacity building programmes within indigenous peoples' communities about how to adapt to climate change impacts in these communities[506]	▽	N, S, L	MIPA, OCC, GFC, RDCs & extension officers
IP5	Support indigenous communities to add value to agricultural goods, for example through processing. This will involve building capacity in quality control, packaging and marketing[507]	*	N, S, L	MIPA, MoA, Village council, NTC
IP6	Provide training and support to the MIPA to help them integrate climate resilience into all development projects. This could be through the use of the Caribbean Climate Online Risk and Adaptation TooL (CCORAL)[508]	*	N	CCCCC
IP7	Provide training and support to NTC on how to develop funding proposals for climate resilience projects[509]	*	N	CCCCC and other external organisations
IP8	Promote wider dissemination and of the Community Guidance Manual on Climate Change[510]	*	S, L	MIPA, NTC, Village council
IP9	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation,	▽	N, S, L	MIPA, GFC, OCC, GGMC, EPA

	using simple language[511]			
IP10	Train local community members in skills required for monitoring and evaluation[512]	▽	N, S, L	Village council, WWF & other environmental organisations, GFC, RDCs, MIPA, Extension officers
IP11	Simplify and translate relevant climate change documents to enable easy understanding for indigenous and hinterland communities[513]	*	S, L	MIPA
IP12	Explore opportunities for the new Youth Development Programme to include elements of climate resilience as part of the vocational training provided to youth and young adults. CCCCC have offered support to help develop this programme.	*	N	MIPA, CCCCC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
IP13	Integrate climate change into Village Resource Development Plans (VRDPs)[li]. VRDPs follow a participatory process to draw up a community sustainable development plan that can be used to communicate development aspirations both within the village and outside, e.g. with government or development partners. The plans allow local communities to maintain natural capital, increase social wellbeing and grow their economies along a healthy sustainable path[514]	▽	L	Village councils, MIPA
IP14	Review land use planning policies, particularly in the context of a potential move inland to avoid flood risk and considering indigenous people's rights[515]	*	N	CH&PA, MIPA
IP15	Improve local health care facilities, including the provision of training and resources to deal with the anticipated impacts of a changing climate[516]	▽	S, L	Ministry of Health, MIPA
1P16	Establish community safety net programmes[517]	▽	N, S, L	Village councils, Ministry of Health
IP17	Ensure gender issues are integrated into sectoral projects/ programmes relevant to building climate resilience[518]	▽	N, S, L	Village councils, Ministry of Social

[li] For example, see: http://www.conservation.org.gy/publications/Village_Resource_Development_Planning_Toolkit_For_Communities.pdf

				Protection, MIPA
IP18	Ensure there is access and integration of indigenous knowledge in the process of adaptation.[519] This could build on knowledge sharing initiatives like Project Cobra.	▽	N, S, L	MIPA, NTC
IP19	Develop a more robust framework for monitoring and evaluation[520]	▽	N, S, L	DNRE, GFC,GGMC, MIPA, MoLA
IP20	Enhance institutional capacity to implement policies and regulations related to climate change and the environment[521]	...	N, S, L	DNRE
IP21	Ensure the resilience actions proposed and implemented are aligned with the UN Declaration on the Rights of Indigenous Peoples[522]	*	N	MIPA
Pillar 4 Actions: Generation and application of technologies				
IP22	Support the development of small-scale renewable energy projects to improve energy security for isolated indigenous communities[523]	*	S, L	MIPA
IP23	Improved existing roads and develop new infrastructure to improve access to markets[524]	▽	N	MPI, MIPA
Pillar 5 Actions: Financing instruments				
IP24	Improve access to soft loans to construct more climate resilient homes, through demonstration or pilot projects[525]	▽	N, S, L	MIPA, MPI
IP25	Allocate national budget to MIPA, and maximize on opportunities through projects and initiatives to support building climate resilience for addressing current climate impacts, preparations and recovery[526]	▽ *	N, S, L	MIPA, GoG

4.2.11 Mining

A: Current situation

Socio-economic importance

- Guyana is home to deposits of gold, diamonds, bauxite, manganese and other precious metals. Mining, one of the country's most important economic activities, primarily takes place in the hinterland.
- In 2009, the sector contributed 10.6% of GDP[527].
- In 2013, gold represented 78% of the total value of the mining sector's output and is an important export for Guyana; in 2012, 51% of the country's total export revenues were attributed to gold production[528].
- The sector also contributes significantly to employment; in 2010 it employed 11,189 people (direct employment), or about 13,900 (direct and indirect employment)[529].
- Three scales of operation are recognised in Guyana: (1) Small-scale (1500 feet x 800 feet whilst a river claim consists of 1 mile of a navigable river); (2) Medium-scale prospecting and mining (between 150 and 1200 acres); and (3) Large-scale prospecting, mining and quarrying (between 500 and 12,800 acres).
- Guyana's wealth of natural resources, high levels of biodiversity and low rates of deforestation are internationally recognized. One of the government's key objectives over recent years has been to sustainably manage natural resources, with the primary aim of conserving and protecting the environment, and a secondary aim of creating income generating opportunities.

Climate vulnerability profile

- The characteristics of Guyana's mining sector make it vulnerable to climate and weather-related hazards, largely due to its dependence on large fixed assets, transport, energy, water and people.
- Medium- and large-scale mining and quarrying activities use a range of large fixed assets, such as recovery and haulage equipment (e.g. dredges, excavators, bulldozers, crushers), which are sensitive to a range of climate-related hazards, including extreme temperatures, flooding and land instability.
- The landform features in hard rock mining, including pit walls and waste rock piles, are also vulnerable to flooding and land instability associated with extreme rainfall events. In May 2015, an open-pit gold mine in remote southern Guyana collapsed and buried up to 10 miners in debris[530]. The collapse occurred in the densely forested Potaro-Siparuni Region near the border with Brazil following recent heavy rains.
- The mining sector depends on transport systems to deliver supplies, workforce and products to and from the mine. As most mining takes place in remote hinterland locations, the transport network is particular vulnerable to weather-related disruption. Road are vulnerable to flooding and landslides, and river transportation is sensitive to both high- and low-flow conditions. If the river levels are too high, following heavy rainfall, river transport will be disrupted. Conversely, if river levels are too low, the rivers will no longer be navigable and infrastructure along the banks (e.g. landings) will be left inaccessible.
- Energy is also a key system that enables production in the mining sector. Energy systems in Guyana are sensitive to climate change. The country's dependence on imported petroleum fuel for energy generation makes the energy sector sensitive to weather-related disruption and associated price volatility in the supply chain, which in turn increases the vulnerability of the mining sector. However, a number of the larger mining operators have invested in technology

to generate most of their own energy[531], reducing their vulnerability to weather-related disruption.

- Water is also critical to the mining sector, serving many uses (e.g. mineral extraction techniques, cooling equipment and controlling dust) and is sensitive to various climatic variables, particularly increases in temperature and changes in rainfall.
- Mining processes produce large volumes of wastewater, often contaminated with harmful chemicals. Tailing ponds and dams, due to their long life spans, pose risks to the surrounding environment and populations long after they have stopped being used. Tailing ponds are vulnerable to flooding and land instability associated with extreme rainfall events, which have the potential to cause the release of harmful chemicals into local ecosystems and water sources. This would cause damage to protected species and natural habitats, or contaminate surface waters, ground waters or land that leads to a risk to human health. Stakeholders commented that pollution of interior waterways is already prevalent in some mining districts[532].
- As discussed in the Health sector briefing note, climate change is likely to significantly affect the health of the human capital that is essential for the operation of the mining sector. The mining workforce is particularly vulnerable to temperature extremes and flood-related hazards. The frequency of days and nights that are considered 'hot' in current climate are projected to increase substantial in all climate scenarios. Annually, projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s[533]. Warmer working conditions are a concern for health, safety and levels of performance. They can lead to diminished mental task ability, increased accident risk and, if prolonged, heat exhaustion or heat strokes[534]. These can significantly affect the productivity of outdoor, production line and factory workers.
- The capacity of the mining sector to adapt to climate change was viewed as low to moderate by stakeholders[535]. In terms of informational resources, stakeholders commented that some information exists, primarily in the form of Environmental Impact Assessments (EIA); however, there is limited monitoring and evaluation capacity. Institutional capacity was viewed as moderately high, as there is existing collaboration among sectoral agencies in the form of committees. The policy and regulatory environment was also assessed as moderately high, with several relevant laws, policies, regulations and codes of practice, although some require updating in the face of a changing climate. The largest barrier identified by stakeholder was the lack of availability of finance to respond and manage the impacts of climate change.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the mining sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

The sector faces a range of different magnitude risks, shown by the dispersed nature of risks across the risk matrix (Figure), ranging from low magnitude right through to "serious". The highest magnitude risks are linked to flooding, erosion and land instability impacting the transport of mining material from the mine (risk ref M1) and the supply chain into mining communities (risk ref M4), drainage, tailings and landform management (risk ref M3 and M6) and workforce health and safety (risk ref M5). Conversely, water scarcity may disrupt hydraulic mining, the main mining method in Guyana, resulting in stoppages in operations and loss of revenue (risk ref M2).

Table 59: Risk register for the mining sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
M1	Increase in extreme rainfall events causes flooding, erosion and land instability with the consequence that roads are damaged and transport of mining materials by truck is disrupted, resulting in loss of revenue for commercial enterprises	Yes	Almost certain	Major impact	Serious
M2	Extreme events particularly droughts, cause water scarcity with the consequence that hydraulic mining, the main mining method in Guyana, is disrupted, resulting in stoppages in operations.	No	Likely	Catastrophic impact	Serious
M3	Increase in extreme rainfall events causes flooding with the consequence that drainage and tailings management compromised, resulting in overflows into waterways, an increase in turbidity levels and subsequent pollution of interior waterways.	Yes	Almost certain	Major impact	Serious
M4	Increase in extreme rainfall events causes flooding with the consequence that roads are damaged and transport of food and other vital resources for workforces is disrupted, resulting in cessation of work and loss of revenue for commercial enterprises.	Yes	Moderate	Catastrophic impact	Serious
M5	Increase in extreme rainfall events causes flooding with the consequence that mine workings are flooded, disrupting operations, jeopardising workforce health and safety and resulting in loss of revenue for commercial enterprises	Yes	Likely	Major impact	Serious
M6	Increase in extreme rainfall events causes erosion and land instability with the consequence that mine workings (active and closed) are washed out and landforms (e.g. pit walls) fail, resulting in environmental degradation	Yes	Likely	Major impact	Serious
M7	Incremental climate change and extreme events particularly increased frequency of droughts, causes rivers (where gold is mined) to dry up with the consequence that rivers are no longer navigable (for transport of equipment) and mining operations cease, leaving miners seeking employment elsewhere	No	Unlikely	Catastrophic impact	High
M8	Increase in extreme rainfall events causes	No	Moderate	Major impact	High

	flooding of tailing dams with the consequence that the dam walls fail, resulting in flooding and the uncontrolled release of contaminants				
M9	Incremental climate change especially increases in rainfall, cause increases in the incidence of infectious diseases (e.g. malaria, dengue and gastroenteritis) with the consequence that health of the mining workforce is negatively affected	Yes	Moderate	Moderate impact	High
M10	Incremental climate change causes drying of open stockpiles or waste storage areas with the consequence that dust is mobilised affecting the health of the mining workforce and nearby communities	Yes	Likely	Minor impact	High
M11	Increase in extreme rainfall events causes riverine flooding with the consequence that loading and transportation of mining materials (e.g. bauxite) along rivers is disrupted, resulting in loss of revenue for commercial enterprises and decrease in export earnings	No	Likely	Moderate impact	High
M12	Increase in extreme rainfall events causes erosion and land instability with the consequence that acid-forming materials are exposed leading to acid rock drainage (ARD)/acid mine drainage and environmental degradation if it is not contained	No	Moderate	Slight impact	Medium
M13	Increase in number of extreme 'hot days' causes electrical equipment (e.g. mechanical, power, IT systems) to underperform or fail with the consequence that commercial mining operations are disrupted, or maintenance costs increase	No	Unlikely	Slight impact	Low
M14	Increase in number of extreme 'hot days' causes heat stress and dehydration with the consequence that mining workforce health and safety is jeopardised	No	Rare	Slight impact	Low

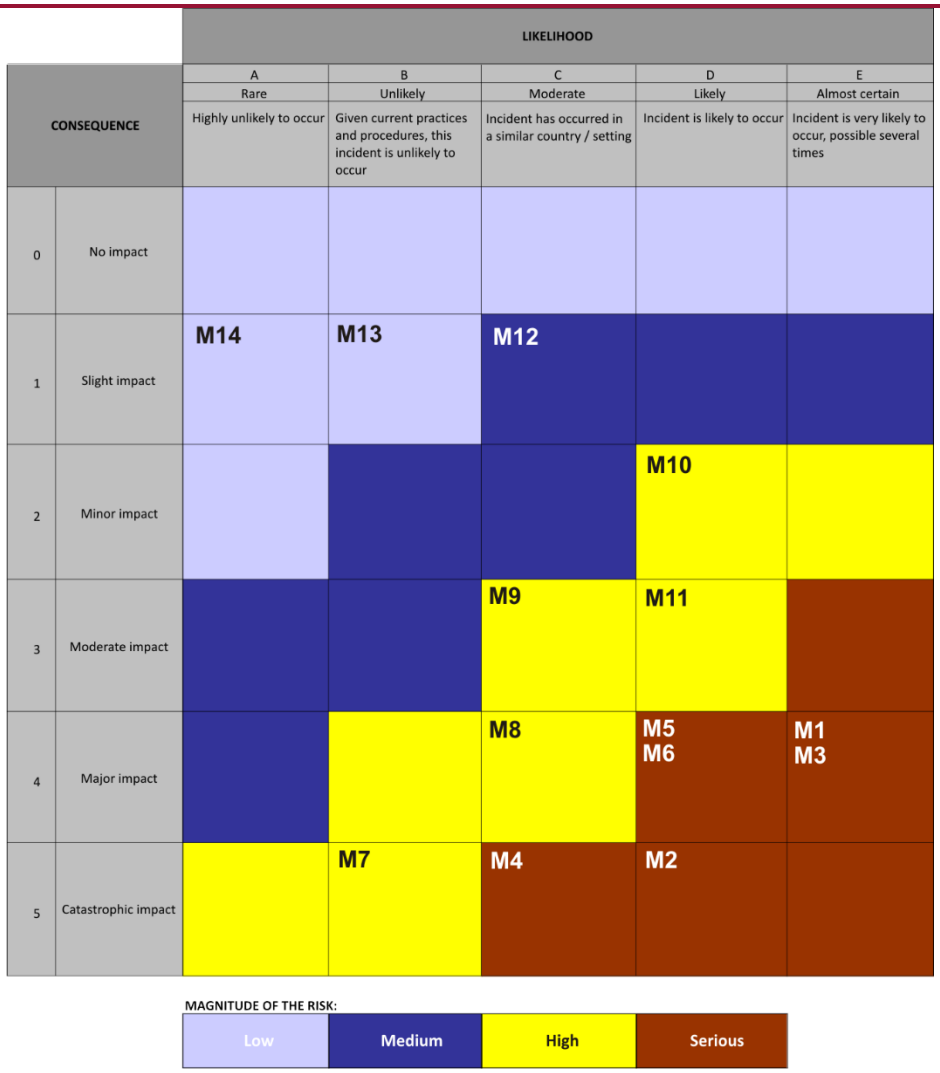


Figure 15: Risk matrix for the mining sector.

Table 6039: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table61: Consequence scoring criteria. The descriptors for Mining have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Loss of production	Loss of production	Loss of production	Loss of production	Loss of production

below 5% Very low level of pollution	between 6 – 19% Low level of pollution	between 20 – 39% High level of pollution	between 40 – 64% Very high level of pollution	65% or more Extremely high level of pollution (water and soil)

B: Future vision

Recommended Sectoral Objectives

- Increase awareness through targeted training of miners to understand better and manage climate change risks
- Reduce the exposure of the mining workforce to health-related risks associated with vector-borne diseases (e.g. use of insecticide treated nets, keeping the immediate environment free of possible breeding sites)
- Promote the adoption of climate resilient methodologies through robust R&D interventions
- Provide financial assistance to miners to implement climate smart recovery methods (e.g. mercury free extraction), reduce the impact of mining and improve prospecting methods
- Review and update mining policies, regulations and relevant codes of practices to ensure effective consideration of climate change adaptation, conservation and reclamation
- Strengthen monitoring and enforcement capacities of relevant regulatory agencies (GGMC & GGDMA) to oversee compliance with climate change adaptation measures
- Restore degraded interior ecosystems caused by mining activities

Climate resilience actions proposed in Guyana

Ref	Action	Scaled-up (▽), Replicated (...) or New action (*)	National (N), Sub-national (S) or Local level (L)	Implementers (lead underlined)
Pillar 1 Actions: Information, research and systematic observation				
M1	Design national research and development programme on climate impacts on the mining sector and climate resilient, sustainable mining practices (e.g. research on climate impacts, alternative sources of freshwater, appropriate reforestation systems and closed circuit mining)[536]	...	S	DNRE, GGMC
M2	Conduct high level analysis on past climate impacts on Guyana's mining sector (small, medium and large scale) and modelling of future risks (e.g. impacts on infrastructure, operations, labour, etc.)[537]	...	S	DNRE, GGMC

M3	Establish digital inventory of EIA findings (when they can be shared) and necessary data sharing mechanisms/platforms (e.g. MOU)[538]	*	N	DNRE, EPA
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
M4	Develop and implement education and awareness raising programmes to promote climate resilient and sustainable mining practices once understood[539]	▽	S	GGMC, GWMA, GGDMA, GMSTC EPA
M5	Train relevant regulatory agencies in satellite imagery interpretation of mining operations to enable better monitoring and enforcement[540]	*	N	GGMC, GGDMA
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
M6	Implement mining regulations to allow sustainable use of forest resources and prevent forest degradation[541]	*	N	DNRE, GGMC
M7	Develop guidance to integrate climate resilience considerations into Environmental Impact Assessments or environmental plans when building new mining infrastructure[542]	*	N	DNRE, EPA
M8	Review and update Mining School curriculum to include climate change considerations in relevant modules[543]	… *	S	GMSTC, GGMC,
Pillar 4 Actions: Generation and application of technologies				
M9	Design and implement land reclamation programmes by small, medium and large scale miners[544]	▽ …	S	GGMC, GGDMA
M10	Utilise connection with international governing bodies (e.g. International Council on Mining and Metals, ICMM) and regional organisations (e.g. Instituto Latinamericano del Fierro y del Acero, ILAFA) to share best practice on the most appropriate climate-resilient technologies for the Guyana mining context[545]	*	N	GGMC
M11	Based on research of appropriate climate-resilient technologies (described above), encourage mining operators to invest and adopt best practice (e.g. water efficient processing equipment, wastewater management processing equipment, geotechnical / engineering solutions)[546]	*	N	GGMC
M12	Implement healthcare measures to protect the mining workforce from infectious and vector-borne diseases (e.g. treated bed nets	▽ …	N, S, L	VCU of MoPH MOC, health centres, MOIA

	to prevent malaria[547] and spraying programmes to prevent malaria, dengue and chikungunya[548])			
Pillar 5 Actions: Financing instruments				
M13	Source sustainable financing for research and capacity building programmes[549] (e.g. Mercury Free Mining Fund)	… *	N	DNRE, GGDMA, GGMC

4.2.12 Sea and River Defence Infrastructure

A: Current situation

Socio-economic importance

- Guyana has a low-lying coastline of approximately 459 km. The majority of Guyana's coastal zone is below sea level and relies largely on engineered (seawalls and rip raps) and natural (mangroves) sea defence structures to protect the coast from the Atlantic Ocean.
- The system of sea defences measures approximately 340 km and covers about 80% of Guyana's coastline[550]. Guyana's sea defence system consists of hard (e.g. concrete sea walls) and soft engineering structures (also called managed realignment, e.g. mangroves). Mangroves function as natural breakwaters along the coast and represent a very important natural sea defence for Guyana.
- About 90% of the population and important economic activities, as well as major infrastructure, are located within the coastal zone. Major economic sectors primarily located in the coastal zone include agriculture, fisheries, health, energy, forestry and tourism; any impact to the coast land would significantly impact Guyana's GDP[551].
- The country's population is concentrated in Georgetown, located on a 14 –20 km estuary of the Demerara River[552]. As the coastal area is vulnerable to sea level rise and flooding, sea and river defence infrastructure is critical for the protection of both the economy and society.

Climate vulnerability profile

- Guyana's sea and river defence infrastructure systems are highly vulnerable to climate change; about 45% of the coastline is currently subject to erosion[553]. A number of characteristics increase the sensitivity and exposure of these systems, including a dependence on large fixed assets and the ecosystem services provided by mangroves, concentration of infrastructure along the coast, and inadequate existing infrastructure.
- The sector is dependent on, and composed of, large fixed assets in the form of sea walls, dams and drainage infrastructure, which are sensitive to the impacts of climate change due to their long life times. As much of this infrastructure is, naturally, concentrated along the coast, exposure to sea level rise is heightened. There is also a high dependence on the ecosystem services provided by mangroves, which offer natural protection from rising sea levels and flooding. Mangroves are highly vulnerable to climate change, in particular sea level rise, which could destroy or damage them. This further increases the sensitivity of sea defence systems. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[554]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[555]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[556].
- Exposure to flooding is also linked to heavy rainfall events and overtopping of drainage and irrigation systems. Neglect of essential maintenance to the drainage and irrigation infrastructure over the past few decades has resulted in much of the system not operating at full capacity, and some sections being completely inoperable. For example, the 2005 floods, a result of heavy rainfall, were exacerbated by overtopping of the EDWC[557]. Also, in early June 2015, several days of heavy rainfall resulted in extensive flooding in Georgetown and surrounding areas[558]. The city's drainage system depends mainly on 13 sluices, of which 10 were fully functional in early June, 2015[559]. Pumps are used to drain water off the land when the sluice gates are closed, but not all are functional[560]. Among the measures suggested to

prevent flooding in the future, local residents are requesting more frequent openings of the kokers, regular cleaning of canals and for authorities to ensure that drainage pumps were in proper working order[561]. Future rainfall projections are likely to create further challenges for Guyana's coastal drainage systems. Trends in annual rainfall are uncertain across a range of climate models, with different models projecting a wide range of possible changes – both decreases and increases in rainfall amounts. However, there is a higher level of agreement that the proportion of heavy rainfall events may increase, particularly during the wet season of November, December and January and in the dry season of February, March and April[562].

- Much of the country's sea defence structures are currently inadequate, which increase their vulnerability to climate change. Despite the significant investments to rehabilitate sections of Guyana's sea defence system, a 2014 survey[lii] showed that 2.28 km (1%) is in critical condition, 20.53km (9%) is poor and 80.22km (34.4%) is in fair condition[563]. Regions 2, 4 and 6 have the weakest points in the line of defence. A 1 meter rise in sea level is expected to increase the risk of inundation across all administrative regions; however, Regions 4 and 6 have the highest expected exposure[564].
- The capacity of Guyana's sea and river defence systems to adapt to the impacts of climate change was assessed by stakeholders as low to moderate[565]. This is due to a number of informational, policy/regulatory and institutional barriers. Stakeholders commented there is limited historical data, and many references are outdated by over 40 years. Many policies have been developed around sea and river defence linked to climate change, yet there has been little implementation. Finally, institutional coordination is problematic due to disaggregation between bodies (e.g. MPI, D&I, NDCs, RDCs, etc.).

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for sea and river defence, as detailed in Table 3220 and presented on the risk matrix in Figure .

The climate risks identified for sea and river defence infrastructure are clustered towards the higher magnitude end of the scale (Figure); two thirds of the risks identified were deemed "serious", with the remainder viewed as high magnitude. The risks of highest concern relate to sea level rise and increase in storm surge height causing overtopping of the current sea defence infrastructure (risk ref SRD1 and SRD5), damaging drainage and irrigation systems (risk ref SRD4) and increasing coastal erosion and sediment movements (risk ref SRD2) and destroying mangroves, which currently offer natural coastal protection (risk ref SRD3). All these risks are serious and they threaten Guyana's socio-economic development objectives.

Table 6240: Risk register for sea and river defence. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex 2 of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
SRD1	Sea level rise and increase in storm surges causes overtopping of current sea defence infrastructures with the consequence that widespread flooding will occur	Yes	Almost Certain	Major impact	Serious

[lii] The survey covered 91.2% of the total length of sea defence structures.

SRD2	Sea level rise and increase in storm surges causes changes in water velocity and currents with the consequence of increased rate of movement of mud-bands and the erosion-accretion cycle	Yes	Almost certain	Major impact	Serious
SRD3	Sea level rise causes destruction of mangroves and associated subsidence / erosion with the consequence that the coastal sea defence system is threatened	Yes	Likely	Major impact	Serious
SRD4	Sea level rise and increase in storm surge causes stress to aging sea defence infrastructure and drainage and irrigation systems with the consequence that socioeconomic development objectives are compromised	Yes	Likely	Major impact	Serious
SRD5	Increase in storm surge height causes coastal flooding and erosion with the consequence that coastal infrastructure is damaged or destroyed	Yes	Likely	Major impact	Serious
SRD6	Increase in extreme rainfall events causes flooding with the consequence that critical infrastructure (e.g. telecommunications, transport, energy, water, sewerage) is threatened	Yes	Moderate	Moderate impact	High
SRD7	Increase in extreme rainfall events causes flooding due to additional stress on inadequate coastal drainage infrastructure with the consequence that socioeconomic development objectives are compromised	Yes	Moderate	Major impact	High

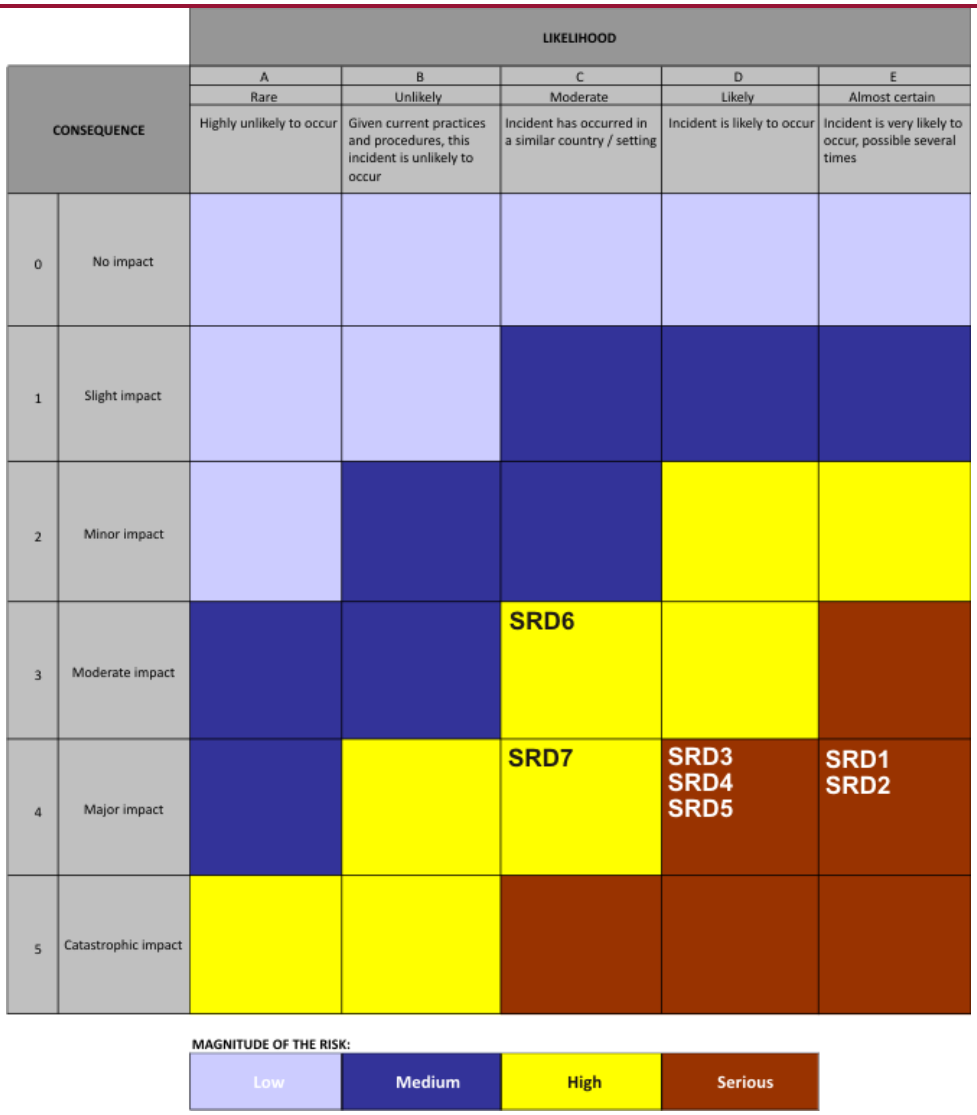


Figure 16: Risk matrix for the sea and river defence infrastructure.

Table63: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table64: Consequence scoring criteria. The descriptors for sea and river defence infrastructure have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact

Time: < 3 months (recovery time) Cost: <US$ 1,000/ m Resources: monitoring staff e.g. rangers, technical staff Losses: little to none <10%	Time: 3 months - 1year (recovery time) Cost: US$ 1,000 – 2,500/ m Resources: minimal trained professionals, trained labourers Losses: damage to property (10-20%)	Time: 1- 2years (recovery time) Cost: US$ 2500–3500/ m Resources: minimal expert staff & trained professionals, skilled labourers Losses: damage to property, disruption of livelihood, economic setbacks (social, economic, environmental) 20-40%	Time: 2- 5years (recovery time) Cost: US$ 3500 – 5000/ m Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: property, infrastructure, industry, agriculture (social, economic, environmental) 40-60%	Time: 2- 5years (recovery time) Cost: US$ 3500 – 5000/ m Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: property, infrastructure, industry, agriculture (social, economic, environmental) 40-60%

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge of flood exposure and vulnerable locations to inform investment in sea and river defences
- Use climate change information to inform land use planning and infrastructure developments consider the impacts of climate change
- Improve understanding of the benefits and challenges of managed retreat
- Improve the coordination/collaboration for sharing knowledge between local and regional governmental organisations whose mandates are similar to Guyana's. (i.e. countries that face similar risks with regards to sea level rise)
- Increase the institutional capacity to monitor and evaluate climatic impacts with a link to the design of projects through improved technologies and data collection
- Improve effectiveness of the policy framework associated with sea and river defence, with a workable link between development and implementation
- Foster cooperation between private and public sector entities and funding with key emphasis on the varying climatic conditions

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
SRD1	Inspect, monitor and collect data on environmental conditions and structural response at greater frequency[566]	▽ ...	N	MPI, MoA
SRD2	Update early warning systems to improve monitoring and implementation, for example, integrating an electronic monitoring for sea defence gate opening/closure and alert system[567]	*	N	MPI, CDC
SRD3	Ensure that early warning systems utilize CIMH 3 months forecasts and transboundary information (e.g. from Suriname) and long-term climate change projections (e.g. from OCC)[568]	*	N	MPI, CDC, Hydromet
SRD4	Conduct hazard and vulnerability mapping nationally to identify and prioritise coastal areas that are most vulnerable to the impacts of climate change, particularly flooding[569]	▽	N	MPI, GL&SC, MOA
SRD5	Conduct feasibility studies on the potential for planned gradual retreat to higher grounds [570]	*	N	MPI, MOA, MOC, MOH, MLG&RD, GL&SC, GT&T, GPL, GWI, MOF, GFC
SRD6	Conduct feasibility studies on relocation of key sectors and infrastructure (e.g. roads, energy) away from the coast to less vulnerable areas and to attract people to move inland[571]	▽	N	MPI, MOA, MOC, MOH, MLG&RD, GL&SC, GT&T, GPL, GWI, MOF, GFC
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
SRD7	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation[572]	▽ *	N	MPI, MoA, MLoGRD, EPA
SRD8	Train local community members in skills required for monitoring and evaluation[573]	*	L	MPI, MLOGRD, MoA
SRD9	Develop and implement capacity building program to undertake climate-related research, feasibility studies,	*	N, S, L	MPI

	vulnerability/hazard and risk assessments[574]			
SRD10	Provide training and support to the MPI to help them integrate climate resilience into all development projects. This could be through the use of the Caribbean Climate Online Risk and Adaptation TooL (CCORAL)[575]	*	N	CCCCC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
SRD11	Develop a Public Investment Plan that will provide a single guide and reference to rural infrastructure investment in Guyana over the next 10 years, and building on the Agricultural Support Services Programme, Agricultural Export Diversification Programme and Sea Defence Rehabilitation. This will make public investment in the sector more stable and sustainable[576]	*	N	MPI, MOC, D & I
SRD12	Revise Sea Defence Act (Chapter 64:02) to take into account climate change considerations[577]	*	N	MPI, EPA, MOC, GFC
SRD13	The formulation and implementation of land-use planning policies to address the location of infrastructure, housing schemes, agricultural development schemes and other land uses such as commercial and industrial, to reduce risk of inundation deriving from sea-level rise and storm surges, and to strengthen resilience[578]	▽ … *	N	MOH, MPI, MOA
SRD14	Mainstreaming adaptation measures into the integrated coastal zone management plans (ICZM) and urban planning; developing new building codes that include risk assessment; implementing of an emergency response plan and upgrading early warning systems[579]	▽ …	N	MPI, MOA, GFC, MOC, MoC, GL&SC, CDC
SRD15	Develop Coastal Zone Management System to monitor and create an inventory of coastal resources to determine risk, and monitor development in the vulnerable coastal plain[580]	▽	N	MPI, MOA, GFC, MOC, MoC, GL&SC
SRD16	Develop appropriate policy and legislation for the enforcement of setbacks in vulnerable areas, limiting/prohibiting buildings and other major developmental work in vulnerable	▽ …	N	MPI, MOA, MOC, GL&SC

	coastal areas and encouraging gradual retreat to higher grounds[581]			
SRD17	Based on feasibility study, consider planned gradual retreat to higher grounds by making land available in the interior; resettlement of inhabitants,[582]	*	N	MPI, MOA, MOC, Health, MoC, GL&SC, GT&T, GPL, GWI, MOF, GFC
SRD18	Mainstream climate change into due diligence, feasibility studies, financing, EIAs and design specifications (terms of reference and budgets) for infrastructure projects[583]	*	N	MPI
Pillar 4 Actions: Generation and application of technologies				
SRD19	Construction, maintenance and reinforcement of sea defence and water infrastructure, informed by climate impact studies. This may include increased use of dykes, levees and flood walls/flood gates and tidal barriers, as well as reinforcement/retrofitting of sea wall, revetments and bulkheads[584]	▽ … *	N	MPI, D & I
SRD20	Reconstruct and retrofit approximately forty (40) km of the most critical sea and river defences in coastal regions[585]	▽ …	N	MPI
SRD21	Expansion of mangrove beds (natural sea defence) which not only stabilises the coastlines but also provides protection for the sea wall[586]	▽ … *	N	MPI, MOA
SRD22	Relocate critical infrastructure to less vulnerable areas, away from the coast[587]	*	N	MPI, MOA, MOC, MOPH, MoC, GL&SC, GT&T, GPL, GWI, MOF, GFC
Pillar 5 Actions: Financing instruments				
SRD23	Secure adequate financing for adaptation works and permanent financing for adequate maintenance[588]	▽	N	MOF

4.2.13 Tourism

A: Current situation

Socio-economic importance

- Tourism, an important economic activity in Guyana, is centred mainly on ecotourism in the hinterland area. Activities include horse riding, hunting, fishing, swimming, sport fishing, yachting and bird-watching. While most ecotourism activities take place in the hinterland, most of the tourism infrastructure is located in the coastal zone[589].
- In 2013, the total contribution of travel and tourism to GDP was 7.6%[590].
- In the same year, the sector directly supported 8,000 jobs (3.3% of total employment). If jobs indirectly supported by the industry are included, then the contribution to employment was 19,000 (8% of total employment)[591].
- Visitor exports (spending by international tourists) generated 3.9% of total exports in 2013[592].

Climate vulnerability profile

- With its close connections to the environment and climate itself, tourism is considered to be a highly climate-sensitive industry[593]. Due to the fact that the tourism industry is heavily dependent on environmental conditions and quality, a wide-range of climate-induced environmental changes will have significant effects on tourism at the local and national destination level.
- The concentration of tourism infrastructure (e.g. airports, ports, hotels) along the coast increases the exposure of the sector to sea level- and storm surge-related flood damage. Stakeholders commented that tourists frequent the sea walls, some of which are already in a poor state of repair and will be further impacted by coastal erosion and inundation[594]. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[595]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[596]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[597].
- The tourism sector is also vulnerable to flooding from rainfall, which can cause damage to tourism infrastructure along the coast and in the hinterland (e.g. washing out roads), making it difficult to access tourist activities (e.g. eco-tourism). For example, in May 2015 sections of the Linden-Lethem road were washed away due to heavy rainfall, causing two major culverts to break and leaving travellers stranded. Planks were temporarily installed across gaps to allow smaller vehicles to cross; however these were reported to have been safe only if there was no rainfall[598]
- Eco-tourism activities are vulnerable to climate-driven changes in ecosystems and biodiversity. Stakeholders commented that this is particularly true for areas such as the Rupununi Region, which is identified as a pristine eco-tourist destination, where any changes in weather and climate would have detrimental impacts[599]. For instance, migration of birds from popular nesting areas (e.g. Mahaicony River, Abary Areas, and Victoria) will impact tourism activities in these locations. Species are also sensitive to wildfires, potentially leading them to migrate from Guyana's savannahs into neighbouring countries.
- Water is a critical system for tourism, as it supports a number of tourism-related activities, such as cleaning, consumption, landscaping and irrigation at resorts and for water-based sports. Water resources are sensitive to changes in temperature, rainfall and saltwater intrusion. Two main aquifers provide drinking water on the coastal plain and salt-water intrusion has already

been observed[600]. Saltwater intrusion is likely to be caused by both natural and human-induced processes (e.g. over-abstraction)[601], however the dynamics between water systems, hydrology and the climate remain largely under-analysed[602]. Sea level rise is likely to only aggravate the situation. Drought periods also affect water supplies with knock-on effects for tourism; in May 2015, Regions 1 and 9 were affected by drought, causing lakes and rivers to dry up, leading to a higher cost of water which had to be transported from greater distances[603].

- People are critical for the functioning of the tourism industry, which is hospitality-based and requires significant face-to-face interaction. Climate change will affect the health of people employed in the tourism sector and tourists visiting Guyana, through exposure to temperature extremes and flood-related hazards, for example. The frequency of days and nights that are currently considered 'hot' are projected to increase substantially in all climate scenarios. Annual projections indicate that 'hot' days are projected to occur on 18-56% of days by the 2060s, and 19-79% of days by the 2090s[604]. Heat-related health impacts may have a particularly strong effect on the tourism industry given that tourists are likely to be engaged in more outdoor activities, and hotter temperatures will not only make these activities uncomfortable, but also lead to higher demand for air conditioning, resulting in higher costs. Furthermore, if temperatures become too hot, visitors may find it too uncomfortable and choose to visit other destinations[605]. Mean annual temperatures are projected to increase by 0.4°C to 2°C by the 2030s, 0.9 to 3.3°C by the 2060s and 1.4 to 5.0°C by the 2090s[606]. The largest increases in temperature are projected for the southern portion of the country.
- The capacity of the sector to deal with climate impacts is affected by a number of informational, financial and policy and regulatory barriers. In terms of information, stakeholders commented that there is a need for more studies to be conducted on the impacts of climate change on key sectors in Guyana, and that information sharing should be more widely promoted[607]. The strength of the policy and regulatory environment and access to finance was assessed as low, with stakeholders noting that the Guyana Office for Investment (GO-Invest) has recommended support to the sector; however, there are currently budget restriction issues[608]. Access to finance becomes critical especially given the high cost associated with the increased demand for energy, required to keep tourists comfortable, safe and healthy (e.g. air conditioning, clean water supply etc.). On the positive side, institutional capacity within the sector to deal with the impacts of climate change is viewed as moderately high, through capacity building programmes within MOT, THAG, GTA and tour operators[609].

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the tourism sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

Only a small number of risks were identified for the tourism sector. The highest magnitude risk relates to the damage sea level rise may have on tourism assets (e.g. national landmarks, beaches, coastal ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) (risk ref To1). In addition to the detrimental impacts from environmental degradation, tourism-related revenue may also decrease.

Table 6541: Risk register for the tourism sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk

TO1	Sea level rise causes coastal flooding and erosion with the consequence that tourism assets (e.g. national landmarks, beaches, coastal and interior ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) are damaged, there is an increased incidence of illness due to water and vector-borne diseases, and tourism-related revenue decreases	Yes	Likely	Major impact	High
TO2	Increased rainfall causes flooding with the consequence that tourism assets (e.g. national landmarks, beaches, coastal ecosystems and biodiversity) and supporting infrastructure (e.g. administrative buildings, transportation and communication lines) are damaged and tourism-related revenue decreases	Yes	Likely	Major impact	High
TO3	Decreased rainfall causes drought, with the consequence that tourism in areas such as the Rupununi is negatively impacted and revenue is lost.	Yes	Likely	Major impact	High
TO4	Incremental climate change causes migration of wildlife to more favourable habitats with the consequence that the wildlife-related tourism is negatively impacted and revenue is lost	Yes	Moderate	Moderate impact	High
TO5	Increasingly unpredictable weather patterns cause detrimental impacts on natural resources with the consequence that community-based tourism ventures are affected	Yes	Likely	Moderate impact	High
TO6	Extreme events causes negative impacts on wildlife and biodiversity with the consequence that the wildlife-related tourism is negatively impacted and revenue is lost	Yes	Unlikely	Minor impact	Medium

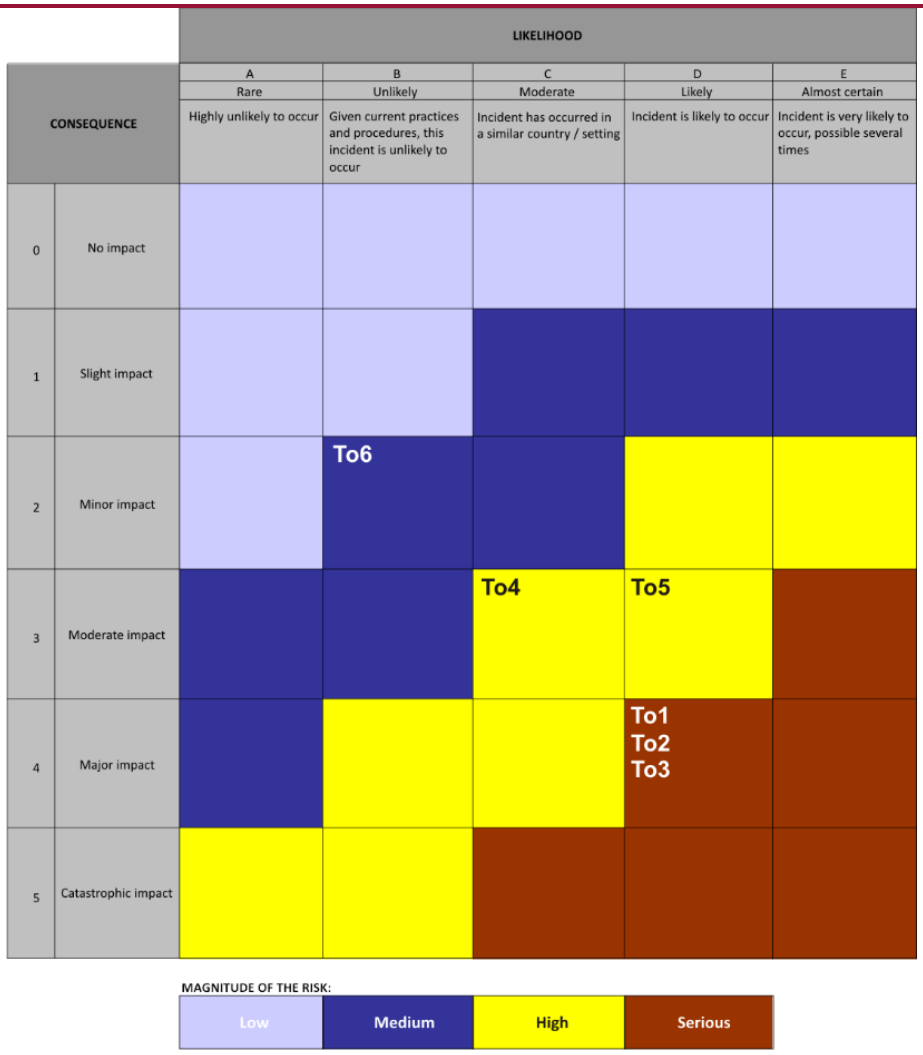


Figure 17: Risk matrix for the tourism sector.

Table 6642: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 6743: Consequence scoring criteria. The descriptors for the tourism sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Limited to affecting profits on	Reduction in tourist arrival	4 to 10 % reduction in tourist	Reduction of 11 to 20% average	Low investment operations

a low scale Scarcely affects overall GDP 0.5 to 1.0 % reduction in average tourist arrivals Very low recording of animal migration	between 1.5 – 3.0% 1.0% reduction I GDP	arrivals 1.5 to 4% reduction in GDP High level of pollution of livelihood, economic setbacks (social, economic, environmental) 20-40%	tourist arrivals 5 to 9% reduction in GDP Reduced commercial activities Significant resource depletion in tourist destinations Widespread animal migration (social, economic, environmental) 40-60%	Loss of interest in the tourism sector(school systems) High rate of animal migration High incidence of resource depletion 50% decrease in marine and aquatic life forms More than 10% decrease in GDP More than 20% reduction in tourist arrivals

B: Future vision

Recommended Sectoral Objectives

- Provide tourism businesses with the skills, training, knowledge and tools to understand and manage climate change risks
- Foster coordination among governing bodies and relevant stakeholders within the tourism industry; to contribute information that will support the development of climate resilience strategies
- Encourage the development of eco-sensitive ecotourism that has at its core the conservation of the natural resource endowment of Guyana
- Develop, implement and enforce law, policy and regulation to integrate climate resilience into tourism operations

Climate resilience actions proposed in Guyana

Ref	Action	Scaled-up (▽), Replicated (...) or New action (*)	National (N), Sub-national (S) or Local level (L)	Implementers (lead underlined)
Pillar 1 Actions: Information, research and systematic observation				
TO1	Develop, implement and institutionalise a	*	N, S, L	GTA, OCC

	research and knowledge management programme through national institutions to address identified climate change vulnerability and resilience issues affecting the tourism sector[610]			Tourism stakeholders
TO2	Conduct analysis on past and current impacts of climate on tourism, including economic impacts[611]	▽	N, S, L	MOT, GTA, Bureau of stats, OCC
TO3	Assess the economic implications of climate change on the tourism sector, particularly eco-tourism,[612]	*	N	MOT, GTA
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
TO4	Develop and implement awareness raising programme within the tourism sector at local and national levels of the implications of climate change[613]	▽	N	MOT, GTA, OCC,
TO5	Engage communities dependent on eco-tourism (such as forest based communities) on effective management of a variable and changing climate, including climate resilient development in community level decision making[614]	*	L	GTA, village councils
TO6	Provide training to tourism aspirants, through schools and universities and through work attachments, on the impacts of climate change and how to manage them.[615]	*	N	MOT, MOE
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
TO7	Amend tourism policy and legislation to include requirements for actors in the tourist industry to develop effective planning for climate resilience[616] (e.g. the Accommodation Act, Lodges and Resorts Act)	▽	N, S, L	MoLA, MOT, GTA, MOF, OCC
TO8	Develop guidelines for hotels, mostly located in the vulnerable coastal zone, including evacuation plans, insurance coverage, staff training, first aid kits, food and water storage and early warning systems[617]	▽	N, S, L	MOT, GTA, MOH, NIS, CDC
TO9	Develop a risk management strategy to address issues experienced by tourism businesses as a result of climate change (e.g. coastal flooding and soil erosion, increase in energy demand)[618]	*	N, S, L	MOT, GTA, CDC, MPI
Pillar 4 Actions: Generation and application of technologies				

TO10	Introduce, where appropriate, technologies to adapt to the impacts of climate change, for example water-efficient technologies (e.g. low-flush toilets, water-efficient taps, rainwater harvesting, drip irrigation systems), or energy-efficient technologies (e.g. energy-efficient appliances, smart lighting in hotels).	* ▽ …	N, S, L	MOT, GTA
Pillar 5 Actions: Financing instruments				
TO11	Source financing for research (e.g. to conduct feasibility studies), awareness raising and capacity building programmes[619]	▽	N, S, L	MOT, GTA, MOF, OCC
TO11	Provide incentives for tourism businesses that support green tourism (e.g. encouraging the use of solar panels, sustainable waste management to avoid burning)[620]	…	N	MOT, GEA, Go-Invest

4.2.14 Trade

A: Current situation

Socio-economic importance

- As a result of the small size of its internal market and historical patterns of development, Guyana is highly dependent on international trade as an engine of economic growth. It is also dependent on trade taxes as a source of government revenue[621].
- Guyana's main export is gold, which accounted for 40.5% of exports in 2014, followed by rice and paddy, which accounted for 20.4%, bauxite, which accounted for 11.8% and sugar, which accounted for 5.9%. Timber, shrimp and prawns, fish and by-product, prepared foods, bottled rum and spirit and diamonds also constituted exports of importance[622].
- As seen above, much of Guyana's exports are agricultural, for example sugar, which has primarily been exported to the European Union[623].

Climate vulnerability profile

- The trade sector is intrinsically linked to a number of other sectors, including agriculture, mining and transport. As a result, climate vulnerabilities in these sectors[liii] have the potential to impact trade and export earnings.
- Much of Guyana's exports are related to the agricultural sector (e.g. sugar), which is extremely vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions and plant development and animal health. Any negative impacts of climate variability and change on agriculture will reverberate through economies where agriculture is a major contributor to total GDP.
- Trade is highly dependent on functioning transport systems in order to move goods from Guyana to their international destinations and vice versa. Transportation hubs, such as ports and airports, as well as the transportation networks such as shipping routes, air routes and road and rail networks are vulnerable to weather-related disruption. For example, in May 2015, heavy rains washed out sections of the Linden-Lethem road, which is a critical connection between Guyana and Brazil[624]; such events can restrict trade between the two countries. When transport disruptions occur, many supply chains break-down and take a long time to recover, with significant costs to individual businesses and the wider economy.
- The clustering of transport infrastructure along Guyana's coast provides significant economic benefits to the national economy. However, it also increases the vulnerability of the economy to the impact of climate change, namely sea level rise and storm surge[625]. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[626]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[627]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[628].
- Furthermore, road connections to the hinterland are poor and there are insufficient all weather access roads connecting agriculture, forest and mining areas, in the hinterland, to Georgetown. These roads are vulnerable to flooding and land instability associated with heavy rainfall events. Climate projections suggest that the proportion of rainfall occurring in heavy events may increase (although the trend is weak), particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February,

[liii] For further details please see the associated sectoral briefing notes in the CRSAP.

March and April[629].

- The capacity of the trade sector to adapt to the impacts of climate change was assessed by stakeholders as moderate to low[630]. This is due to a number of institutional, informational and financial barriers. Stakeholders noted that despite the different monitoring agencies having competent and knowledgeable individuals, there is limited collaboration between agencies and very little guidance is provided to sector actors (e.g. farmers) on actions to be taken to adapt to climate change[631]. Stakeholders also commented that very little financial assistance is available for the sector[632].

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the trade sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

Only a small number of risks were identified for the trade sector. The highest magnitude risks relate to climate impacts on the agricultural and mining sectors and the detrimental consequences this may have on export earnings, from sugar cane for example (risk ref T1) and gold (risk ref T2).

Table 6844: Risk register for the trade sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
T1	Increase in extreme rainfall events causes riverine flooding with the consequence that wharves and stellings that provide coastal and inland linkages, are damaged and riverine transportation is disrupted, with detrimental impacts for trade and industry	No	Moderate	Major impact	High
T2	Sea level rise and increase in storm surge height, causes coastal flooding and erosion with the consequence that ports are damaged or operations are disrupted, with detrimental impacts for trade and industry	Yes	Likely	Moderate impact	High
T3	Incremental climate change and extreme events causes a decrease in average agricultural production with the consequence that foreign exports decrease (e.g. sugar cane and rice) and revenue is lost	Yes	Moderate	Moderate impact	High
T4	Incremental climate change and extreme events causes drought and drying up of rivers (where gold is mined) with the consequence that rivers are no longer navigable (for transport of equipment) and gold export earnings decrease	Yes	Moderate	Moderate impact	High
T5	Incremental climate change and extreme	Yes	Moderate	Slight impact	Medium

	events causes changes in biodiversity and natural forest habitats of wild birds with the consequence that foreign exports decrease and revenue is lost				

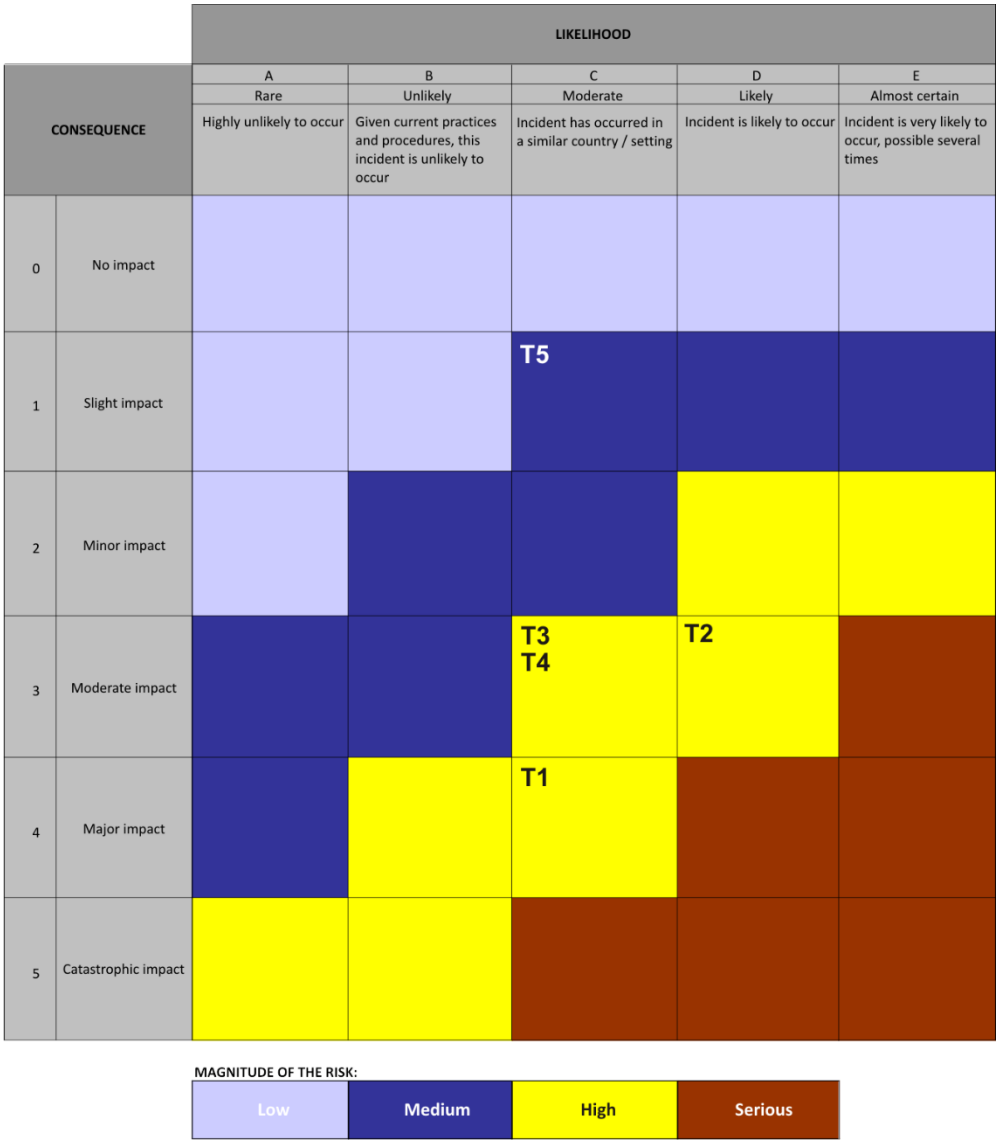


Figure 18: Risk matrix for the trade sector.

Table 6945: Likelihood scoring criteria. Based on feedback from the OCC, qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

	to occur			

Table 460: Consequence scoring criteria. The descriptors for the trade sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Decrease of GDP by less than 0.2%	Decrease of GDP by more than 0.2% but less than 0.5%	Decrease of GDP by more than 0.5% but not exceeding 1%	Decrease of GDP by more than 1% but not exceeding 5%	Decrease of GDP by more than 5%

B: Future vision

Recommended Sectoral Objectives

- Improve knowledge of how climate variability and change affect Guyanese trade (imports, exports and domestic trade) and what adaptation options are available
- Provide mechanisms to protect Guyanese businesses from climate variability and change, particularly supply chain disruption due to extreme weather events
- Introduce measures that encourage climate resilient technologies to be delivered through the market, which may include the provision of incentives for business

Climate resilience actions proposed in Guyana

Ref	Action	Scaled-up (▽), Replicated (...) or New action (*)	National (N), Sub-national (S) or Local level (L)	Implementers (lead underlined)
Pillar 1 Actions: Information, research and systematic observation				
T1	Undertake a climate vulnerability and risk assessment to understand climate impacts on significant current and future contributors to the Guyanese economy, including an assessment of impacts on future imports and exports[633]	▽	N, S, L	MOA, DNRE
T2	Undertake research on the climate/ disaster vulnerability of transport networks in Guyana to identify highly vulnerable locations. Make recommendations on which transport assets should be made more resilient as a priority[634]	▽ ...	N	CDC, MPI, EPA, OCC

Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
T3	Promote education and social learning on climate change for private sector actors, including on successful case studies and maladaptation[635]	▽	N, S, L	MOA, DNRE
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
T4	Develop an enabling environment for climate resilient technology transfer (e.g. removal of technical, legal and administrative barriers; design of sound economic policy; regulatory frameworks and transparency)[636]	▽	N, S, L	MOA, DNRE
T5	Strengthen Guyana's trade diversification programme to diversify production and export base, reducing reliance on climate-sensitive commodities[637]	▽	N	Ministry of Foreign Affairs
Pillar 4 Actions: Generation and application of technologies				
	No actions identified	•	•	•
Pillar 5 Actions: Financing instruments				
T6	Develop affordable credit and finance mechanisms to enable businesses to secure funding for resilience-building. Mechanisms will be required for all businesses from the sole trader (e.g. microfinance and credit unions) to large companies[638]	▽	N, S, L	GRA, MOF, Commercial Banks, NGOs
T7	Examine whether appropriate insurance opportunities are available for Guyanese businesses to protect them from losses and interruptions arising from climate variability and change. Develop and support appropriate opportunities where there are gaps[639]	▽	N, S, L	MOA, DNRE
T8	Develop financial and fiscal measures to incentivise investment in goods and services (including new technologies and manufacturing processes/ equipment) that will assist in building resilience to existing climate vulnerability and climate change. Technologies could include renewable energy systems, water treatment and sewage treatment plants[640]	▽	N, S, L	GRA, EPA, Ministry of the Presidency, MOA, Go-Invest
T9	Promote and provide financial support to business start-ups that deliver climate resilient solutions, such as renewable energy systems, water-efficient technologies etc.[641]	▽	N, S, L	Ministry of the Presidency

4.2.15 Transport

A: Current situation

Socio-economic importance

- Guyana's transport system consists of road, marine and air transport. In 2014, the sector "transport and storage" contributed 6.7% of GDP[642].
- Guyana has a 3995 km road network, which serves a national fleet of more than 80,000 vehicles[643].
- The public transport system is dominated by privately-owned mini-buses in urban areas, and these connect urban centres with rural areas. Mass transport systems in Guyana are poor; barriers toward enhancing the system include limited integrated land use planning, cost-effectiveness issues due to a limited population to serve and commuter preferences for private cars[644]. New public transport systems will require expanded roadway capacity, modern terminals and roadside infrastructure such as and parking bays and bus stops, and developing such infrastructure will require significant investment[645].
- The main port of Georgetown is located at the mouth of the Demerara River and other water transport infrastructure is located along the banks of the navigable rivers, namely, the Essequibo, Demerara and Berbice. In addition to the wharves and stellings that provide coastal and inland linkages, there are facilities that handle both the country's overseas and local shipping requirements. Ports, wharves and stellings play an important role in supporting economic activities in the hinterland, since they act as a crucial connection between sea and land transport. They are also an important source of employment[646].

Climate vulnerability profile

- The characteristics of Guyana's transport sector make it vulnerable to climate and weather-related hazards. This stems from the concentration of infrastructure along the coast and rivers, and the inadequate maintenance of roads and bridges.
- The clustering of infrastructure along the coast provides significant economic benefits to the national economy. However, it also increases the vulnerability of the economy to the impact of climate change, namely sea level rise and storm surge[647]. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[648]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[649]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[650].
- The main port of Georgetown and other maritime infrastructure along the banks of the navigable rivers are vulnerable to sea level rise, storm surge and riverine flooding associated with heavy rainfall events. Stakeholders commented that poorly maintained ports and harbours (wharves) may experience loss of materials as a result of inundation (e.g. decking)[651].
- Guyana's paved road network, which is largely located along the coast, depends heavily on large fixed assets, particularly the bridges and culverts that serve a dense system of drains, canals, and sluices along the coastal lowlands, where most of the population lives. Building and maintaining this infrastructure is already difficult and costly[652], particularly in the face of increasing vulnerability to sea level rise and storm surge. Stakeholders mentioned the Rupert Craig Highway as a perfect example of a road that regularly experiences inundation and results in the blockage of transportation of people, equipment and supplies[653]. Furthermore, poor bridge maintenance procedures increase their vulnerability to flood-related damage and

potential for failure (e.g. timber damage).

- Road connections to the hinterland are poor and there are insufficient all weather access roads connecting mining, forest and agriculture areas, in the hinterland, to Georgetown. These roads are vulnerable to flooding and land instability associated with heavy rainfall events. Climate projections suggest that the proportion of rainfall occurring in heavy events may increase (although the trend is weak), particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April[654].
- The capacity of the transport sector to adapt to the impacts of climate change was assessed by stakeholders as moderate to high[655]. In terms of information, the sector has been strengthened through numerous donor-funded projects Institutional capacity was assessed as moderately high, with stakeholders acknowledging that the mandate of the NDCs, RDCs, GWI (utilities) include scope for collaboration; although in some cases this is not achieved[656]. The strength of the policy and regulatory environment was assessed as moderately low, with stakeholders commenting that improving the policy framework is a continuous process. Access to finance was viewed as moderate, with stakeholders commenting that financial resources were strong through donor-funded projects. However, minimal finance is allocated to climate resilience in the aviation, river or minor road sectors[657].

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the transport sector, as detailed in Table 3220 and presented on the risk matrix in Figure .

All the risks identified for the transport sector have a high or moderate magnitude; no risks have been assigned with a sufficiently high likelihood or consequence to make them a “serious” risk (Figure). The highest magnitude risks relate to damage to critical transport infrastructure from flooding, due to overflowing drainage canals and culverts (risk ref TP1), sea level rise and storm surge (risk ref TP3 and TP3), or landslides (risk ref TP2). Conversely, decreases in precipitation may mean that some rivers are no longer navigable and infrastructure along the banks (e.g. wharves and stellings) is no longer accessible (risk ref TP5). Climate-related disruption to ports, wharves, stellings and roads has the potential to have knock-on consequences for trade and industry.

Table 7147: Risk register for the transport sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
TP1	Increase in extreme rainfall events causes flooding, due to overflowing drainage canals with the consequence that critical transport infrastructure (roads, bridges and culverts) are damaged or destroyed, particularly along the coastal lowlands and in the hinterland	Yes	Moderate	Major impact	High
TP2	Increase in extreme rainfall events causes flooding and landslides with the consequence that rural transport networks are damaged or destroyed, and	Yes	Moderate	Major impact	High

	communities and commercial enterprises in the hinterland are cut off				
TP3	Sea level rise and increase in storm surge height, causes coastal flooding and erosion with the consequence that ports are damaged or operations are disrupted, with detrimental impacts for trade and industry	Yes	Likely	Moderate impact	High
TP4	Increase in extreme rainfall events causes riverine flooding with the consequence that wharves and stellings that provide coastal and inland linkages, are damaged and riverine transportation is disrupted, with detrimental impacts for trade and industry	No	Moderate	Major impact	High
TP5	Decrease in mean annual rainfall causes lower river levels with the consequence that rivers are no longer navigable and infrastructure along the banks (e.g. wharves and stellings) are no longer accessible, with detrimental impacts for trade and industry	Yes	Moderate	Major impact	High
TP6	Increase in number of extreme 'hot days' causes paved (tarmac) airport runways to melt / bleed with the consequence that airport operations are impacted and maintenance costs increase	Yes	Unlikely	Major impact	High
TP7	Increase in mean annual temperature and increase in number of extreme 'hot days' causes aviation equipment to be operating near or above critical temperature thresholds with the consequence that aircraft underperform, affecting maximum weight and fuel consumption, resulting in weight restrictions (especially at airports with short runways) and additional costs	Yes	Unlikely	Major impact	High
TP8	Increase in extreme rainfall events cause surface flooding of airports due to overflowing drainage systems with the consequence that airport operations are disrupted	Yes	Moderate	Moderate impact	High
TP9	Increase in number of extreme 'hot days' causes paved (tarmac) road surfaces to melt / bleed with the consequence that road networks are damaged and maintenance costs increase	Yes	Unlikely	Moderate impact	Medium

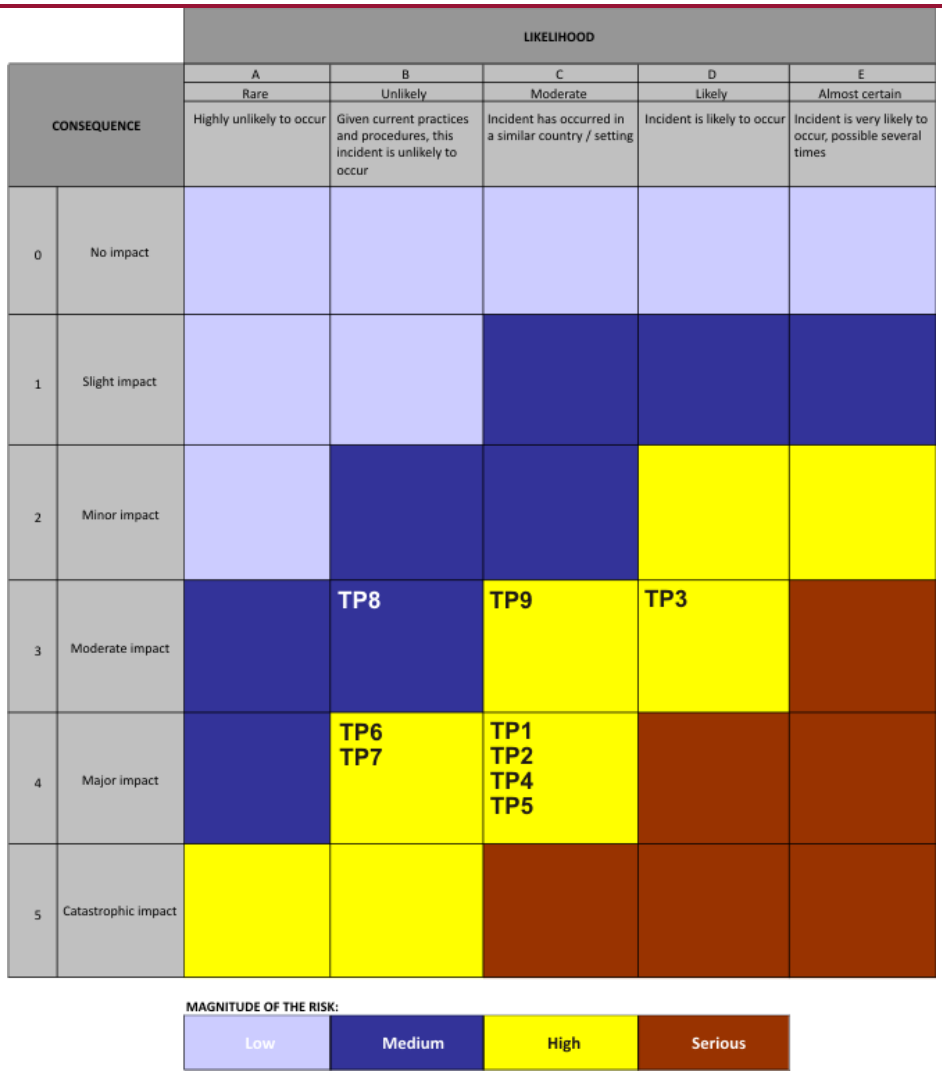


Figure 19: Risk matrix for the transport sector.

Table 7248: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 7349: Consequence scoring criteria. The descriptors for the transport sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Time: < 6 months	Time: 6 months -	Time: 1- 2years	Time: 2- 5years	Time: > 5years

(recovery time) Cost: US$ 100,000 Resources: minimal trained professionals, trained labourers Losses: time, little to none.	1year (recovery time) Cost: US$ 100,000 – 250,000 Resources: minimal trained professionals, trained labourers Losses: time (delays)	(recovery time) Cost: US$ 250,000 – 500,000 Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: Life, property, time	(recovery time) Cost: US$ 500,000 – 1 M Resources: minimal expert staff, trained professionals, skilled/trained labourers Losses: property, time, additional budgetary allocations	(recovery time) Cost: US$ 10,000/m (US$1M/km) Resources: expert staff, trained professionals, skilled/trained labourers Losses: Life, property, inaccessible area, damage to collector, feeder and main NADSC pavement layer-material strength, time, GDP

B: Future vision

Recommended Sectoral Objectives

- Improve the coordination and collaboration between local, regional and international bodies and to implement changes in the design of transport systems
- Improve the effectiveness of the transport division's policy framework, with a workable link between development and implementation
- Foster international cooperation and funding (from private and public sector entities) with a key emphasis on climate change
- Maximise the available funds in the agency's budget allocated to capacity building of personnel with emphasis on climate change resilience, adoption of good practice and development of innovative solutions

Climate resilience actions proposed in Guyana				
Ref	**Action**	**Scaled-up (▽), Replicated (...) or New action (*)**	**National (N), Sub-national (S) or Local level (L)**	**Implementers (lead underlined)**
Pillar 1 Actions: Information, research and systematic observation				
TP1	Undertake research on the climate/ disaster vulnerability of transport networks in Guyana to identify highly vulnerable locations. Make recommendations on which transport assets should be made more resilient as a priority[658]	▽ …	N	CDC, MPI, EPA, OCC
TP2	Develop a functional GIS database which captures all climatic data with regards to the design of Guyana's land, water and air transport systems[659]	*	N	MPI
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
TP3	Raise awareness of relevant Ministry of Public Infrastructure staff and Guyanese engineering firms of the impacts of climate change on the transport sector and how to build climate resilient infrastructure. Use of Caribbean Climate Online Risk and Adaptation TooL (CCORAL) training is one option to consider[660]	▽	N	MOT, GTA, OCC, MPI, CCCCC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
TP4	Integrate a climate resilience component into all transport infrastructure rehabilitation project terms of reference and feasibility studies (road, rail, maritime, aviation)[661]	▽ …	N	OCC, MPI, MoA, MDLE
TP5	Integrate climate resilience into next review of transport sector legislation, regulations, codes of practice, quasi-regulatory guidance and policy[662]	▽ …	N	OCC, MPI, CDC
TP6	Mainstream climate change into due diligence, feasibility studies, financing, EIAs and design specifications (terms of reference and budgets) for infrastructure projects	*	N	MPI
Pillar 4 Actions: Generation and application of technologies				
	No actions identified			
Pillar 5 Actions: Financing instruments				

TP7	Source funding for capacity building programs on climate change resilience, adoption of good practice and development of innovative solutions[663].	*	N	MOF, MPI

4.2.16 Water

A: Current situation

Socio-economic importance

- Water is a crucial resource for virtually all other sectors in Guyana, and conversely, is also affected by activities from many other sectors (e.g. pollution from mining activities, inadequate household waste management). Guyana uses both surface and groundwater resources for agricultural, industrial, and domestic purposes.
- Surface water resources are abundant across the country, with brackish to saline water on the coast[664]. In the coastal plain, where roughly 90% of the population live, residents depend almost entirely on groundwater supply to meet domestic needs. Georgetown is an exception, as 30% of the water used is surface water from the East Demerara Water Conservancy (EDWC)[665]. Water conservancies have two functions: to provide flood regulation and to facilitate irrigation. Changes in population, agricultural demand, land use and sea level rise have stressed the irrigation and drainage canals system[666]. Consequently, continuous maintenance, rehabilitation and upgrading is undertaken[667].
- In the hinterlands, a combination of groundwater and surface water extraction with domestic rainfall harvesting is used[668]. Some areas are highly dependent on surface water sources, for instance in Bartica, 100% of the water supply is from surface water, and similarly in Wismar and Linden, the sole water source for the new treatment plant is the Dakoura Creek[669]. As such, all land-based activities (e.g. agriculture, mining) have the potential to affect the water quality of these surface sources.
- The majority of government investment in water is allocated to agricultural water resources and water supply and sanitation[670]. Significant progress has been made over the past twenty years in achieving access to improved drinking water sources, but the quality is hindered by deterioration of distribution networks[671]. The sewerage system covers a small proportion of the population, and the rest relies on individual solutions[672]. In 2012, improved sanitation coverage was 88% in urban areas, and 82% in rural areas[673].

Climate vulnerability profile

- The vulnerability of Guyana's water sector stems primarily from two climate-related factors; first, extremes in rainfall, with excess rain fall leading to flooding and lack of rainfall leading to water deficit, and second, sea level rise and storm surges leading to flooding[674]. There are also a number of other factors which increase the sensitivity of the water sector and have contributed to the almost seasonal flooding along the coast, including the effectiveness of the drainage and irrigation and sea defence systems, the gradient of the land, and the conditions of the water storage areas[675].
- The water sector is sensitive to changes in precipitation, particularly the regular droughts that take place across the country, which show a strong correlation with El Niño conditions[676]. Drought conditions can cause groundwater deficits, as exemplified in late 2014 – early 2015 when a lack of rainfall caused decreased water levels in the wells and other water sources in Region 9 (Upper Takutu-Upper Essequibo) and parts of Region 1 (Barima-Waini)[677]. Stakeholders commented that in Regions 5 and 6, hot weather (and less precipitation) had caused water levels to drop and iron content, which clogs and restricts the flow of water, to rise[678]. These impacts are likely to become worse given projections across a range of future climate change scenarios, which indicate decreases in seasonal precipitation (up to 6mm for

the 2030s, 17mm for the 2060s and 20mm for the 2090s[679]) and increases in the proportion of heavy rainfall events, particularly in the southern parts of the country during the wet season of November, December and January and in the dry season of February, March and April[680]. However, across all seasons and time periods, there is considerable uncertainty about the direction of trend in rainfall amounts and distribution; when minimum and maximum values are considered, positive and negative projections of rainfall change are generated. Drought also impacts water in conservancies, especially if they occur during the secondary wet season November to January[681].

- Coastal populations depend almost wholly on groundwater for domestic supply, with the exception of Georgetown, which uses 30% surface water from the East Demerara Water Conservancy (EDWC). A dense network of drainage and irrigation canals transects the coastal zone and connects to the EDWC, which provides regional agricultural lands and urban areas with irrigation and drinking water. During times of heavy rainfall this system acts as a regional drainage and flood control mechanism. Regular maintenance is crucial to maintain the efficient operation of the drainage system, lack of which can result in the growth of vegetation which impedes flow and increases siltation[682]. The EDWC itself is under considerable stress already. Relief canals (built to stop the EDWC dam from overtopping) are currently operating with limited effectiveness, due to changes in land use (as their use for emergency relief normally floods inhabited lands downstream) and sea level rise. Degradation of the EDWC has been compounded by a number of recent severe weather events, such as the floods of 2004-2005. Overtopping of the dam during these rains has weakened the already vulnerable system[683], increasing its sensitivity to further sea level rise, storm surge and flooding and threatening water resources in the coastal zone. Sea level is projected to increase in Guyana by up to 26 cm by the 2030s, 43 cm by the 2050s and 51cm by the 2070s[684]. When storm surge heights are incorporated in the projections, heights may be close to 3m in the minimum scenario, and close to 6m in the maximum scenario by the 2030s[685]. Under the maximum storm surge scenario, at least 139,000 hectares of land may be inundated by the 2030s, and at least 140,000 hectares by the 2070s[686].
- Salt-water intrusion has already been observed in Guyana's groundwater resources, but dynamics between water systems, hydrology and the climate remain under-analysed[687]. Coupled with over-abstraction and inadequate recharge, sea level rise viewed as the main threat to coastal aquifers[688]. Surface water resources are vulnerable to salinization from storm surge and contamination from flood events, leading to reduced water quality and sanitation for populations living in or close to these environments. However, this risk can be easily mitigated through adequate well-head protection[689]. In the interior regions where gold and diamond mining activities have changed and/or inhibited water flows, surface water pollution and salinization is currently a critical issue, which may be further exacerbated in a changing climate.
- The water sector depends on a stable energy supply, which is used for treatment and pumping, among other uses. Energy systems are sensitive to changes in climatic variables, particularly increases in temperature extremes[690]. Guyana's plans to exploit the country's significant hydropower potential are sensitive to changes in precipitation and compounding impacts on water resources.
- The capacity of the water sector to adapt to the impacts of climate change was assessed by stakeholders as low to moderate[691]. Institutional resources were assessed as moderate, as the institutional framework is currently fragmented. Stakeholders commented there is a need to strengthen coordination among agencies and recommended the reinvigoration of the National Water Council. Human resources were assessed as moderate, and stakeholders noted the need for stronger agencies (GWI, river and sea defence, MMA, Hydromet, NDIA, MoPH, EPA and GNBS). The policy and regulatory environment was assessed as weak. An Integrated Water Resource Management (IWRM) plan is still in a draft stage, as is a Waste Water Strategy. Lack

of information remains a barrier. Stakeholders noted that there is a need for more current and detailed information to be used as a foundation for decision-making, as the last national studies were conducted in the 1970s/80s. Financial resources were viewed as moderately weak; funding lacks consistency and varies among agencies, as different agencies are supported by different budget lines or have project support.

Climate risks and opportunities

The vulnerability profile described above creates a number of climate change risks for the water sector, as detailed in Table 3220 and presented on the risk matrix in Figure .Due to the cross-cutting nature of water use, all the sectors covered in this chapter of the CRSAP have water-related risks, highlighting the need for cross-sectoral collaboration. A number of direct risks were identified for the water sector, covering water supply and sanitation, with the majority clustered at the higher magnitude end of the scale. These relate to risks to water supply due to sea level rise and saline intrusion of aquifers, freshwater systems and water supply distribution networks (risk ref W1), incremental changes in rainfall and temperature affecting surface water systems (e.g. rivers, creeks, ponds, springs and wells, particularly for riparian communities in the hinterland) (risk ref W3 and W2) and groundwater recharge (risk ref W5). The final high magnitude risk is linked to flooding of the low coastal plain, including Georgetown, and interior townships, due to overflowing drainage canals causing damage to water supply and sewerage systems and networks (risk ref W4).

Table 7450: Risk register for the water sector. The risk descriptions and scoring are based on a combination of literature review, expert judgement and stakeholder consultation. [Full details of the methodology are provided in Annex A of the CRSAP.] The scoring criteria for likelihood and consequence are provided in Table and Table 3421 respectively.

Ref	Risk description	Current risk?	Likelihood (2030s)	Consequence	Magnitude of risk
W1	Sea level rise causes saline intrusion of aquifers, freshwater systems and water supply distribution networks with the consequence that water supplies are threatened	Yes	Almost certain	Major impact	Serious
W2	Incremental climate change and extreme events particularly increased frequency of droughts, causes water shortages with the consequence that household water supplies are threatened, particularly in areas reliant on surface water resources	Yes	Almost certain	Major impact	Serious
W3	Incremental climate change and extreme events particularly increased frequency of droughts, causes rivers, creeks, ponds, springs and wells in riparian and hinterland regions to dry up / shrink in size with the consequence that drinking water becomes scarce and community health and wellbeing are threatened	Yes	Almost certain	Major impact	Serious
W4	Increase in extreme rainfall events cause flooding of the low coastal plain, including Georgetown, and interior townships, due	Yes	Almost certain	Major impact	Serious

	to overflowing drainage canals with the consequence that water distribution pipes, treatment plants and pumping equipment, as well as sewage pumping systems, are damaged				
W5	Decrease in mean annual rainfall causes reduced groundwater recharge with the consequence that water shortages occur (however, recharge patterns will be variable across the country, depending on different hydrogeology and aquifer systems)	Yes	Likely	Major impact	Serious
W6	Decrease in mean annual rainfall causes soil degradation and erosion, leading siltation of rivers and lakes with the consequence that water supplies are impacted	Yes	Moderate	Major impact	High

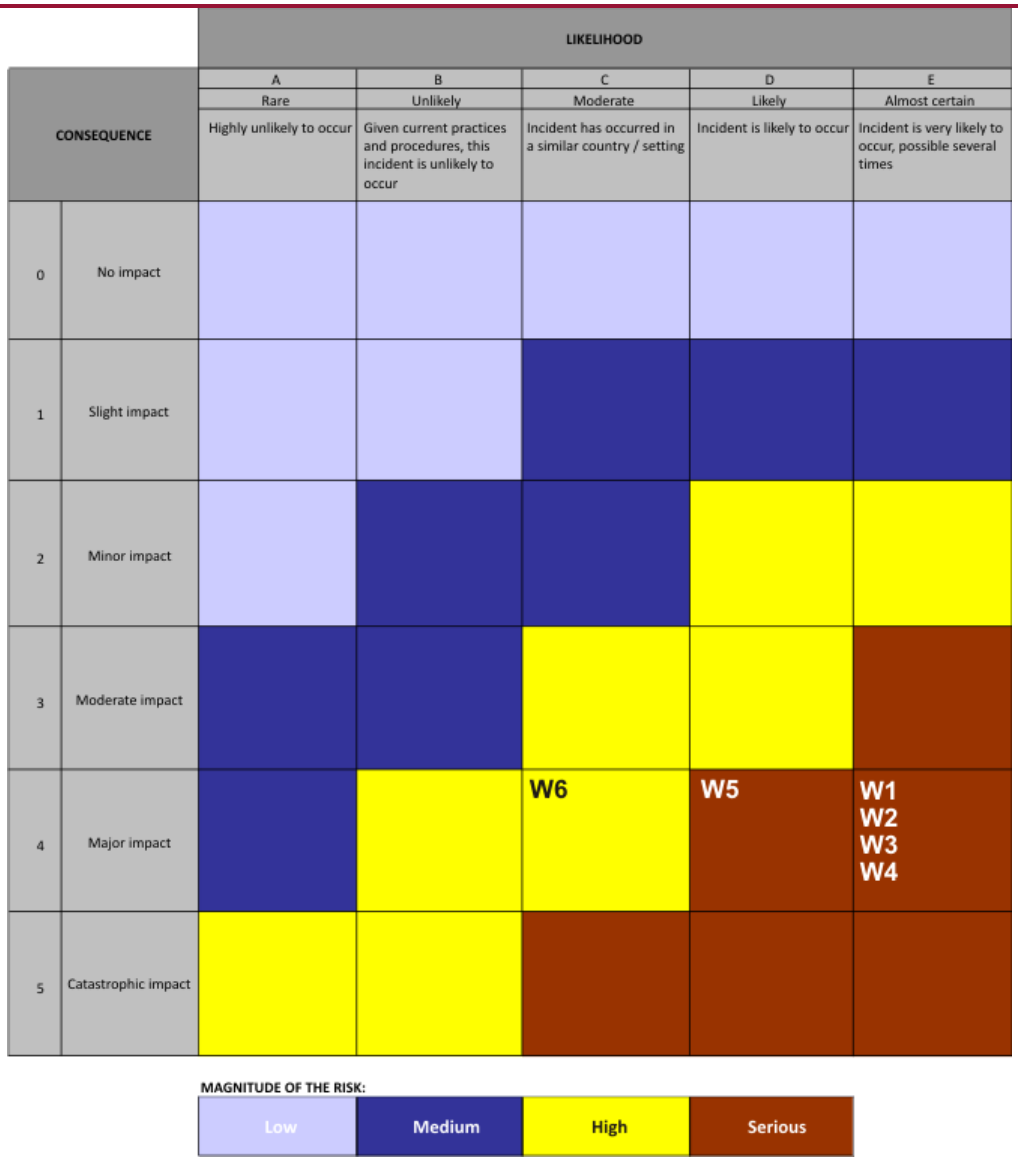


Figure 20: Risk matrix for the water sector.

Table 7551: Likelihood scoring criteria. Qualitative descriptors have been used to assess the likelihood of each risk occurring in the 2030s.

1: Rare	2: Unlikely	3: Moderate	4: Likely	5: Almost certain
Highly unlikely to occur	Given current practices and procedures, this incident is unlikely to occur	Incident has occurred in a similar country / setting	Incident is likely to occur	Incident is very likely to occur, possibly several times

Table 7652: Consequence scoring criteria. The descriptors for the water sector have been defined in collaboration with in-country stakeholders.

1: Slight impact	2: Minor impact	3: Moderate impact	4: Major impact	5: Catastrophic impact
Flooding Economic: increased cost/expenditure for cleaning supplies at a household level Water treatment options Drought Heat stress	Flooding Socio-economic: closure of schools & business Delays and absences at enterprises (business, commercial) Drought Health impacts – rashes allergies	Flooding Contamination of domestic water supply e.g. shallows wells in Hinterland areas Drought Destruction of agriculture and vegetation (pest, insects)	Flooding Social: High incidences of water borne diseases Social – displacement Social/health – pit latrines Economic – salt water intrusion/ inundation of agricultural lands, surface water Environmental – degradation of ecosystems/ loss of habitat Drought Low water levels impacting river transportation therefore Low productivity Loss of shallow wells → increased exposure to water borne diseases due to contaminated water Wilting of plants → lack so sustenance at community levels e.g. Hinterland Region Accessibility to water supply → rice farmers (agricultural) → Irrigation Loss of freshwater supply	Flooding Loss of livelihood at community level → household level Loss of lives Drought Loss of livelihoods at community and household levels (particularly in the Hinterland areas)

B: Future vision

Stakeholder Recommended Sectoral Objectives

- Improve knowledge of social vulnerability to climate-induced changes in water resources
- Increase availability and accessibility to water resources and supply in the face of a changing climate, particularly for indigenous communities, namely provision of reliable supply, especially during drought, improved quality of potable water and to reduce the risk of saltwater intrusion
- Promote integrated water resources management
- Build research and technical capacity in context of water resources management
- Examine and assess the state of water aquifers, particularly in areas where indigenous communities are reliant on groundwater and where economic activities are conducted (e.g. mining) to ensure the aquifers are not compromised
- Improve water management during climate-related disasters, to avoid contamination and associated health issues

Climate resilience actions proposed in Guyana

Ref	Action	Scaled-up (▽), Replicated (...) or New action (*)	National (N), Sub-national (S) or Local level (L)	Implementers (lead underlined)
Pillar 1 Actions: Information, research and systematic observation				
W1	Develop and implement comprehensive national research programme on social, environmental and economic baselines, climate science, vulnerability, impacts and risk management[692]	▽	N	MoC, MoA, UG (SEES), DNRE
W2	Conduct analysis on past and current impacts of climate on water, including economic impacts[693]	*	N, S, L	MoC, MMA, MoC, MoE, UG, MoF, GTA
W3	Undertake research into the functioning of watersheds, the impacts of economic activities (e.g. mining, agriculture) and possible alternative livelihoods for affected communities[694]. For example, a community in Wisma has witnessed a decrease in functioning watersheds from 5 to 1 due to mining activities using other sources.	*	S, L	MoC
Pillar 2 Actions: Institutional framework and capacity building, education and awareness				
W4	Develop a widespread educational awareness program on the importance of monitoring and evaluation for adaptation[695]	▽	N	MOT, GTA, OCC
W5	Promote & implement awareness raising	▽	N, S	National Water

	programme on the impacts of climate change on water resources and how to manage these impacts[696]			Council* GWI, OCC, MoPH
W6	Strengthen and implement awareness raising programme on addressing water management issues and water contamination post-disaster[697]	▽	N	CDC, GWI, MoPH, EPA, MoC
Pillar 3 Actions: Policy, legal framework and tools to integrate adaptation into development planning				
W7	Advance an Integrated Water Resource Management approach, including establishment of a national water council[698]	▽ *	N	MoC
W8	Develop a more robust framework for monitoring and evaluation[699]	▽	N, S, L	Attorney General's Office, MOC, National Water Council (to be reinstated)
W9	Develop policy and legislation to promote water saving measures[700]	* ▽	N, S, L	Attorney General's Office, MOC
Pillar 4 Actions: Generation and application of technologies				
W10	Improve sanitation systems and access to potable water[701]	▽	N, S, L	MoPH, GWI, GNBS, MoC
W11	Develop climate-resilient infrastructure to ensure availability of clean drinking water[702]	*	N	MoC, GWI
W12	Develop and upgrade infrastructure for water supply, irrigation, drainage and flood protection, in order to increase the efficiency of water use, including storage and distribution, without compromising sanitation systems[703]	▽	N	GWI, NDIA, MMA, MoC
Pillar 5 Actions: Financing instruments				
	No actions identified			

Appendix 1 Climate profile

Appendix 1 provides visual representations of observed and projected annual and seasonal mean temperature and precipitation across Guyana. Figure 2 presents annual and seasonal average daily temperatures from 1958-2001, Figure 3 presents annual and seasonal average daily precipitation from 1958–2001, and Figure 4 presents projected changes in mean annual temperature and precipitation in the 2030s, 2060s and 2090s.

Figure 2: Annual (a) and seasonal (b–e) average daily temperature based on available observations (black dots) for 1958-2001. Seasons are: February to April (b) secondary dry season; May to July (c) primary wet season; August to October (d) primary dry season; November to January (e) secondary wet season. (Source: Bovolo et al., 2011[704]).

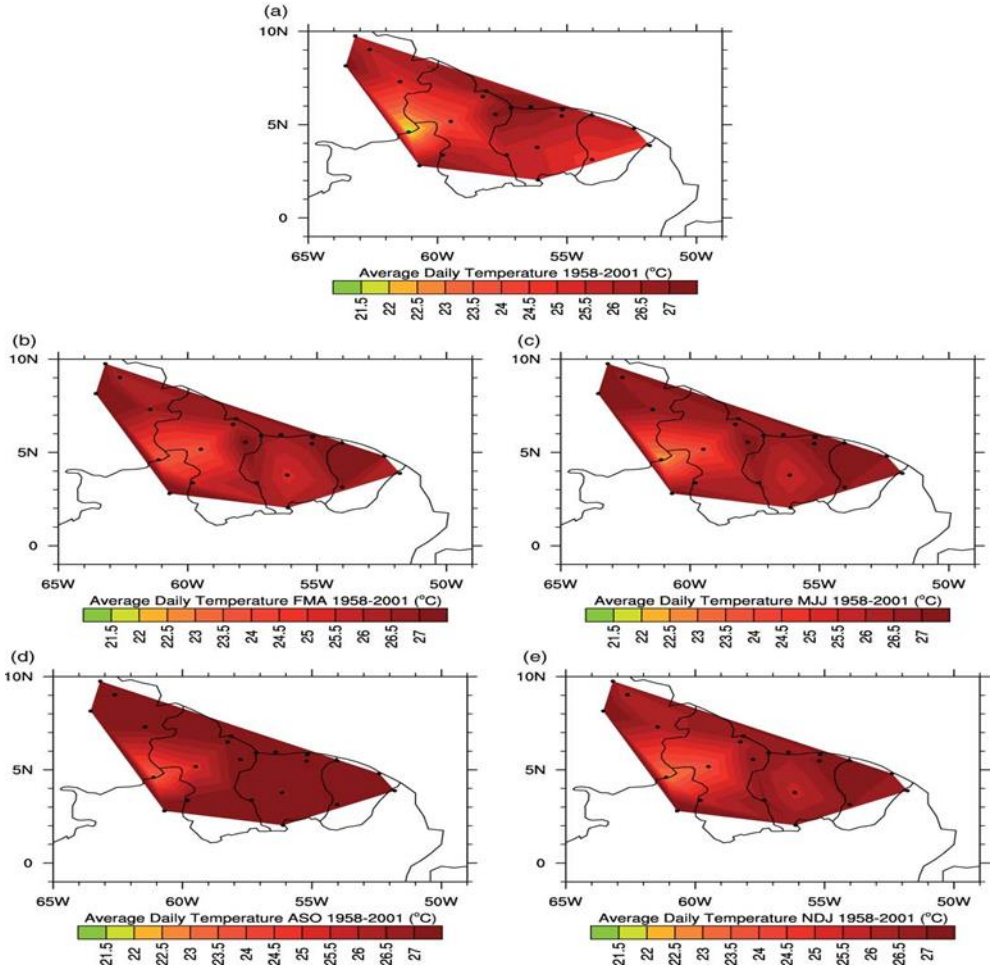


Figure 3: Annual (a) and seasonal (b–e) average daily precipitation based on available observations for 1958–2001. Seasons are: February to April (b) secondary dry season; May to July (c) primary wet season; August to October (d) primary dry season; and November to January (e) secondary wet season. (Source: Bovolo et al., 2011[705]).

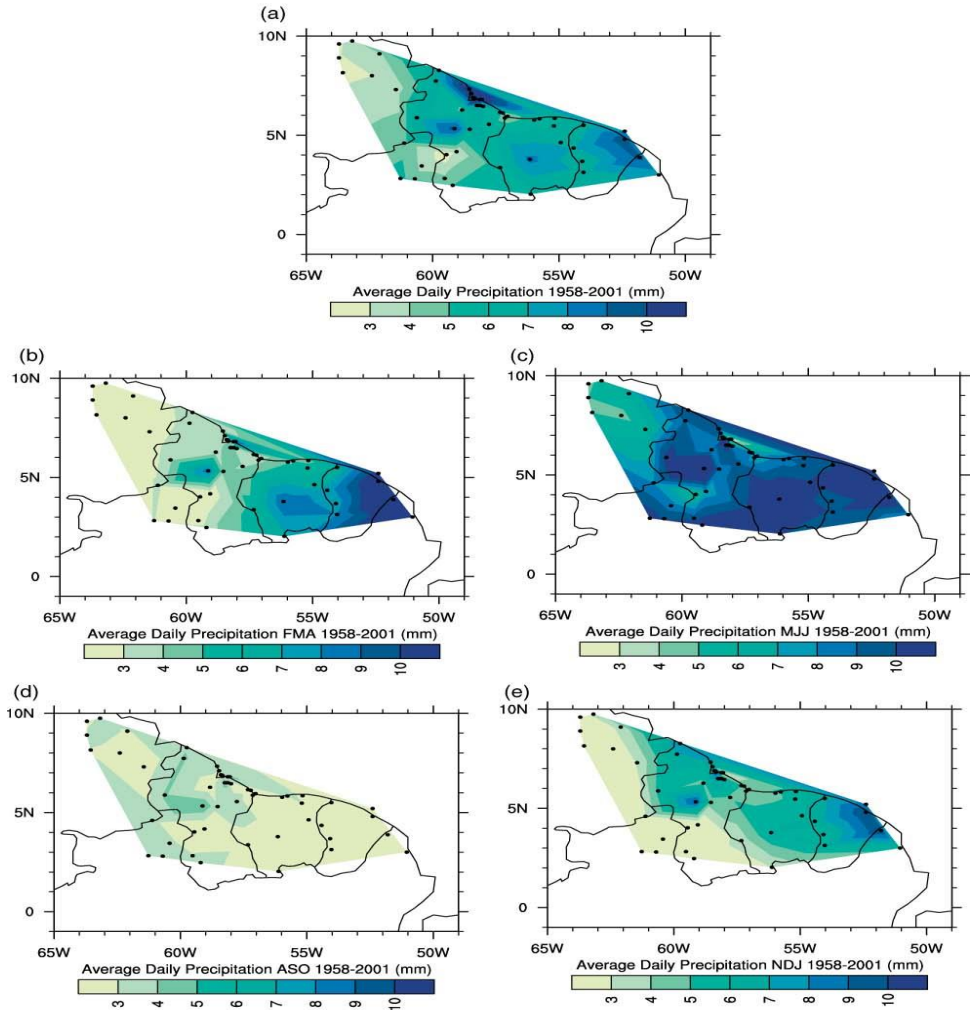
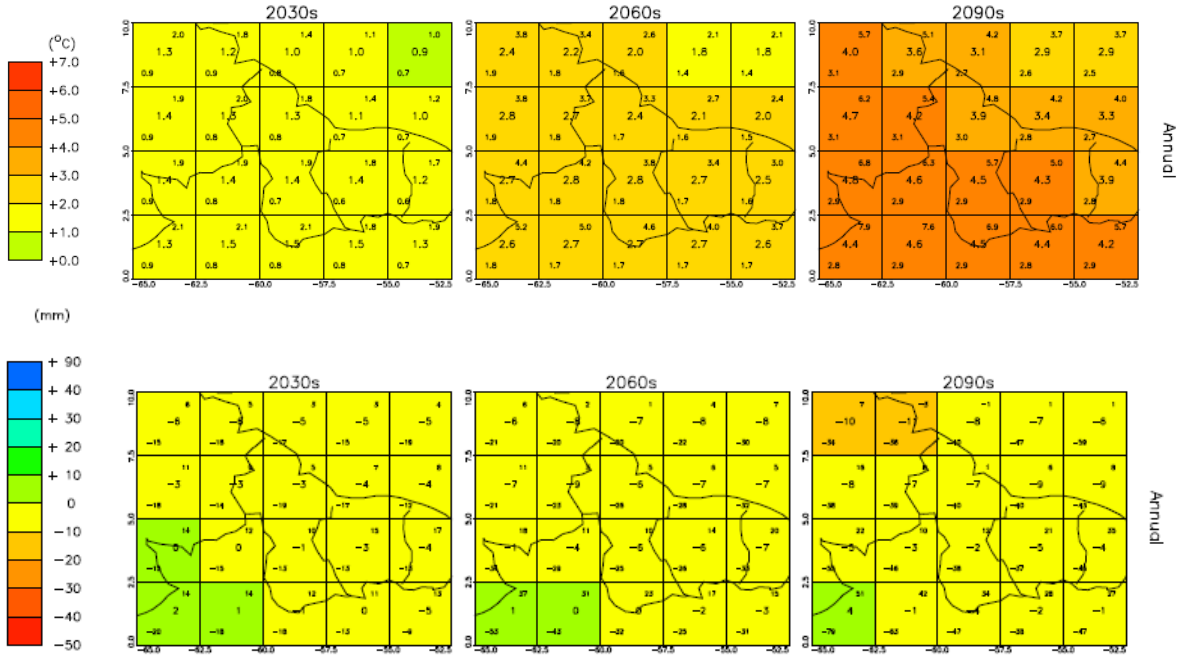


Figure 4: Spatial patterns of projected change in mean annual temperature and precipitation for 10-year periods in the future under the Special Report on Emissions Scenarios (SRES) A2 scenario[liv]. All values are anomalies relative to the mean climate of 1970-1999. In each grid box, the central value gives the ensemble median and the values in the upper and lower corners give the ensemble maximum and minimum. (Source: McSweeny et al., 2010[706]).



[liv]The SRES A2 scenario is a 'medium' marker scenario which assumes a heterogeneous world in which there is relatively slow demographic transition, slow convergence in inter-regional GDP per capita difference, slow end-use and supply side energy efficiency improvements, a delayed development of renewable energy and no barriers to using nuclear energy.

Glossary of terms

Adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects[707].

Adaptive capacity: The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences[708].

Baseline: The baseline (or reference) is the state against which change is measured. A baseline period is the period relative to which anomalies are computed[709].

Capacity: A combination of all the strengths and resources available within a community, society or organization that can reduce the level of risk, or the effects of a disaster. Capacity may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management[710].

Climate change: Refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use[711].

Climate change scenario: A coherent and internally-consistent description of the change in climate by a certain time in the future, using a specific modelling technique and under specific assumptions about the growth of greenhouse gas and other emissions and about other factors that may influence climate in the future[712].

Climate resilience: The capacity of an individual, community, or institution to dynamically and effectively respond to shifting climate impact circumstances while continuing to function at an acceptable level. Simply put, it is the ability to survive and recover from the effects of climate change. It includes the ability to understand potential impacts and to take appropriate action before, during, and after a particular consequence to minimize negative effects and maintain the ability to respond to changing conditions[713].

Climate variability: Refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability)[714].

Disaster: A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources[715].

Emissions: The release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time.

Extreme weather event: An event that is rare at a particular place and time of year. Definitions of 'rare' vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called 'extreme weather' may vary from place to place in an absolute sense. An 'extreme climate event' is an average of a number of weather events over a certain period of time, an average which is itself extreme (e.g., rainfall over a season)[716].

Greenhouse gas: Gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of terrestrial radiation emitted by the Earth's surface, the atmosphere itself and clouds. This property causes the greenhouse effect. Water vapour (H2O), carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4) and ozone (O3) are the primary greenhouse gases in the Earth's atmosphere[717].

Low regret: A low regret option is one for which the implementation costs are low, while the benefits under projected climate changes are potentially large[718].

Maladaptive: Maladaptive resilience building actions inadvertently increase vulnerability to climatic stimuli or involve spending a disproportionate amount of effort and investment focussed on resilience beyond what is required[719].

Mitigation (of climate change): A human intervention to reduce the sources or enhance the sinks of greenhouse gases[720].

No regrets: A no regrets option is one which would be justified under all plausible future scenarios, even in the absence of climate change[721].

Risk: The potential for consequences where something of value is at stake and where the outcome is uncertain, recognising the diversity of values[722]. Risk is often represented as probability of occurrence (likelihood) of hazardous events or trends multiplied by the impacts (consequence) if these events or trends occur.

Sensitivity: Is the degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g. a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g. damages caused by an increase in the frequency of coastal flooding due to sea level rise)[723].

Threshold: A property of a system or a response function, where the relationship between the input variable and an output or other variable changes suddenly. It can be important to identify thresholds, and other non-linear relationships, as these may indicate rapid changes in risk[724].

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity[725].

Win-win: A win-win action reduces the impacts of climate change/ greenhouse gas emissions and has other environmental, social or economic benefits[726]

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