The Virgin Islands

Climate Change Green Paper

Prepared by the Conservation and Fisheries Department,
Ministry of Natural Resources and Labour

Author: Angela Burnett Penn

August 2010

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Foreword

Honourable Omar W. Hodge
Minister for Natural Resources and Labour

Although we do not consciously think about it, climate shapes our world, and the relatively stable climate that has nurtured the growth of modern civilization is now changing quite rapidly.

The Caribbean region is one of the most threatened by the phenomenon known as climate change. Climate change is not just an environmental issue – it affects the foundations on which this Territory is built. Through various impacts to our natural resources, increases in severe weather events and disease, sea level rise and more, climate change will have serious consequences for our economy, way of life, health and wellness.

We, therefore, can not afford to simply wait and hope for solutions from the international community - we must be proactive and seek to develop strategies to adapt to climate change impacts now. The Virgin Islands *Climate Change Green Paper* is an important tool in charting our islands' response to climate change.

Climate change by its very nature requires a strong bottom-up or community approach. Government can not simply sit behind closed doors and decide what the problems are and the best solutions. A dialogue with the stakeholders most affected is integral to developing adaptation and education strategies that will actually be implemented and work.

I encourage everyone to read The Virgin Islands *Climate Change Green Paper* and become more informed about climate change, its local impacts and possible strategies for responding. Most importantly, armed with this information, I urge you to join the significant conversation about our collective future that is happening now by engaging in the climate change public consultation process.

PREFACE

THE GREEN PAPER – PURPOSE AND ORIGINS

Climate change affects us all and it takes an informed citizenry to react. *The Virgin Islands Climate Change Green Paper* has been produced to help the general public and policy makers learn more about the emerging issue of climate change and its projected impacts locally. It is also meant as a precursor to a *Climate Change Adaptation Policy and Strategy* for The Virgin Islands.

The *Green Paper* identifies and discusses the potential impacts of climate change locally, our vulnerabilities, adaptation options, and the Territory's capacity to respond.

It is hoped that the *Green Paper* will generate informal discussion about climate change and ultimately put the public and policy makers in a strong position to meaningfully contribute to the development of a *Climate Change Adaptation Policy and Strategy* through participation in an ongoing public consultation process.

The *Climate Change Adaptation Policy and Strategy* that is eventually developed out of the *Green Paper* is meant to ensure that the local impacts of climate change are minimised through proactive planning and protective measures. To be successful, the *Adaptation Policy and Strategy* should be fully integrated into Territory level planning and policy in all impacted sectors. In a practical sense, this means that managers and policy makers in tourism and finance, land and critical infrastructure planning, water and electricity, the environment, agriculture and fisheries, health and so forth should all be making decisions about the future with the realities of climate change in mind.

The *Green Paper* is an output of the Enhancing Capacity for Adaptation to Climate Change in the Caribbean UK Overseas Territories (ECACC) Project. The overarching goal of the Project is to build local capacity to plan and implement measures to adapt to climate change within the context of national development planning processes. ECACC provides funding for climate and ecosystem monitoring, vulnerability and capacity assessments, adaptation strategy development, and public education.

ECACC is a three (3) year initiative to be concluded in September 2010 being funded by the UK Department for International Development (DFID) and managed by the Caribbean Community Climate Change Centre (CCCCC). The Permanent Secretary of the Ministry of Natural Resources and Labour is serving as the National Focal Point for the Project and the Conservation and Fisheries Department is serving as the lead technical agency.

How to Read the Green Paper

The *Green Paper* has been written with the general public and policy makers in mind, yet contains a wealth of information useful for a technical audience.

The bulk of the main text of the *Green Paper* (Chapter 3.0) focuses on identifying and discussing potential and existing climate change impacts across key impact areas (such as tourism, agriculture, fisheries, water resources) identified for the Territory; the following chapter (Chapter 4.0) prioritises these climate impacts and impact areas. The main appendix (Appendix A) is a series of tables that set out adaptation options for each impact discussed in the main text, with Appendix B outlining opportunities and constraints that arise from the options discussed.

The other sections of the *Green Paper* provide background information that help to understand the discussion of the impact areas and adaptation options, and the local institutional, legal and management framework in which climate change adaptation will have to take place.

In the main text, each impact area is treated specifically in a separate sub-chapter, allowing a reader to skip directly to any area of interest, such as tourism or agriculture. Additionally, each impact area is discussed in a standard format starting with an introduction to the significance of the impact area, followed by an explanation of the potential and existing climate change impacts, and ending with a discussion of existing factors that complicate the climate change impacts or our ability to address them.

In Appendix A, the adaptation options are also presented in a standard format. Each impact area is treated in its own table in the same order as presented in the main text. Within each table, a series of adaptation options, supporting activities, and timelines are presented for each potential or existing impact identified for that impact area. This makes it easy for a reader to focus on the area or areas of interest.

Acknowledgements

The Conservation and Fisheries Department and Ministry of Natural Resources and Labour would like to thank all those Government Ministries, Departments and Statutory Bodies that reviewed and commented on various sections of The Virgin Islands *Climate Change Green Paper* including, British Virgin Islands Fisheries Complex, British Virgin Islands Tourist Board, Department of Agriculture, Department of Disaster Management, Environmental Health Unit, Financial Services Commission, Ministry of Health and Social Development, National Parks Trust, Town and Country Planning Department, and Water and Sewerage Department.

Gratitude is also expressed to the Caribbean Community Climate Change Centre (CCCCC), Belize, for the initial guidance provided in the preparation of this document. The Author would like to specially acknowledge Ms. Lynda Varlack, former Environmental Education Officer at the Conservation and Fisheries Department, for her significant initial contributions to this document.

INTRODUCTION

CLIMATE CHANGE – WHAT IS IT?

In basic terms, climate change is exactly what it sounds like - a change in the Earth's climate, the long term average weather conditions for various regions.

Climate change is an issue of much global debate, and has been described by many as "the defining challenge of our time". To provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences, the Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations. The IPCC defines climate change as

> "a change in the state of the climate that can be identified (e.g. 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. It refers to any change in climate over time, whether due to natural variability or as a result of human activity" (Pachauri, R.K., Reisinger, A. & Core Writing Team, 2007).

Over its extensive history, the Earth's climate has gone through many transformations. However, for the first time since modern civilization (which developed in a fairly stable climate) the Earth's climate is changing in a profound way – the average global temperature is warming at an unprecedented rate triggering changes in other fundamental aspects of our climate.

Over the 100 year period (1906-2005), average global temperatures increased by 0.74°C (1.33°F). By the end of this century, the year 2100, average global temperatures are expected to rise another 1.5°C – 5.8°C (2.7°F - 10.4°F) (Pachauri, R.K., Reisinger, A. & Core Writing Team, 2007; Taylor et al., 2007)

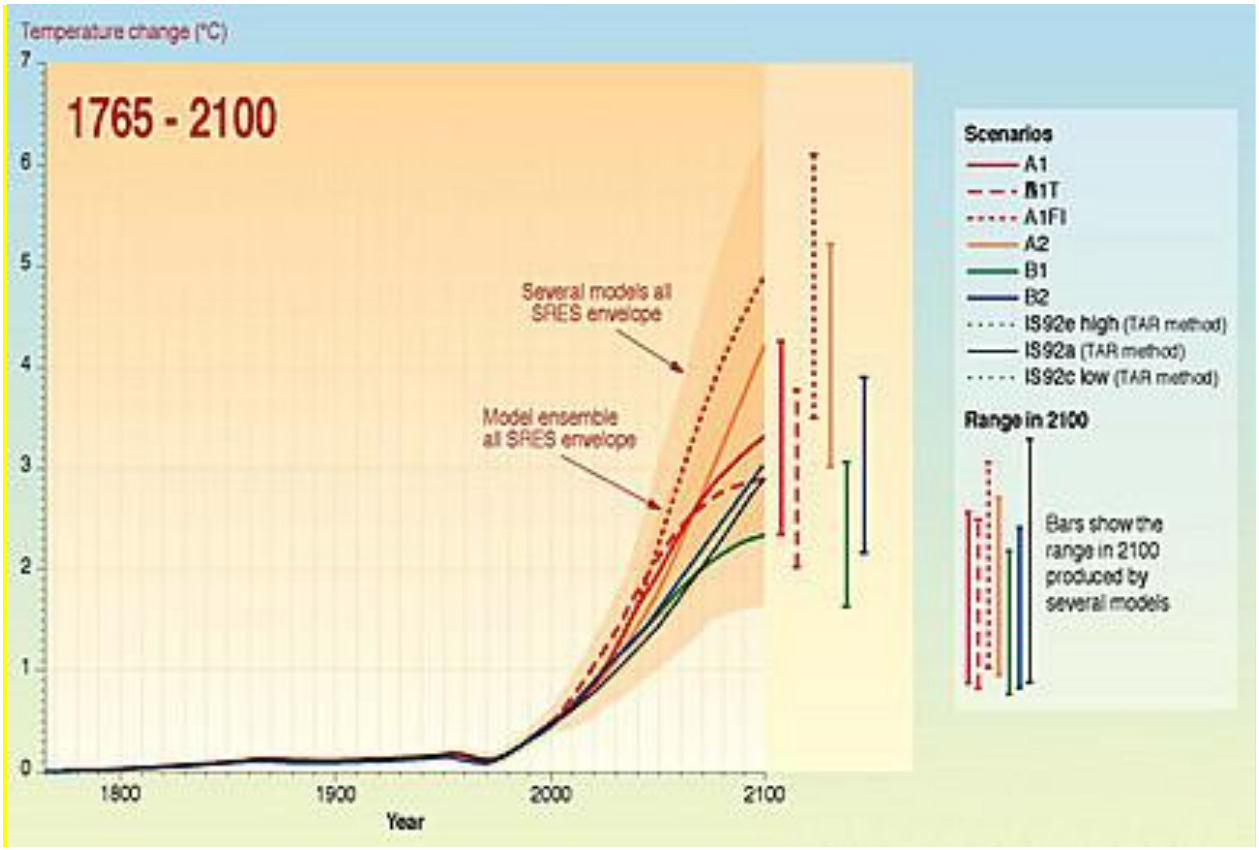


Figure 1. Past and predicted changes in average global temperatures under different greenhouse gas emission scenarios. *(Source: IPCC Third Assessment Report).*

While these figures may appear to be small, they are actually quite significant in the context of the global climate system where just a few degrees make a big difference in experiences on the ground. This warming characterises the current period of global climate change, thus the phenomenon is commonly referred to as global warming (CANARI, 2008 a).

The other novelty about present day *global climate change* is that humans are primarily responsible for the problem (UNFCCC, 2010).

Since the dawn of the Industrial Revolution (18th Century or 1700s), human activities related to fossil fuel-derived energy use in homes, industry and transportation, as well as agriculture and deforestation have been causing a rapid and excess buildup of carbon dioxide and other "greenhouse gases" such as methane in our atmosphere. These gases act as a huge invisible blanket that is trapping more and more of the sun's heat within the Earth's atmosphere, thus causing our average air and ocean temperatures to rise. This is called the enhanced greenhouse effect (UNFCCC, 2010).

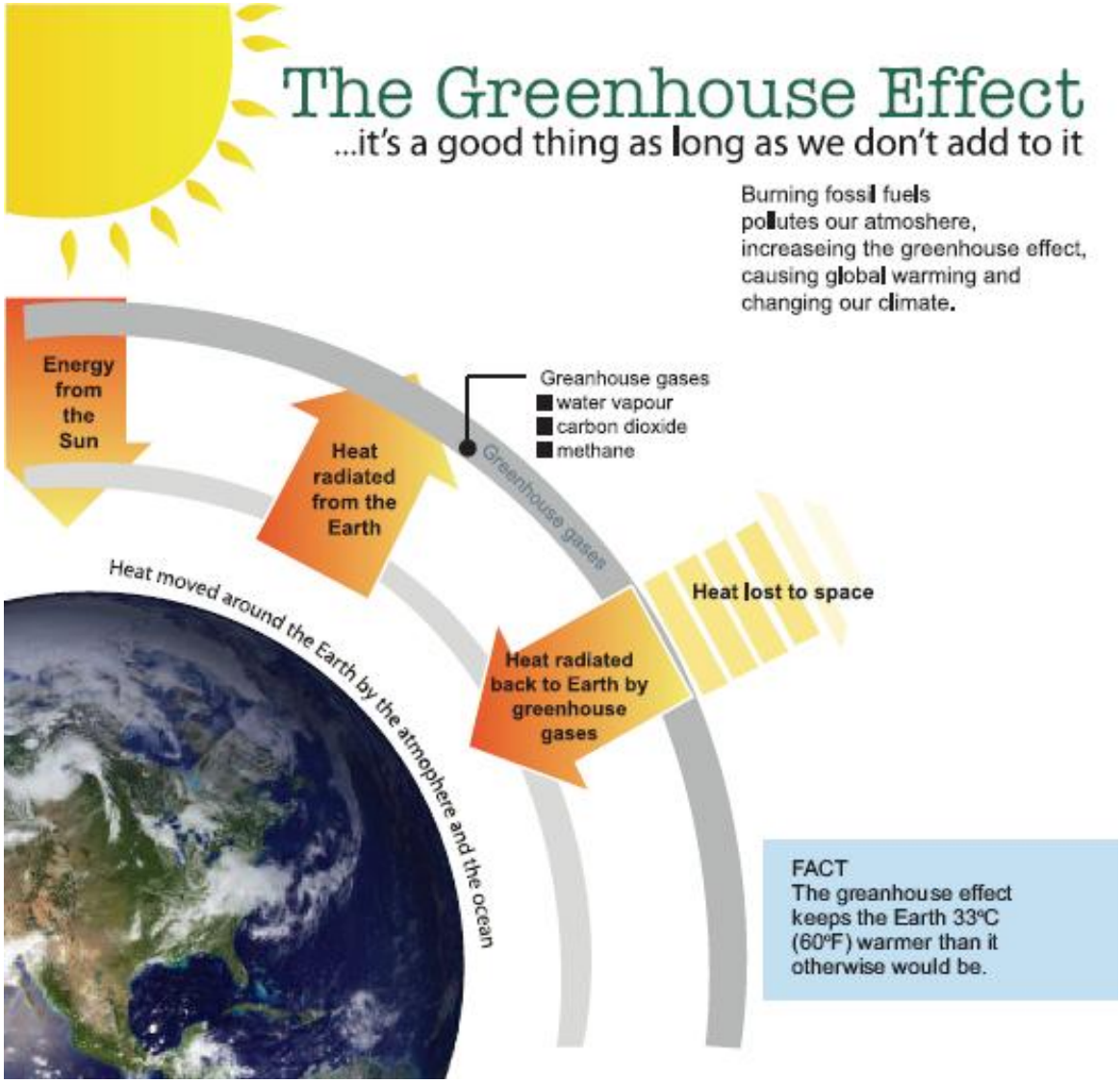


Figure 2. The Greenhouse Effect. Excess greenhouse gases (heating trapping gases such as carbon dioxide) in the atmosphere are causing the average temperature of the Earth to rise.

The science on climate change is clear. In their 2007 Synthesis Report, the IPCC states, "warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level" (Pachauri, R.K., Reisinger, A. & Core Writing Team, 2007).

Contrary to a popular misconception, the ozone hole is not responsible for climate change. There is a limited connection, however, in that in an attempt to fix the ozone hole, the approved replacement chemicals for chlorofluorocarbons (CFCs) (the cause of the ozone hole) produce greenhouse gases that contribute a small percentage to climate change.

Since temperature is a basic control of the Earth's climate, climate change is not just limited to increasing temperatures, but changes in other fundamental aspects of climate (UNFCCC, 2010).

In the Caribbean region the projected changes of most concern include:

- ***Rising temperatures***
- ***Decreasing overall rainfall,* accompanied by a *change in rainfall patterns such that more, heavier rain events and thus floods are likely***
- ***Stronger, more persistent and devastating hurricanes***
- ***Rising sea level***

Some changes are already being experienced to varying degrees and will continue to intensify as described under the *Projected and Existing Changes in Climate* section.

WHY CARE ABOUT CLIMATE CHANGE?

The Virgin Islands, like all small island developing states, is among the countries that will be the first and worst affected by climate change, as identified by the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC).

The Virgin Islands, like all of the Caribbean, is climate sensitive. Whether we are consciously aware of it, our lives and livelihoods revolve around or are closely linked to climate – temperature, rainfall patterns, humidity, the trade winds, and severe events including drought, floods and hurricanes.

Nearly all of our main economic activities (tourism, fisheries, and agriculture) have been developed around traditionally dependable patterns in these key elements of climate or are impacted by climatic events – droughts, floods and hurricanes. We also find that climate has strongly influenced our infrastructure and construction style, our choice of recreation as well as our health and well-being.

Taking tourism as an example, a fundamental element of the product is our relatively stable tropical climate, constantly moderated by the Northeast Trade Winds. Our tourism attractions, primarily nature-based, are directly impacted by even slight changes in weather and cycles of extreme events – coral reefs can bleach with just a 1-2 °C (1.8-3.6 °F) rise in ocean temperature above the normal maximum and beaches are highly prone to erosion due to hurricane events and long-term sea level rise.

In terms of infrastructure and construction style, developments have traditionally not taken into account appropriate building standards, drainage, elevation, and set-back considerations to deal with regular floods, strong hurricanes and storm surges and sea level rise. Tourism infrastructure and properties, in particular, are concentrated in the low-lying coastal zone where they are very vulnerable to these climate change impacts.

Because The Virgin Islands economy and society are so dependent on a relatively stable climate it is highly vulnerable to changes in climate – that is, the present phenomenon known as *global climate change*.

The Virgin Islands is aware of this inherent sensitivity when we experience short term abrupt changes such as droughts and floods, hurricanes, and unusually hot days and nights. While changes over the long-term occur more slowly, they are more permanent, and unless we take adequate measures to prepare, we remain equally or perhaps more vulnerable to long-term changes in climate such as decreased total rainfall by up to 25% by the 2080s and sea level rise possibly up to 1.9 feet by the end of the Century. Importantly, predictions about long-term changes in climate include a tendency towards more frequent and or higher impact extreme climatic events, particularly floods and hurricanes.

CLIMATE CHANGE IMPACT AREAS

The following areas have been identified as aspects of the Territory that could be seriously impacted by climate change.

Figure 3. Climate change impact areas.

THE VIRGIN ISLANDS VULNERABILITY AND ADAPTATION POTENTIAL

While climate change impacts are diverse and costly they are also manageable, in most cases through implementation of a variety of well-established environment and development best management practices, and strengthening of existing legislation, policies, institutions and programmes.

The topography of The Virgin Islands, characterised by steep hills and limited flat lands in the interior, has resulted in the majority of the Territory's critical infrastructure and settlements being located in the low-lying coastal zone. This, together with the Territory's small size, limited capacity, narrow economic base, and strong dependence on tourism, which is built around fragile coastal and marine resources, makes the islands highly vulnerable to the impacts of climate change.

Studies, including the Stern Review on the Economics of Climate Change have proven that "the benefits of strong and early action [on climate change] far outweigh the economic costs of not acting" (Stern, 2007).

Some of the major constraints that will have to be faced in the adaptation process include, limited financial and human resources, and creating legislative and systemic reforms that institutionalise and integrate climate change adaptation into the Territory's development policies and planning.

If The Virgin Islands continues to take sustained and early action on addressing climate change, while impacts will be incurred, they can be significantly minimised. In the process the Territory can take advantage of the opportunities presented to improve environmental management and the development planning process, reduce our inherent vulnerabilities to natural disasters and external shocks, diversify our tourism and energy portfolios, and ultimately increase our security and long-term viability.

EXECUTIVE SUMMARY

THE VIRGIN ISLANDS CONTEXT

The Virgin Islands is comprised of about 60 islands, cays, and rocks that rise from the Puerto Rican Shelf with a total land area of 154 square kilometres (59 square miles).

With the exception of the limestone island of Anegada, the islands are dominated by hilly ridges; flat land is scarce and is concentrated in the valley bellies and the narrow coastal zone.

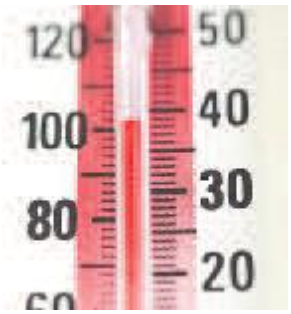
The climate is subtropical, moderated by the Northeast Trade Winds and has a distinguishable wet and dry season. Located directly in the hurricane belt, tropical cyclones are a significant climatic threat while, until recent years, flooding and landslides were traditionally not a concern outside of hurricane events.

The Virgin Islands has at least four (4) distinctive vegetative communities - moist forests, dry forests, woodlands, and shrublands that support a diverse group of animals, including island endemics. Coastal and marine habitats are particularly important and primarily include salt ponds, mangroves, beaches, seagrass meadows, and coral reefs and are home to an extremely diverse marine wildlife community.

The Virgin Islands enjoys a relatively stable and prospering service-based economy, dominated by tourism and the financial services sectors. In 2008, tourist expenditure was estimated at some $552.43 million; the industry accounts for a significant percentage of gross domestic product (GDP) and employment. There are 16 inhabited islands in The Virgin Islands with a total population estimated at 28,882 in 2009. Between 1984 and 1994 the population doubled, largely due to immigration; today population growth and immigration continue to be rapid (DPU, 1999; DPU, 2009b).

PROJECTED CHANGES IN CLIMATE

In the Caribbean region the projected changes of most concern include:



Rising temperatures

1°C - 5°C (1.8°F – 9°F) warmer by the 2080s under the Medium-High Carbon Emissions Scenario (Taylor et al., 2007);

Changing rainfall patterns

Up to 25% drier by the 2080s under the Medium-High Carbon Emissions scenario, accompanied by a *change in rainfall patterns such that more, heavier rain events and thus floods are likely* (Taylor et al., 2007);

Stronger, more persistent and devastating hurricanes

A greater likelihood of category 4 and 5 hurricanes as is already being observed (Mimura et.al, 2007).

Rising sea level

0.19 – 0.58 metres (0.6 – 1.9 feet) higher sea level by 2100 as a result of warmer ocean temperatures and melting polar glaciers (Mimura et.al, 2007).

CLIMATE CHANGES HAPPENING NOW

While the changes described above would be most noticeable later this century, changes are happening continuously and are already being experienced to varying degrees and will continue to intensify.

- January 2000 to December 2009 was the warmest decade on record globally since precise measurements began in 1880 (NASA, 2010).

- The percentage of days in the Caribbean region having very warm maximum or minimum temperatures has increased considerably since the 1950s, while the percentage of days with cold temperatures has decreased (Taylor et al., 2007).

- Many islands across the Caribbean are experiencing generally drier conditions, but more episodes of heavier rain events resulting in flooding (Taylor, et al., 2007). Records show that the frequency of droughts has "increased significantly" since 1960 and flood events have increased since the mid 1990s (Taylor et al., 2007). From October 2009 to at least May 2010, the majority of Caribbean islands experienced severe drought, the worst ever seen in many cases (BBC, 2010).

- Over the period 1990-2004 compared to the period 1975-1989, the number of categories 4 and 5 storms in the South-West Pacific has more than doubled. While the trend has not been as strong in the Caribbean basin, there has been an increase in hurricane activity since 1995 compared to the 1981-2000 baseline, with all except two Atlantic hurricane seasons having above normal activity (Mimura et.al, 2007).

- Finally, the average global sea level has been rising steadily, at an average rate of 1.8 mm/yr since 1961 and at an increased rate of 3.1mm/yr since 1993 (Pachauri, R.K., Reisinger, A. & Core Writing Team, 2007).

POTENTIAL AND EXISTING CLIMATE CHANGE IMPACTS

Given the diversity of impacts, it can not be overemphasised that climate change is everyone's business and a cause for concern and action at every level.

Small islands will be among the first and worst affected by climate change as recognised by the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC (CANARI, 2008 b; Mimura et al., 2007; UNFCCC, 2007).

Based on the work of the IPCC and local experiences, the potential and existing impacts across various aspects of the Territory (referred to in this Paper as "impact areas") have been identified and are summarised in Table 1 below and explained in detail in the body of the Green Paper.

IMPACT AREAS	POTENTIAL AND EXISTING CLIMATE CHANGE IMPACTS
BEACH & SHORELINE STABILITY	✓ Increase in beach erosion and shrinkage. ✓ Shorelines retreating and more vulnerable to flooding.
COASTAL & MARINE ECOSYSTEMS	✓ Coral reefs experiencing increased bleaching, structural damage, disease and death. ✓ Landward migration or inundation of mangroves and increased mortality. ✓ Decreased growth of seagrass beds and increased stress and mortality.
CRITICAL INFRASTRUCTURE	✓ Road network, critical facilities, utilities, developable lands and the sewerage system (especially coastal) at greater risk of damage.
HUMAN SETTLEMENTS	✓ Homes and developable lands (especially those in the coastal zone) at greater risk of damage.
ENERGY SECURITY	✓ Energy generation and distribution system at greater risk of damage. ✓ Increase in energy costs. Increase in energy use for cooling.
FOOD SECURITY: AGRICULTURE	✓ Decrease in agricultural yield (or increased costs of production) due to decrease in rainwater. ✓ Increase in agricultural pests, weeds, diseases and invasive species. ✓ Soil degradation, resulting in reduced yield. ✓ Increase in crop damage and disruption of production cycles. ✓ Increased stress to livestock, resulting in decreased productivity. ✓ Changes in imported food availability, cost and quality.

FOOD SECURITY: FISHERIES	✓ Loss of critical fish habitat and changes in plankton food resources. ✓ Migration of some fish species to cooler waters. ✓ Potential changes in spawning opportunities and rates of mortality and disease. ✓ Increase in opportunities for establishment of marine invasive species. ✓ Increased damage to landing sites, on-shore facilities, boats and equipment.
FORESTRY & BIODIVERSITY	✓ Decline in health and abundance of marine resources. ✓ Decline in turtle nesting activity and creation of long-term reproduction issues. ✓ Shrinking upland forests and reduction of associated biodiversity. ✓ Disruption of bird migration and reproduction patterns. Increased mortality. ✓ Increase in opportunities for establishment of invasive species.
HUMAN HEALTH	✓ Increase in Dengue Fever outbreaks (frequency and severity). ✓ Increase in prevalence of ciguatera (fish poisoning). ✓ Increase in respiratory diseases, such as asthma. ✓ Increase in risk of diarrhea and other environmentally transmitted illnesses. ✓ Increased potential for heat stress. ✓ Increase in risk of damage to health care facilities. ✓ Greater threat of epidemics and pandemics.
INSURANCE & BANKING	✓ Increased insurance rates, potentially leading to uninsurance/under-insurance. ✓ Increase in interest rates and difficulty in obtaining construction loans.
TOURISM	✓ Loss of, or more costly damage to, tourism infrastructure and properties. ✓ Degraded natural attractions, e.g. coral reefs, beaches and wildlife, resulting in reduced demand by tourists. ✓ Rising overheads in energy, water and insurance. ✓ Deterrents to travelers, e.g. warmer winters, less comfortable and stable VI climate, higher airfares and increased Dengue Fever outbreaks. ✓ More tourists seeking carbon neutral or energy efficient destinations.
WATER RESOURCES & HYDROLOGICAL CHARACTERISTICS	✓ Increase in likelihood of flood events. ✓ Decreased rainwater, leading to greater dependency on the desalinated public water supply and an increased threat of water shortages in emergencies. ✓ Increase in cost of desalinated water.

Table 1. Potential and existing climate change impacts.

INSTITUTIONAL, LEGAL & MANAGEMENT ARRANGEMENTS FOR RESPONDING

Adapting to climate change will require an ongoing collaborative effort between Government, the private sector and communities.

There are at least seventeen (17) Government Departments and Statutory Bodies among all five Ministries and the Governor's Office that will be integral in the Territory's adaptation to climate change. The capacity of these to respond is limited by technical expertise, funding and equipment, law enforcement powers, relatively weak data collection and management systems, and poor communication and information flow.

In addition, there are several Territory level inter-agency committees or bodies whose portfolios allow them to have a direct influence on policies and decisions relevant to climate change adaptation. These are the Inter-agency Planning Review Committee (Pre-Planning Authority), Planning Authority, Building Authority, Technical Review Committee, Health Services Authority, and Disaster Management Council.

There is a lot to be desired in the legal framework, especially that governing the environment and physical development. The Law Reform Commission has identified environmental law as one of the priority areas for reform and towards that end has drafted a comprehensive Environmental Management and Conservation of Biodiversity Bill (2008) still up for review by the House of Assembly. The Bill fills many existing gaps in coastal resources protection and waste management, and if passed would go a long way towards improved environmental management and climate change adaptation.

The Building Regulations, 1999 and Development Control Guidelines, 1972 currently in use are outdated; however, new planning regulations are being formulated to accompany the Physical Planning Act 2004. Enforcement of planning and building legislation is in need of improvement.

Key existing management plans, policies and processes in the areas of the environment, physical planning and disaster management are:

- National Integrated Development Strategy (NIDS; 1999-2003)
- National Environmental Action Plan (NEAP, 2004)
- Protected Areas System Plan (2007-2017)
- Physical development approval process (inclusive of an environmental impact assessment, EIA, process)
- National Disaster Plan (2009)
- Disaster Mitigation and Development Planning Framework (2002)

Key management gaps in these areas are:

- A comprehensive Coastal Management Plan
- Specific management plans for beaches (work is currently ongoing in this area)
- A sustainable management programme for fish stocks
- Management plans for Fisheries Protected Areas
- A comprehensive Land Use and Physical Development Plan inclusive of zoning (draft prepared in 2009)

TOWARDS AN ADAPTATION STRATEGY

Locally, many institutions, a body of legislation, policies and programmes exist and can be built upon to ensure effective climate change adaptation, which in large part boils down to seriously implementing the measures and precautions long identified to protect ecosystems, build resilience in key industries, and develop wisely, especially in the coastal zone (CANARI, 2008 a).

Climate change ***adaptation*** refers to any action to minimise or adjust to the local impacts (as described above) of climate change (UNFCCC, 2009 a). While there is some overlap, it is distinct from climate change ***mitigation*** which refers to efforts to tackle the cause of climate change, that is, to reduce the amount of "greenhouse gases" in our atmosphere (UNFCCC, 2009 b).

In 2009, CARICOM signed the Liliendaal Declaration on Climate Change and Development that prioritises adaptation while insisting that mitigation be part of the regional climate change strategy (CARICOM, 2009).

The *Climate Change Green Paper* is intended to facilitate the creation of The Virgin Islands *Climate Change Adaptation Policy and Strategy* through a series of public consultations in 2009 and 2010 in which stakeholders will help to crystallise specific sectoral climate change impacts, prioritise impacts and develop appropriate strategies for responding. The resulting draft *Climate Change Adaptation Policy and Strategy* (White Paper) will be submitted to Cabinet for approval. If approved, it should affect all relevant decision making processes to deliver on the vision of sustainable development (expounded on in the Green Paper) given the new reality of climate change. Heightened public knowledge will be critical in building support for proactive adaptation measures.

While the science of climate change adaptation is still developing, there are some established principles. Adaptation measures should:

- preferably be "no regrets" measures that are necessary or beneficial in any event,
- be SMART (specific, measurable, achievable, realistic, and time bound),

- take an ecosystem-centred approach,
- consider the many interacting issues,
- be in harmony with each other,
- promote the integration of new technologies, and
- be integrated / mainstreamed into sectoral and Territory-level management plans and decision making.

The full cost climate change adaptation is still being assessed for the Caribbean. What is known, however, is that climate change impacts will be extremely expensive and that it is more cost effective to adapt early than to accept losses (CANARI, 2008 a).

Analysis from the Caribbean has shown that reconstruction costs can be as much as 40% of the original investment (CANARI, 2008 a). A World Bank report, for example, roughly estimates that the Caribbean could spend $1.3 billion by 2050 replacing hotel rooms lost as a result of sea level rise alone (Margaree Consultants, 2002). It is also well established that adaptation measures should be taken as early as possible to minimise associated costs and maximise effectiveness.

Adaptation to climate change will require a sustained input of resources (financial, technological, and human) above that available locally. The Territory's constitutional status, however, excludes access to the billions of dollars and other assistance provided by the international community under the United Nations Framework Convention on Climate Change (UNFCC). There is, therefore, a need for the United Kingdom to support a long-term programmatic approach to addressing climate change in the Overseas Territories. The Virgin Islands, however, should be proactive in its own interest by looking inward for adaptation financing opportunities.

CLIMATE CHANGE ADAPTATION OPTIONS

The following table summarises the general guiding climate change adaptation principles and specific adaptation options proposed for each impact identified across the twelve (12) impact areas.

Impacts highlighted with 3, 2, or 1 yellow stars have been identified by stakeholders as first, second and third tier priorities for action, respectively. That is, an impact with 3 stars is a first tier priority and so forth. Adaptation options have been developed in collaboration with respective Government agencies and refined with input from the public stakeholder consultation process thus far. Each option is rated as either a "preferred action" (PA), "acceptable alternative" (AA), or "last resort action" (LRA). In Appendix A these adaptation options are expounded on, including identifying the relevant adaptation category, supporting activities, and time-frame for action.

Impact Areas and Potential and Existing Climate Change Impacts	General Guiding Adaptation Principles and Specific Adaptation Options
BEACH & SHORELINE STABILITY	✓ Avoid undermining natural beaches/shorelines or creating vulnerable man-made ones. ✓ Protect beaches and vulnerable shorelines with natural defences where practical. ✓ Allow for natural adjustments in beaches/shorelines as sea level rises, unless it would pose danger or too significant a loss.
☆ Sea level rise and stronger hurricanes and storm surges causing: - Increased beach erosion and shrinkage; - Shoreline erosion and increased flood risk to low-lying coastal areas.	• Develop and implement beach management plans. (PA) • Increase beach monitoring activities. (PA) • Increase fines for violations of the Beach Protection Ordinance. (PA) • Improve and strictly enforce planning and building laws/regulations, especially increasing coastal development setbacks. (PA) • Educate construction industry about environmentally-friendly practices for the coast. (PA) • Encourage (incentives, ideas) "soft" developments along beaches/vulnerable shorelines. (PA) • Increase protection and restoration of shallow reefs that act as coastal defences. (PA) • Strongly protect all remaining significant mangrove forests. (PA) • Invest in "soft" protective measures (such as mangroves) along vulnerable shorelines. (PA) • If necessary, invest in "hard" engineering structures along vulnerable shorelines. (LRA) • Beach re- nourishment (mechanically replace beach sand that has eroded). (LRA) • Where practical, elevate critical, undeveloped, low-lying shorelines to buffer them from erosion/flooding resulting from sea level rise. (LRA)
COASTAL & MARINE ECOSYSTEMS	✓ Enhance the resilience and natural adaptive capacity of coastal and marine ecosystems by increasing protections and reducing local impacts.
☆☆☆ Coral reefs experiencing increased bleaching, structural damage, disease and death due to increased ocean temperatures, ocean acidification, and more intense hurricane events and storm surges.	• Improve management of Marine Protected Areas (MPAs). (PA) • Implement a rotating system of closure (recovery periods) for reefs. (PA) • Decrease damage from divers and snorkelers by introducing mandatory orientations. (PA) • Decrease anchor damage - mandate an orientation for skippers and bareboat charters, implement stricter controls on mega yacht/small cruise ship anchoring, and increase capacity and maintenance of the buoy system and mandate its use. (PA) • Decrease sedimentation – require timely paving of roads/driveways, create permit system for the regrading of roads and land clearing, restrict vegetation clearing to the construction footprint and require timely landscaping, and improve capture and reuse of stormwater. (PA) • Decrease marine nutrient pollution - improve sewage management through constructing tertiary treatment systems and pump out stations. Decrease agricultural runoff. (PA) • Increase monitoring of coral reefs. (PA) • Increase public awareness about coral reefs. (PA) • Develop coral nurseries to repair damaged reefs and rear species resilient to bleaching. (PA) • Create artificial reefs where suitable. (AA) • Use low-voltage electrical current to stimulate coral reef regrowth (AA).

Landward migration or inundation of mangroves. Increase in mortality from stronger hurricanes.	• Strongly protect all remaining significant mangrove forests. (PA) • Expand and enhance the mangrove re-forestation programme. (PA) • Land use planning to allow room for landward migration of mature mangrove forests. (PA) • Shelter young mangroves from storm surges by protecting natural coral reefs and, where suitable, constructing artificial reefs in priority areas. (PA)
Decreased growth of seagrass beds and increased stress and mortality.	• Enhance legal protections for seagrass beds. (PA) • Protect seagrass beds from high-energy waves by protecting coral reefs. (PA)
CRITICAL INFRASTRUCTURE	✓ Enhance the resilience of existing critical infrastructure to climate impacts. ✓ Avoid building new infrastructure in areas or with materials vulnerable to climate hazards.
Road network (especially coastal) at greater risk of damage from floods, stronger storm surges, and sea level rise.	• Improve drainage of roads and surrounding areas, especially in flood prone areas – improve road drainage design and construction; improve land use planning; minimise land clearing and creation of impervious surfaces; utilise pervious concrete or porous pavement; and clean, prune and monitor ghuts instead of lining with concrete. (PA) • Start concerted reforestation programme to reduce storm water run-off and erosion. (PA) • Reinforce undermined roads and improve road cutting techniques. (PA) • Continue to build safe, high volume alternative road network through islands' interior. (PA) • Avoid building new roads in areas vulnerable to stronger storm surges and sea level rise. (PA) • Elevate critical areas of the coastal road network that are particularly vulnerable (where no alternative route exists/ is feasible). (LRA)
Critical facilities and developable lands (especially those in the coastal zone) at greater risk of damage from floods, stronger hurricanes and storm surges, and sea level rise.	• Improve drainage around critical facilities and developable lands through the measures described above for roads. (PA) • Ensure "climate-proof" structures by improving construction standards - overhaul outdated building regulations, retrofit existing structures, and improve surveillance and enforcement of planning and building laws/regulations and approval conditions. (PA) • Ensure adequate insurance of critical facilities against climate hazards. (PA) • Enhance hurricane preparedness of critical facilities.(PA) • Improve management of and increase the Disaster Relief Fund. (PA) • Increase minimum elevation requirement above the high water mark for reclamations. (PA) • Plan for future relocation of facilities at risk to sea level rise and stronger storm surges. (PA) • Invest in "soft" measures (e.g. mangroves) to protect existing vulnerable facilities and developable lands. (PA) • Where feasible, in highly vulnerable areas, establish "no build areas" for critical facilities. (PA) • If "no build area" is unfeasible, mandate proper elevation of buildings' foundations and other safeguards in vulnerable areas. (AA) • If necessary invest in 'hard" engineering structures (e.g. sea walls) to help protect existing vulnerable critical facilities. (LRA)

Critical utilities at greater risk of damage from floods, stronger hurricanes and storm surges, and sea level rise.	• Improve drainage around critical utilities, e.g. the main electricity generation plant at Pockwood Pond. (PA) • Continue to improve construction standards. (PA) • Bury electrical lines where determined to be strategic. (PA) • Plan for future relocation of utilities at risk to sea level rise and stronger storm surges. (PA) • Avoid siting buildings for critical utilities in vulnerable areas. (PA)
Sewerage system at greater risk of damage from stronger storm surges and floods.	• Minimise stormwater entering sewerage collection system through improved drainage. (PA) • Implement the National Sewerage Plan – including overhaul of the sewerage system in the greater Road Town area to handle large volumes of stormwater in flood events, and use of water-tight manholes and materials able to withstand stronger storm surges. (PA)
ENERGY SECURITY	✓ Enhance the resilience of the electricity generation and distribution system. ✓ Implement policies to reduce energy use and encourage greater energy independence.
Electricity system at greater risk of damage from floods, stronger hurricanes and storm surges, and sea level rise.	• Improve drainage around the main electricity generation plant at Pockwood Pond. (PA) • Ensure existing and new facilities are "climate ready."(PA) • Bury electrical lines where determined to be strategic. (PA) • Plan for the future relocation or retrofitting of electricity generation stations and sub-stations that will be inundated by sea level rise and stronger storm surges. (PA) • Avoid siting new electrical stations in vulnerable areas. (PA)
Increase in fossil fuel derived energy costs. Increase in energy use for cooling.	• Diversify energy portfolio to include alternative energies (especially solar and small wind). (PA) • Start Territory-wide solar water heater programme. (PA) • Implement energy conservation policies and programmes. (PA) • Develop and enforce energy efficiency standards. (PA) • Incorporate "green" design into buildings, e.g. natural cooling and lighting systems. (PA) • Encourage use of more efficient cooling systems (and proper maintenance of systems). (PA)
FOOD SECURITY: AGRICULTURE	✓ Expand and increase resilience of local agricultural production (with policies that encourage water efficiency, environmental sensitivity, technology and local capacity building).
Decrease in agricultural yield (or increased cost of production) due to decreased overall rainfall.	• Increase efficiency of irrigation systems and techniques. (PA) • Use water conservation measures and mulching practices. (PA) • Enhance infrastructure for water capture and storage for agricultural purposes. (PA) • Integrate less water intensive methods, e.g. greenhouses and organic recirculation hydroponics. (PA) • Focus on drought-resistant and high value crops. (AA) • Enhance use of groundwater resources for farming. (AA)

Increase in agricultural pests, weeds, diseases and invasive species due to increased concentrations of carbon dioxide (CO_2), warmer soils and changes in humidity. Increased stress to livestock from heat, drought and disease.	• Develop standard protocol for responding to pests, diseases and invasive species, including a good reporting and alert system. (PA) • Develop and practice methods of Integrated Pest Management. (PA) • Insure crops, livestock and poultry against outbreaks of pests, diseases etc. (PA) • Introduce organic recirculation hydroponics for high value vegetables such as tomatoes. *(Hydroponics aids by isolating crops from the soil, thus reducing exposure to diseases, pests, weeds, etc. and has additional advantages such as reduced water, fertiliser, pesticide and land area demand).*(PA) • Depend more heavily on agriculture in controlled environments (e.g. greenhouses, organic recirculation hydroponics, poultry units, small stock units, feedlots and dairy units). (PA) • Introduce more pest resistant crop varieties (and keep traditionally resistant varieties). (AA)
Soil degradation from saltwater intrusion and soil erosion / leaching, resulting in decreased yields.	• Encourage best management practices for erosion control. (PA) • Introduce greenhouses and organic recirculation hydroponics for high value vegetables. (PA) • Where feasible, introduce more salt-tolerant crop species. (AA) • Abandon unproductive or flooded agricultural lands. (LRA)
Crop damage and disruption in agricultural production from stronger hurricanes, droughts and floods.	• Insure crops against natural disasters. (PA) • Diversify crops to include those less vulnerable to wind damage. Use natural windbreaks. (PA) • Implement changes in planting schedules, where feasible. (PA) • Continue use of the McDonald Almanac Guide. (PA) • Integrate use of controlled environments (e.g. greenhouses, and poultry and dairy units). (PA) • Invest in hurricane resistant storage facilities for produce and equipment. (PA) • Improve drainage of agricultural lands, especially the Agricultural Station. (PA) • Improve hurricane preparedness measures. (PA)
Changes in imported food availability, cost, and quality.	• Work towards greater agricultural self-sufficiency. (PA)
FOOD SECURITY: FISHERIES	✓ Place greater emphasis on protection of fisheries habitat and sustainable fisheries practices.
☆☆ Degradation of critical fish habitat and changes in plankton food resources.	• Enhance protection of mangrove forests and seagrass beds • Stricter controls on fishing techniques and marine recreational activities that impact coral reefs. (PA) • Tighter enforcement against illegal fishing and overfishing. (PA) • Reduce stress on natural habitats and fish stocks through sustainable aquaculture and aquaponics. (AA)

☆ Migration of some fish species to cooler waters.	• Develop fisheries that are less temperature sensitive or that will become more favourable as climate changes. (PA)
Increase in opportunities for establishment of marine invasive species.	• Develop an invasive species reporting system, early warning system and a standard response protocol. (PA)
Increased damage to landing sites, on-shore facilities, boats and equipment.	• Construct new landing sites and onshore facilities (and retrofit existing ones) to withstand stronger hurricanes and storm surges and sea level rise. (PA) • Insure fishing vessels and equipment against natural disasters. (PA) • Improve hurricane preparedness measures. (PA)
FORESTRY & BIODIVERSITY	✓ Enhance protection of wildlife and associated habitats. Engage in habitat restoration. ✓ Add value to wildlife preservation through tourism.
☆☆☆ Decline in health and abundance of marine resources.	• Pass the draft Environmental Management and Conservation of Biodiversity Bill. (PA) • Improve management of Marine Protected Areas (MPAs). (PA) • Work with neighbouring islands to create protected migration corridors for marine species in the Caribbean basin. (PA)
Decline in turtle nesting activity and long-term reproduction issues.	• Minimise beach development, beach erosion and marine habitat loss. (PA) • Develop contingency plan to rescue and relocate or incubate turtle nests that could be flooded by the sea. (LRA)
☆☆☆ Shrinking upland forests and reduction of associated biodiversity.	• Conduct a forest/terrestrial biodiversity inventory. Expand protected areas to target vulnerable species and sensitive areas. (PA) • Restrict vegetation clearing to construction footprint and require timely landscaping with primarily native species. (PA) • Enhance legal protection and management of remaining forested areas. (PA) • Start concerted reforestation programme.(PA) • Develop bird watching trails and lookouts as a key tourist attraction. (PA)
Bird migration and reproduction patterns disrupted. Increased mortality.	• Enhance protection of bird stopover habitats such as salt ponds and mangroves. (PA) • Reduce introduced bird egg predators such as cats, rodents and mongoose. (PA)
Increased invasive species.	• Develop invasive species reporting and early warning system and standard response protocol. (PA)

HUMAN HEALTH	✓ Emphasise preventative versus treatment approach for impacted health issues. ✓ Increase the resilience of the population to health impacts. ✓ Enhance the capacity of the health care sector.
Increase in Dengue Fever outbreaks (frequency and severity)	• Build strong community cooperation in reducing mosquito breeding grounds. (PA) • Encourage the incorporation of mosquito screens and nets in homes. (PA) • Strengthen dengue fever reporting and early warning system for outbreaks. (PA) • Increase fumigation of mosquitoes. (LRA)
Increase in prevalence of ciguatera (fish poisoning).	• Increase testing of local and imported fish catch. (PA) • Conduct study to identify high risk fishing grounds and conditions. (PA) • Increase reporting and treatment of ciguatera cases. (PA)
Increase in respiratory diseases, such as asthma.	• Early detection and improved treatment of asthma patients. (PA) • Reduce prevalence of and exposure to irritants that trigger asthma attacks. (PA)
Increase in risk of diarrhea and other environmentally transmitted illnesses.	• Increase community resilience to hurricanes and flood events that increase the rise of such illnesses. (PA) • Reduce and control rodent populations. (PA) • Enhance capacity of emergency response services. (PA)
Increase in potential for heat stress.	• Increase public awareness about heat stress and survival strategies. (PA) • Incorporate “green” design into buildings to maximise natural light and ventilation. (PA) • Install backup AC units in critical public buildings, esp. for children, elderly and the sick. (AA)
Increase in risk of damage to health care facilities.	• Improve the structural integrity of health care facilities. (PA) • Where practical, elevate facilities located in flood prone areas. Plan for the future relocation of facilities highly vulnerable to stronger storm surges and sea-level rise. Avoid building new facilities in high risk areas. (PA)
Greater threat of epidemics and pandemics.	• Focus on increased wellness and resilience of the population. (PA) • Encourage continuous good hygienic practices. (PA) • Develop standard operating procedures to respond to epidemics and pandemics. (PA) • Enhance capacity of emergency response services. (PA)
Combination of impacts detailed above.	• Establish observatories and information centres on climate change and health. Strengthen existing health surveillance systems. (PA) • Strengthen human resources and increase awareness among the public. (PA) • Integrate climate change considerations in health sector policies. (PA) • Enhance emergency response of health care system in natural disasters and epidemics. (PA)

HUMAN SETTLEMENTS	✓ Enhance resilience of existing human settlements to climatic disasters and sea level rise. ✓ Avoid developing new settlements in areas highly vulnerable to climate change impacts.
Homes and developable lands (especially those in the coastal zone) at greater risk of damage from floods, stronger storm surges, and sea level rise.	• Improve drainage of roads and surrounding areas, especially in flood prone areas – improve road drainage design and construction; improve land use planning; minimise land clearing and creation of impervious surfaces; utilise pervious concrete or porous pavement; and clean, prune and monitor ghuts instead of lining them with concrete. (PA) • Start concerted reforestation programme to reduce storm water run-off and erosion. (PA) • Enhance local weather monitoring and modeling to provide early flood warning systems. (PA) • Flood prevention programme in low-lying areas, including preparation, evacuation and recovery plans. (PA) • Encourage homeowners to purchase adequate flood insurance. (PA) • Improve management of and expand the Disaster Relief Fund. (PA) • Increase minimum elevation requirement above the high water mark for reclamations. (PA) • Consider sea level rise and stronger storm surges in distribution of Anegada crown lands. (PA) • Use "soft" measures (e.g. mangroves) to protect existing vulnerable coastal settlements. (PA) • Where feasible, in highly vulnerable areas, establish "no build areas" for settlements. (PA) • If "no build area" is unfeasible, mandate proper elevation of buildings' foundations and other safeguards in vulnerable areas. (AA) • If necessary, invest in 'hard" engineering structures (e.g. sea walls) to help protect existing vulnerable settlements. (LRA) • Develop a compensation system for persons that lose land as a result of sea level rise. (LRA) • Relocation to "safe islands" and "safe areas." (LRA)
Increased damage to homes from more severe hurricane events.	• Ensure "climate-proof" structures by improving construction standards - overhaul outdated building regulations, retrofit existing structures, and improve surveillance and enforcement of planning and building laws/regulations and approval conditions. (PA) • Encourage adequate property insurance against natural disasters. (PA) • Enhance community hurricane preparedness, including preparation, evacuation and recovery plans. (PA) • Improve management of and expand the Disaster Relief Fund. (PA)
INSURANCE & BANKING	✓ Depend less on global insurance companies and look towards more regional solutions. ✓ Minimise vulnerability of insured and mortgaged properties to climate change impacts.
Increased insurance rates, potentially leading to uninsurance or underinsurance. Increased interest rates and difficulty in obtaining construction loans due to increased risk.	• Work towards the Caribbean being recognised as an insurance zone separate from the U.S. so that climatic events in the U.S. do not increase insurance rates in the Caribbean. (PA) • Improve management of and increase the Disaster Relief Fund. (PA) • Ensure "climate-proof" structures. (PA) • Work with insurance companies, banks and property developers to encourage better building practices to increase resilience to climate change impacts. (PA)

TOURISM	✓ Take strong "no regrets" measures to preserve the quality of natural and historical attractions. ✓ Enhance the resilience of tourism infrastructure and facilities to climate impacts. ✓ Create a more environmentally responsible tourism industry.
☆☆ Loss of or more costly damage to tourism infrastructure and properties from floods, stronger hurricanes and storm surges, and sea level rise.	• Improve drainage around critical tourism infrastructure and properties. (PA) • Ensure "climate-proof" structures by improving construction standards - overhaul outdated building regulations, retrofit existing structures, and improve surveillance and enforcement of planning and building laws/regulations and approval conditions. (PA) • Encourage adequate insurance coverage of critical tourism infrastructure and properties. (PA) • Enhance industry hurricane preparedness, including preparation, evacuation and recovery plans. (PA) • Increase setback and elevation requirements for coastal tourism infrastructure/facilities. (PA) • Where feasible, in highly vulnerable areas, establish "no build areas" for critical tourism infrastructure and properties. (PA) • Educate developers about the increasing risk of building in low-lying coastal areas. (PA) • Develop best practice guidelines for developers to protect their properties from climate impacts. (PA) • Avoid higher risk tourism development styles, e.g. building villas in the ocean. (PA) • Invest in "soft" measures (e.g. mangroves) to protect existing vulnerable tourism infrastructure and properties. (PA) • If necessary, invest in "hard" engineering structures (e.g. sea walls) to help protect existing vulnerable tourism infrastructure and properties. (LRA)
☆☆☆ Diminished natural tourist attractions, e.g. coral reefs, beaches, wildlife.	• Enhance protection of natural tourism attractions and supporting ecosystems. (PA) • Diversify base of tourism industry – develop and promote less vulnerable land-based attractions and activities (e.g. national parks, historical sites, bird watching, hiking and cultural events). (PA)
☆ Rising overheads in energy, water and insurance.	• Increase energy and water conservation and efficiency in tourism properties. (PA) • Encourage use of renewable energies in tourism properties. (PA) • Incorporate "green" design in tourism properties, e.g. natural cooling and lighting. (PA) • Encourage use of more efficient cooling systems (and proper maintenance of systems). (PA) • Reduce insurance claims by ensuring "climate-ready" structures. (PA)
Deterrents to travelers including, warmer winters, less comfortable and stable VI climate, higher airfares and increased Dengue Fever Outbreaks.	• Reframe/reposition The Virgin Islands as more than just a winter getaway. (PA) • Offer incentive packages and develop events to attract vacationers during the summer. (PA) • Reorient the industry towards more resilient high-end and adventure-driven tourists. (PA) • Enhance dengue fever prevention and control programmes to maintain high traveler confidence. (PA)

More tourists seeking carbon neutral or energy efficient destinations.	• Develop opportunities for tourists to "offset" their vacation carbon emissions. (PA) • Make tourism industry more environmentally friendly to attract the growing number of environmentally conscious travelers. (PA) • Encourage energy conservation programmes in the tourism sector.(PA) • Develop and enforce energy efficiency standards for the tourism sector. (PA) • Encourage use of renewable energies at tourism properties. (PA) • Participate in green certification programmes for the tourism sector, such as Green Globe. (PA)
WATER RESOURCES & HYDROLOGICAL CHARACTERISTICS	✓ Increase resilience to heavy rain events and water shortages. ✓ Use water more conservatively and efficiently. ✓ Diversify freshwater sources.
Increased likelihood of flood events.	• Improve drainage of roads and surrounding areas, especially in flood prone areas – improve road drainage design and construction; improve land use planning; minimise land clearing and creation of impervious surfaces; utilise pervious concrete or porous pavement; and clean, prune and monitor ghuts instead of lining the with concrete. (PA) • Start serious reforestation programme to reduce stormwater runoff and erosion. (PA) • Enhance local weather monitoring and modeling to provide early flood warning systems. (PA) • Start flood prevention programmes in low-lying areas, including preparation, evacuation and recovery plans. (PA) • Encourage homeowners to purchase adequate flood insurance. (PA)
☆ ☆ ☆ Decreased availability of rainwater leading to greater dependency on the desalinated public water supply and an increased threat of water shortages in emergencies.	• Develop a sustainable freshwater, watershed and coastal waters management and pollution prevention plan. • Conduct a water carrying capacity study. (PA) • Repair and expand public infrastructure for water capture, storage and delivery. (PA) • Continue and expand the leak detection programme for water distribution system. (PA) • Work to eliminate water theft through illegal water connections (PA). • Improve methods of household capture, storage and use of rainwater. (PA) • Tap into groundwater resources for use in specific sectors, e.g. agriculture. (AA) • Implement concerted water conservation and efficiency programmes. (PA) • Invest in capture, basic treatment and reuse of stormwater for specific purposes. (PA) • Plan for expansion of desalination production capacity to meet projected water demand. (PA)
Increased cost of desalinated water.	• Increase competition in the bidding process to produce desalinated water. (PA) • Explore possibility and economics of using solar-powered desalination technology. (PA) • Reduce per capita demand for desalinated water. (PA)

Table 2. General guiding adaptation principles and specific adaptation options for climate change impacts.

1.0 | THE VIRGIN ISLANDS CONTEXT

1.1 | LOCATION

The Virgin Islands (U.K.) is located approximately 97 kilometres (60 miles) east of Puerto Rico in the Eastern Caribbean at Latitude 18.4 North, Longitude 64.6 West. Geologically these islands belong to the Greater Antilles and with the United States Virgin Islands (USVI) rise from the Puerto Rican shelf. The location of The Virgin Islands is shown in Figures 4 and 5 below.

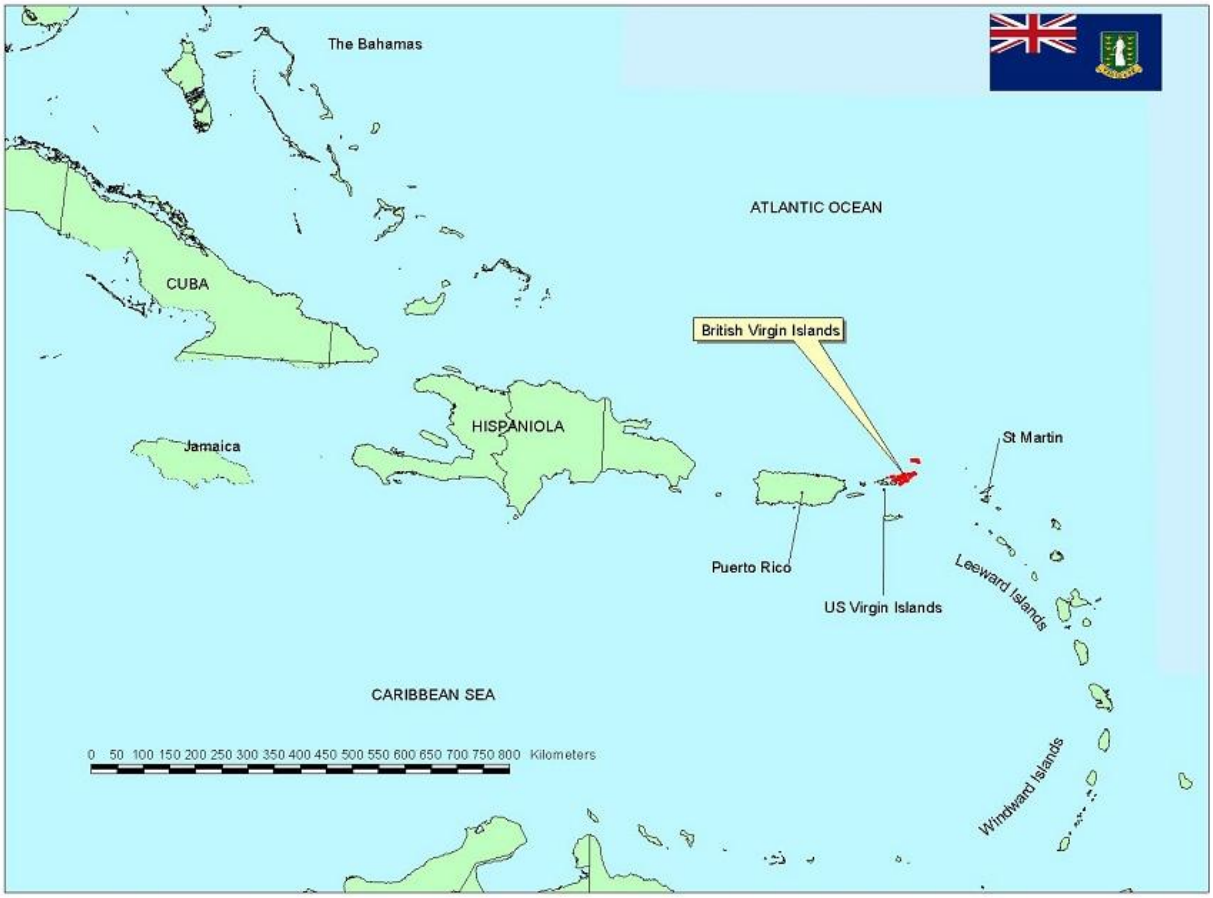


Figure 4. Location of The Virgin Islands (U.K.) in the Caribbean Sea. *(Source: The National GIS).*

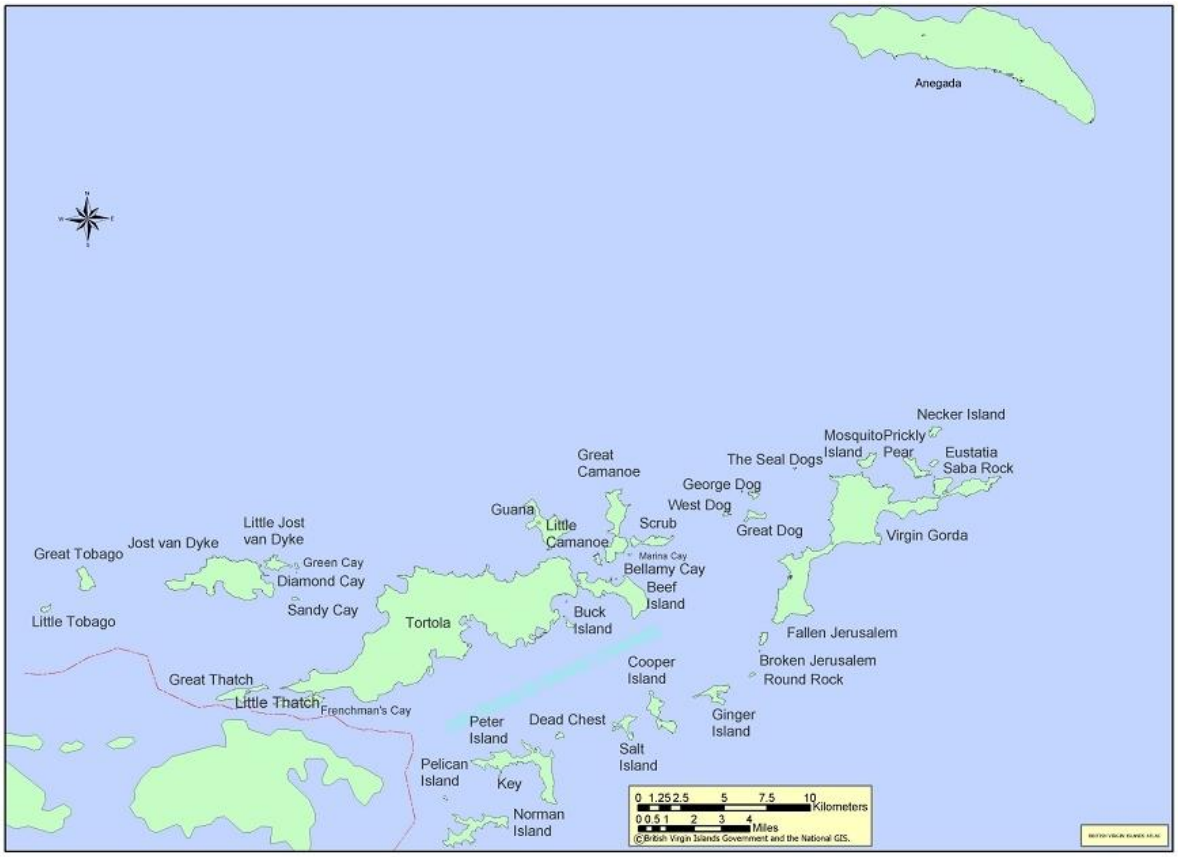


Figure 5. The islands of The Virgin Islands (U.K.). *(Source: The National GIS).*

1.2 | GEOGRAPHY AND TOPOGRAPHY

The Virgin Islands is comprised of about 60 islands, cays, and rocks and has a total land area of 154 square kilometres (59 square miles). The main islands include Tortola (54 square kilometres / 21 square miles), Anegada (39 square kilometres / 15 square miles), Virgin Gorda (21 square kilometres / 8 square miles), and Jost Van Dyke (9 square kilometres / 3.4 square miles) [Development Planning Unit (DPU), 1999].

The territorial sea of The Virgin Islands covers a much larger area of 1,489 square kilometres (575 square miles) and extends 5.6 kilometres (3.5 miles) from the low water line. The Exclusive Economic Zone (EEZ) extends 322 kilometres (200 miles) north and northeast and up to 80 kilometres (50 miles) southeast from the islands' coasts (Gore, Hayward, Hastings, James-Lord, Jarecki, Lettsome, et al., 2008).

The islands (with the exception of Anegada, a very flat limestone island) were part of a submerged mountain range created through volcanic activity and were formed into the islands they are today through a series of tectonic processes, sea level changes, and erosion. The

islands, therefore, are dominated by a series of steep-sloping hills punctuated by deep valleys in which there are drainage channels known locally as “ghuts.” There is a relative scarcity of flat land, all of which is concentrated in the valley bellies and the surrounding narrow coastal zone that has been extended by reclamation in many instances. The highest point, Sage Mountain, is on the main island of Tortola and rises to 1,780 feet [Caribbean Disaster Emergency Response Agency (CDERA), 2003].

Appendix C contains maps showing the geography and topography of The Virgin Islands.

1.3 | CLIMATE AND NATURAL HAZARDS

The Virgin Islands experience a tropical climate with temperatures averaging 82°F (28°C) and ranging 77-90°F (25-32°C) (http://www.bvi.gov.vg). The islands are constantly swept by Northeast Trade Winds that have a drying effect at low elevations and produce rainfall when they intersect with land at high elevations.

Data collected at Paraquita Bay, Tortola from 1901 to 1994 shows that The Virgin Islands receive a total annual rainfall that ranges from 24.1 inches to 94.3 inches, with an average total of 50.3 inches. The dry season dominates the year and extends from January to August. During the dry season January to March and June to July are the driest months, with May showing an isolated rainier peak as a result of sporadic showers. The wet season extends from September to December, with November being the wettest month (Earle, 1997).

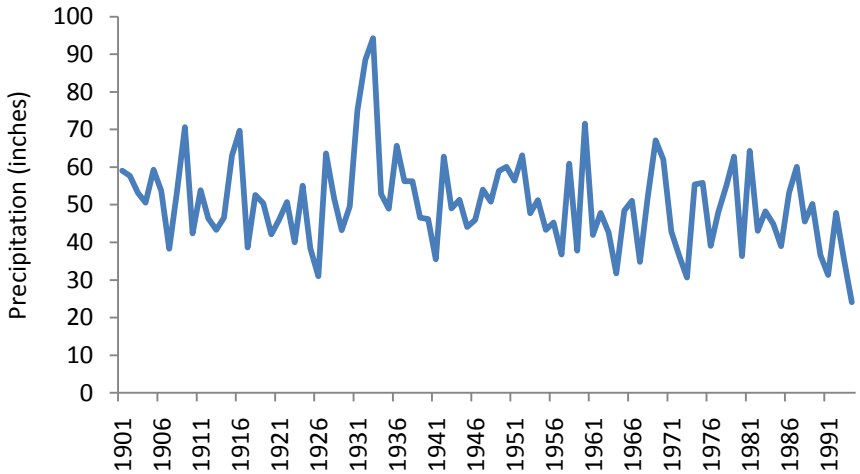


Figure 6. Changes in total annual precipitation in The Virgin Islands, 1901 to 1994, as measured at Paraquita Bay, Tortola. *(Data source: Earle, 1997).*

Hurricanes and earthquakes are the natural hazards of greatest threat, with flooding and landslides traditionally considered a minor threat. During hurricanes and tropical storms, however, inland flooding and coastal surge are of significant concern (CDERA, 2003). Coastal communities or settlements which are experiencing rapid population growth and development are most susceptible to hurricanes [Department of Disaster Management (DDM), 2002).

The location of The Virgin Islands at the northeastern tip of the Caribbean places it directly in the hurricane belt. Traditionally, there is a 25 to 30 year intensity cycle of tropical cyclone activity and during that period The Virgin Islands may expect a category 4 storm and several categories 2 or 3 storms [Department of Disaster Management (DDM), 2002].

The northeastern Caribbean has the potential to experience earthquakes of magnitude 7.4 to 8.5 as has occurred during the 20th and 21st Centuries, on October 8, 1974, and on November 29, 2007 (CDERA, 2003; http://earthquake.usgs.gov/regional/neic/). Most recently, on 12th January 2010, a 7.0 magnitude earthquake devastated Haiti. The Virgin Islands is particularly vulnerable as it sits on the northeastern edge of the Caribbean Tectonic Plate where it meets the North American Plate at the Puerto Rico Trench. This area is a "hotspot for seismic activity" including earthquakes and tremors, tsunamis and volcanic eruptions (CFD & NPT, forthcoming).

Table 3 summarises The Virgin Islands vulnerability to hurricanes, while Table 4 summarises the damages incurred from hurricanes from 1916 to 1999. Appendix D contains maps showing the distribution of natural hazards in The Virgin Islands.

HURRICANE HAZARD	EXISTING VULNERABILITY	FUTURE VULNERABILITY
Wind effects	3	3
Wave and surge effects	2	2
Rainfall effects		
- Flooding	1	1
- Landslides and rockslides	2	3
Loss of life	1	1
Vulnerability rating (mean)	2	2

Table 3. The Virgin Islands vulnerability to hurricanes. The current mean vulnerability rating of "moderate" may change with time as a result of increasing population and land development. *Vulnerability rating: 1 = Low; 2 = Moderate; 3 = High (Source: DDM, 2002)*

YEAR	HURRICANE	CATEGORY	HURRICANE CLOSEST POITION*	DATE	ESTIMATED LOSS
1916	Not Named	2	Lat. 18.0N, Long.64.8W	9 October	Fatalities and Property No Estimate Available
1924	Not Named	2	Lat. 18.3N, Long. 63.4W	29 August	Fatalities and Property No Estimate Available
1960	Donna	4	Lat. 18.4N, Long. 63.4W	5 September	Property No Cost Available
1989	Hugo	4	Lat. 18.2N, Long. 65.5W – 40 miles SW of The Virgin Islands	18 September	US$40 million
1995	Luis	4	Lat. 18.4N, Long. 63.0W – 37 miles NE of Anegada	6 September	No Estimates
1995	Marilyn	3	Lat.18.5N, Long.65.2W - 40 miles SW of Tortola	15 September	US$10 million
1996	Bertha	1	Lat. 18.6N, Long. 64.9W	8 July	US$2 million
1998	Georges	2	Lat.17.8N, Long.65.0W - 46 miles south of Tortola	21 September	US$12 million
1999	Lenny	4	Lat. 17.7N, Long. 64.0W – 5 miles	17 November	US$29 million
2008	Omar	3	Lat.18.2N, Long.63.9W - 40 miles east of Road Town	16 October	Minimal impacts

Table 4. Estimated losses from hurricanes known to have affected The Virgin Islands from 1916 to 1999. *(Source: DDM, 2002)*

1.4 | NATURAL RESOURCES

The biodiversity of The Virgin Islands has been influenced strongly by its close geographical relationship with Puerto Rico from where most of its species migrated thousands of years ago (MacLean, 1982; Acevedo-Rodriguez, 1996). Within their small area, the islands bear vegetative communities that range from moist forests to desert like shrublands that support a diverse group of animals, including island endemics (species found nowhere else on Earth).

Coastal and marine habitats are particularly significant and primarily include salt ponds, mangroves, beaches, seagrass meadows, and coral reefs which are home to an extremely diverse marine wildlife community.

PLANTS (FLORA)

The Virgin Islands has a healthy vegetative cover consisting of moist forests, dry forest, woodlands, and shrublands. From botanical investigations done so far, 484 plant species have been recorded on Tortola; 403 species on Virgin Gorda; 334 species on Anegada and 73 species on Jost Van Dyke (CFD & NPT, forthcoming). Endemic tree species have been recorded with the accounts varying slightly; between 5 to 8 species are found only in The Virgin Islands and another 25 to 26 species are found in The Virgin Islands and wider Puerto Rico Bank (Puerto Rico and British and U.S. Virgin Islands with the exception of St. Croix) (Little, Woodbury, & Wadsworth, 1976; Acevedo-Rodriguez, 1996).

MOIST FORESTS are limited to the wettest (typically highest) areas of the islands and are of the tropical and subtropical seasonal evergreen type. Over 100 species of trees have been recorded, at least 40 of which are common. The trees vary in height from 10-30 metres (33 – 98 feet) and form between two and three canopy layers (UVI, 2005).

DRY FORESTS generally occur below 300 m (984 ft) above sea level, are prone to the drying effects of the Northeast Trade Winds, and receive less rainfall than the moist forests so that canopy height is limited to a maximum of 15-20 metres (49 – 66 feet). In the drier months deciduous trees drop some of their foliage while trees with thickened, hardened leaves adapted to resist water loss remain green (UVI, 2005). The islands' dry forests are of high conservation concern as they are among the few remaining examples of Caribbean dry forest. Although dry forests have mostly been degraded due to land clearing, The Gorda Peak National Park on Virgin Gorda supports a very good example of dry forest (BVI NPT, 2008).

WOODLANDS are identified by their low, open tree canopy and can be found at low elevations on the northern face of steep hills and may extend down to the coast (UVI, 2005). Thorny plants are common here. When woodlands extend down to the coast, the popular *Cocos nucifera* (Coconut Palm) is often dominant (UVI, 2005).

SHRUBLANDS are present on all islands and inhabit hot, dry, windy areas with shallow soils as is typically found on the east and south shores at low elevations. Relatively short thorny shrubs, cactus, and succulents (plants with fleshy tissue that allow for the conservation of water) dominate (UVI, 2005).

ANIMALS (FAUNA)

MAMMALS

Bats are the only land mammals native to The Virgin Islands that still persist (U.S. Geological Survey, 2005). Six species, both insect and fruit eating are present. *Artibeus jamaicensis* is considered the most common and inhabits coastal caves and abandoned buildings (Koopman, 1975). *Stenoderma rufum*, also known as the "Red Fig-Eating Bat" is an endemic of the Puerto Rican Bank and is the only species of its genus. Hurricane Hugo of 1989 and hurricane Georges of 1998 severely depressed its populations; the species is now vulnerable to extinction (Gannon, Rogriguez-Duran, Kurta, & Willig, 2005).

REPTILES AND AMPHIBIANS

There are approximately 39 species of reptiles and amphibians in The Virgin Islands. These include lizards, snakes, frogs, toads, tortoises, and sea turtles, all native to the islands with the exception of tortoises (MacLean, 1982). Two lizard species hold world records - the gecko *Sphaerodactylus macrolepis,* for living at the highest recorded density among all non-aggregated vertebrates and *Sphaerodactylus parthenopion* (The Virgin Gorda gecko), an endemic, for being the smallest reptile (Rodda, Perry, Rondeau & Lazell, 2001; Guinness World Records, 2005).

The reptiles have the highest number of endemic species in the islands. *Cyclura pingus* (The Anegada Rock Iguana) is a well known endemic that is endangered (Carey, 1975). Snake populations have been severely depressed by the introduced presence of the *Herpestes javanicus* (Small Indian Mongoose), known to be a fierce predator (Davis, 1996).

The Virgin Islands are home to five native species of frog of which three are endemic to either the Puerto Rico Bank or one or two islands of The Virgin Islands (MacLean, 1982). For example, *Eleutherodactylus schwartzi* (Virgin Islands Bo-Peep), named for its distinctive two-note call is a tiny endemic of Tortola and Virgin Gorda (MacLean, 1982). The only native toad that occurs in The Virgin Islands is the Puerto Rican Bank endemic, *Bufo lemur*; which the IUCN has classified as critically endangered (IUCN, 2009).

BIRDS

The Puerto Rico Bank is considered one of six "primary endemic bird areas" and thus The Virgin Islands is a "priority conservation area" (Gore, et al., 2008). Bird counts have recorded a total 210 resident and migratory species belonging to 40 different families, with resident birds present from 29 of them (Roy, n.d.). This makes birds the most diverse group of animals in the islands.

The following resident bird species are common year round: *Pelecanus occidentalis* (Brown Pelican), *Sula leucogaster* (Brown Booby), *Fregata magnificens* (Magnificent Frigatebird), *Bubulcus ibis* (Cattle Egret), *Buteo jamaicensis* (Red-Tailed Hawk), *Falco sparverius* (American Kestrel), *Zenaida aurita* (Zenaida Dove), *Columbina passerina* (Common Ground Dove), *Crotophaga ani* (Smooth-billed Ani), *Tyrannus dominicensis* (Gray Kingbird), *Mimus polyglottos* (Northern Mockingbird), *Margarops fuscatus* (Pearly-eyed Thrasher), and *Coereba flaveola* (Antillean Bananaquit) (Roy, n.d.).

Bird populations are highest in the summer when seabirds visit the outer cays to nest, and during the North American winter, when scores of migratory birds seek out the islands as a winter home (Roy, n.d.). Fifteen species of seabirds breed in the Islands with the Magnificent Frigatebird and *Sterna dougallii* (Roseate Tern) having globally significant colonies; eight other species have colonies of regional significance (Gore, et al., 2008).

Among the hundreds of birds are species endemic to the Puerto Rican Bank, including *Otus nudipes* (The Puerto Rican Screech-Owl) and *Myiarchus antillarum* (The Puerto Rican Flycatcher) (Raffaele, Wiley, Garrido, Keith, & Raffaele, 1998).

COASTAL AND MARINE RESOURCES

Table 5 below gives some key statistics on the Territory's coastal resources as of 2004-2006 while Figure 7 shows the location and extent of these resources.

INDICATOR	QUANTITY
Number of mangrove areas	150
Total mangrove area	<1,451 acres
Total coral reef area	~ 28,343 acres
Number of salt ponds	<51
Total salt pond area	~ 2,187 acres*
Sandy beaches	>150
Seagrass meadows	>10,000 acres

*rough approximation extracted from combined data on mangroves and salt ponds.

Table 5. Virgin Islands coastal resources inventory. *(Source: calculated from data provided in Gore, et al., 2008; Dr. Jarecki, 2006; http://www.bvi.gov.vg; Orion Consultancy Services Ltd. & Samuels Richardson and Co. Ltd., 2004).*

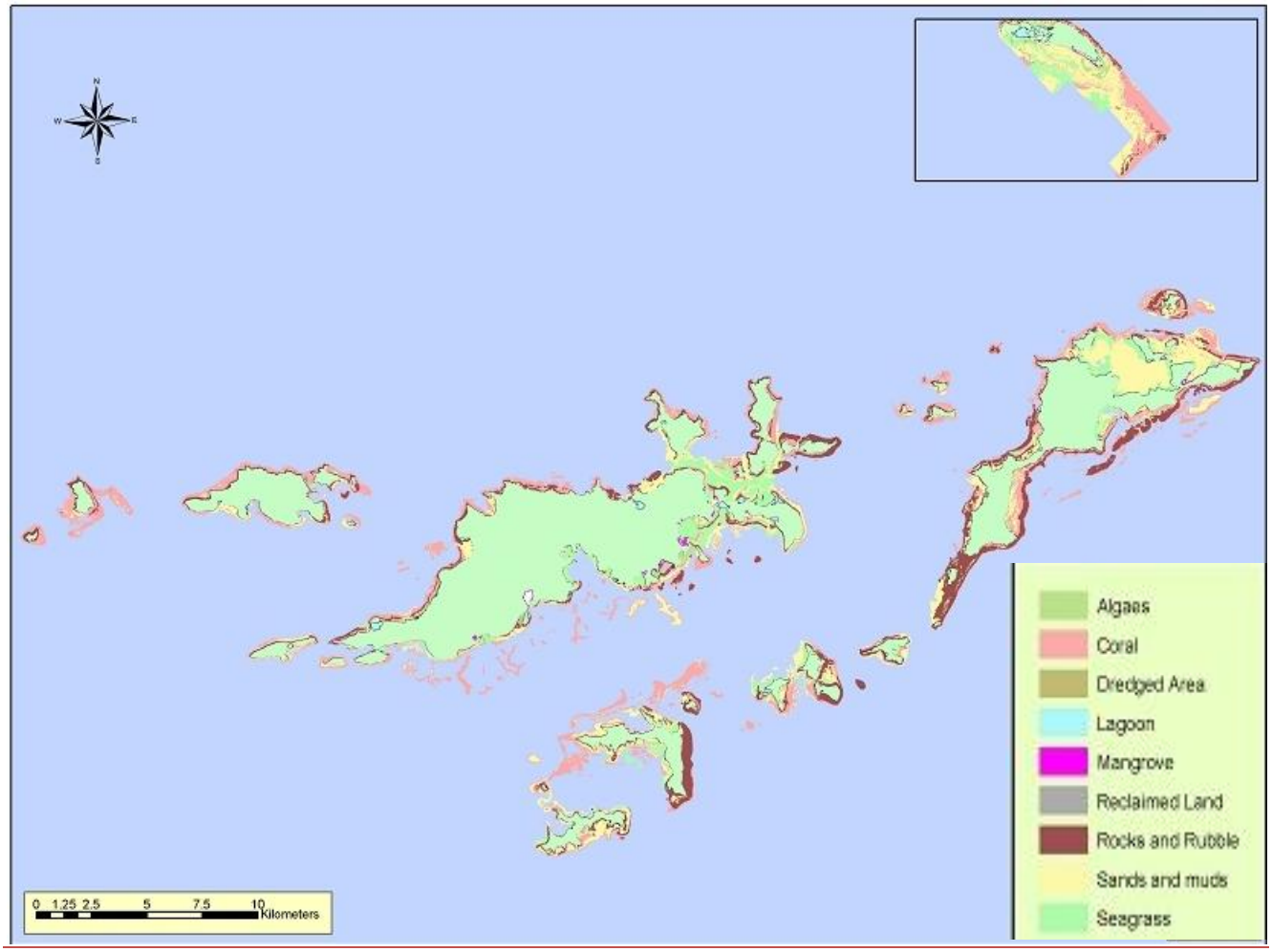


Figure 7. The coastal resources of The Virgin Islands. *(Source: The National GIS).*

SALT PONDS

Salt ponds are a typical part of a mangrove wetland system in The Virgin Islands. They are coastal pools of seawater that have been cut-off from the ocean over a long geological time-scale as *Rhizophora mangle* (Red Mangrove) colonisation and sediment accumulation slowly transform a reef crest into a lagoon and finally a pond (Gore, et al., 2008). Although Red Mangroves are key in salt pond formation, they are eventually replaced by *Avicennia germinans* (Black Mangrove) and *Laguncularia racemosa* (White Mangrove) (CFD & NPT, forthcoming).

Salt ponds provide an important habitat for resident bird populations as well as migratory birds as they fly between North and South America (CFD & NPT, forthcoming). Other key salt pond functions include storm protection, flood mitigation, shoreline stabilisation, runoff filtration, and erosion control (Gore, et al., 2008).

Salt ponds can be found on the four main islands and eighteen of the smaller outer islands, typically at the base of steep watersheds and often landward of popular beaches (Dr. Jarecki,

2006). The largest network of salt ponds can be found in Anegada where they support a population of *Phoenicopterus ruber* (Roseate Flamingos). As of 1999 the Western Salt Ponds of Anegada have been protected under the Ramsar Treaty (CFD & NPT, forthcoming).

MANGROVES

The Virgin Islands is home to four species of mangrove that grow at the interface between land and sea, most often along low energy coastlines, lagoons, and salt ponds; these include *Rhizophora mangle* (Red Mangrove), *Avicennia germinans* (Black Mangrove), White Mangrove (Laguncularia racemosa) and Buttonwood (Conocarpus erectus) (CFD & NPT, forthcoming). The Red Mangrove is the dominant species while the Black Mangrove is perhaps the species most used by the local community (Gore, et al., 2008).

Mangroves help to build land, filter runoff from land, and protect the coastline and boats from wave action, especially during hurricanes. Mangroves also serve as a vital nursery for fish and other marine life, as well as a habitat for birds (CFD & NPT, forthcoming).

Due to coastal development, there are less than 6 km² (587 ha/1,451 acres) of mangroves remaining in The Virgin Islands http://www.bvi.gov.vg). Some examples of significant mangrove areas can be found at Bar Bay, Belmont Pond, Chapel Hill, Dubois Point Pond, Hodge's Creek, Paraquita Bay, Pockwood Pond, Sea Cow's Bay, Slaney Point, and Wickham's Cay on Tortola, Hans Creek and the lining of the Beef Island Channel on Beef Island, Deep Bay on Virgin Gorda, East End on Jost Van Dyke, and Flamingo Pond on Anegada (Gore, et al., 2008).

Mangroves are under considerable threat from coastal development. To combat this trend there is an active mangrove replanting programme managed by the National Parks Trust which has planted over 1,000 red mangrove seedlings since 1999 (Gore, et al., 2008).

BEACHES

While most known for its over 150 white "sandy" beaches, The Virgin Islands also has roughly 100 "gravel" beaches that can consist of coral rubble, volcanic cobbles, and boulders. These have formed since the last ice age, over 6,000 years ago, from deposits of coral, molluscs and other marine animals with shells, and sediments from worn rock (Gore, et al., 2008).

Most of the sandy beaches, especially those on the north shore, are very dynamic and go through an annual cycle of erosion (during the winter "ground season" months – late October – March/ April) and accretion (during the summer months). Besides forming an important part of the tourism product and source of local recreation, beaches help to protect the land from waves, provide an easy access to the ocean, and offer a habitat for some plants and animals such as molluscs and shorebirds. Studying beaches can also provide a unique glimpse into past sea levels and weather events. (Gore, et al., 2008).

SEAGRASS BEDS

Seagrass beds are clusters of flowering marine plants. Five species of seagrass are found throughout the islands of which *Thalassia testudinum* (Turtle Grass) and *Syringodium filiforme*

(Manatee Grass) are the most common, primarily occurring in relatively sheltered and shallow coastal bays (Gore, et al., 2008).

In all there are over 10,000 acres of seagrass in The Virgin Islands (Gore, et al., 2008). Dense seagrass beds can be observed along Anegada's northern and southwestern shores, the Fat Hog's Bay area in Tortola, and Manchioneel Bay in Cooper Island (CFD & NPT, forthcoming).

Seagrass beds serve many important functions such as providing a habitat for several fish of commercial and recreational value, protecting coastal water quality by filtering run-off from land and stabilizing the seabed, and reducing the impact of waves on the coastline (Gore, et al., 2008).

Coral Reefs

Coral reefs are a diverse collection of hard (reef building) corals, soft corals (e.g. sea fans), algae, sponges, echinoderms, molluscs, fish, crustaceans, reptiles (e.g. sea turtles) and many other marine creatures that form a complex ecosystem in relatively shallow, warm, clear waters.

Fringing, patch, and barrier reefs are scattered around all the islands of the Territory. Anegada is home to the Horseshoe Reef, the third largest continuous reef in the Eastern Caribbean spanning 63 kilometres (39 miles). There are 63 popular dive sites – 57 are natural reefs and the reminder artificial reefs growing on shipwrecks (CFD & NPT, forthcoming).

In addition to their high tourism and recreational value, reefs offer a critical habitat for "reef fish" which form an important part of the local diet and are of high commercial value, they help to protect the coastline from storm waves, and they are a primary source of beach sand (Gore, et al., 2008).

The condition of reefs in The Virgin Islands varies with most (over 90%) suffering some form of human-induced degradation (Burke & Maidens, 2004). Many coral reefs today are dominated by soft coral and algae (CFD & NPT, forthcoming). This is in contrast to the past when the reefs were dominated by two species of hard coral, *Acropora palmate* (Elkhorn) and *Acropora cervicornis* (Staghorn), most of which died as a result of White Band disease that swept through the Caribbean in the late 1970s and early 1980s. This was followed by a massive die-off of *Diadema antillarum* (Spiny Sea Urchin) in 1983-1984 that allowed algae to cover large areas of reef (Gore, et al., 2008).

Marine Wildlife

The marine habitats described above are home to a wide variety of species of fish, marine mammals, sea turtles, molluscs, and crustaceans (CFD & NPT, forthcoming; Gore, et al., 2008).

The fishery resources are of particular significance as seafood is a vital source of high quality protein in the local diet and there are huge commercial opportunities to meet the local and

tourist demand for fresh catch and the rising tourist demand for sport fishing (Gore, et al., 2008).

The Virgin Islands' EEZ extends 322 kilometres (200 miles) north and northeast and up to 80 kilometres (50 miles) southeast of the coast and is rich in marine resources, supporting approximately 500 species of reef and pelagic fish (Gore, et al., 2008). According to Mr. Ken Pemberton, Fisheries Assistant at the Conservation and Fisheries Department, important commercial reef species include *Epinephelus guttatus* (Red Hind), *Ocyurus chrysurus* (Yellowtail Snapper), *Caranx crysos* (Blue Runner or Hardnose), and *Calamus nodosus* (Knobbed Porgy); while *Thunnus albacares* (Yellow Fin Tuna), *Coryphaena hippurus* (Mahi Mahi or Dolphin), *Acanthocybium solandri* (Wahoo), and *Xiphius gladius* (Swordfish) are the pelagic species of highest commercial value. Some pelagic species including Billfish such as *Makaira nigricans* (Blue Marlin) are fished strictly as "catch and release" for sport (Pemberton, K., personal communication, October, 2009).

A wide variety (29 species) of marine mammals have been sighted in the waters of The Virgin Islands, including species of baleen whales, toothed whales and dolphins, sirenians (e.g. *Trichechus manatus*, commonly known as the West Indian Manatee), and pinnipeds (e.g. *Cystophora cristata* or the Hooded Seal) (Gore, et al., 2008). Most sightings are rare, especially species from the two latter groups, and include animals that obviously strayed outside of their usual migration paths or escaped from captive facilities in neighbouring islands. Sightings of *Megaptera novaeangliae* (Humpback Whales) are important as the whales are endangered and pass through the islands on their annual migration from the Arctic to the Caribbean (Gore, et al., 2008).

There are three species of turtles that nest in The Virgin Islands: *Eretmochelys imbricata* (Hawksbill Turtle), *Cheonia mydas* (Green Turtle), and *Dermochelys coriacea* (Leatherback Turtle). According to Mr. Joel Dore, Marine Biologist Assistant at the Conservation and Fisheries Department, 777 Green and Hawksbill Turtles have been tagged under the Department's In-Water Tag and Release Programme started in 2002 (Dore J., personal communication, March 22, 2010). While the Leatherback is an annual visitor, the other two are known to forage (feed) in the islands year-round with the Hawksbill being the most common. *Caretta caretta* (Loggerhead Turtles) have also been sighted on rare occasion (Gore, et al., 2008).

The Virgin Islands is home to many commercially important molluscs - such as *Strombus gigas* (Queen Conch) and various species of whelks that enjoy seagrass meadows, sandy bottoms, and rocky shorelines in the intertidal zone - and crustaceans such as *Panulirus argus* (Caribbean Spiny Lobster) (CFD & NPT, forthcoming).

1.5 | ECONOMY

Until the 1960s The Virgin Islands was a subsistence economy depending heavily upon fisheries and agricultural production. Today The Virgin Islands enjoys a relatively stable and prospering service-based economy, dominated by tourism and the financial services sectors. In 2008, tourist expenditure was estimated at some $552.43 million; the industry accounts at least half of gross domestic product (GDP) and a significant percentage of employment (DPU, 2009c; DPU, 2009a).

The main tourist market of The Virgin Islands is the northeast United States. While the cruise ship sector (followed distantly by the charter boat and then hotel and rented accommodations sector) leads the industry in terms of arrivals, the cruise sector lags significantly behind in visitor expenditure which is led by the charter boat sector and trailed closely by the hotel and rented accommodations sector (DPU, 2009c). Figure 8 shows the growth in tourist arrivals and Figure 9 shows the growth in tourist expenditure from 1999 to 2008.

Foreign private sector interests dominate the leading sectors while the local private sector tends to engage in smaller-scale operations, provides support services, and is especially active in construction. Government performs the important role of facilitator, regulator, provider of physical and social infrastructure, and developer of human resources (DPU, 1999). Table 6 below shows the breakdown of main economic activity in the Territory as estimated for 2008.

The small size and narrow production base renders The Virgin Islands a very open economy in which international trade is a dominant factor (DPU, 1999). Most goods (with the exception of minimal agricultural and fisheries produce) are imported from the United States.

ECONOMIC SECTOR	CONTRIBUTION TO TOTAL EMPLOYMENT (%)	MILLIONS GENERATED	CONTRIBUTION TO GDP (%)
Real Estate, Renting and Business Activity	11.1	$320,301	29.3
Hotel and Restaurants	20.3	$173,904	15.9
Wholesale and Retail Trade	12.8	$154,708	14.1
Transport and Communications	3.7	$135,441	12.4
Construction	10.1	$70,840	6.5
Government Services	30.6	$70,433	6.4
Financial Intermediation	2.3	$49,643	4.5
Education	1.9	$28,081	2.6
Manufacturing	2.6	$27,248	2.5
Other Community, Social and Personal Services	3.2	$21,852	2.0
Health and Social Work	0.7	$19,447	1.8
Electricity, Gas and Water	0.0	$18,817	1.7
Fishing	0.1	$5,397	0.5
Agriculture, Hunting and Forestry	0.4	$4,102	0.4
Mining and Quarrying	0.1	$360	0.0

Table 6. Estimated financial activity for The Virgin Islands, 2008. The financial services and tourism sectors are not fully represented. *(Data Source: Development Planning Unit, 2009a)*.

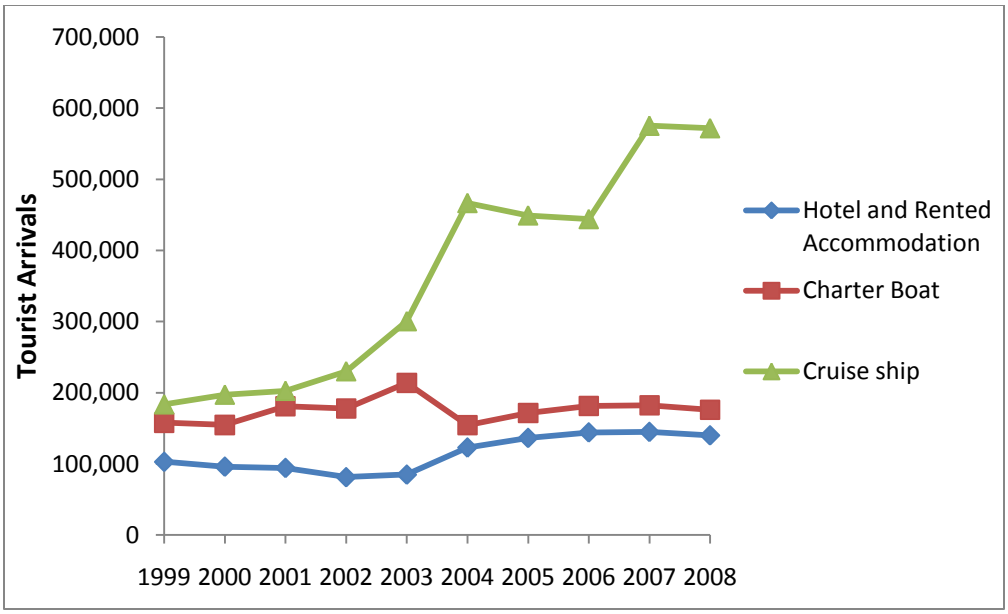


Figure 8. Growth in The Virgin Islands tourist arrivals, 1999-2008. Numbers for 2004 forward are estimates. *(Data source: Development Planning Unit, 2009c)*

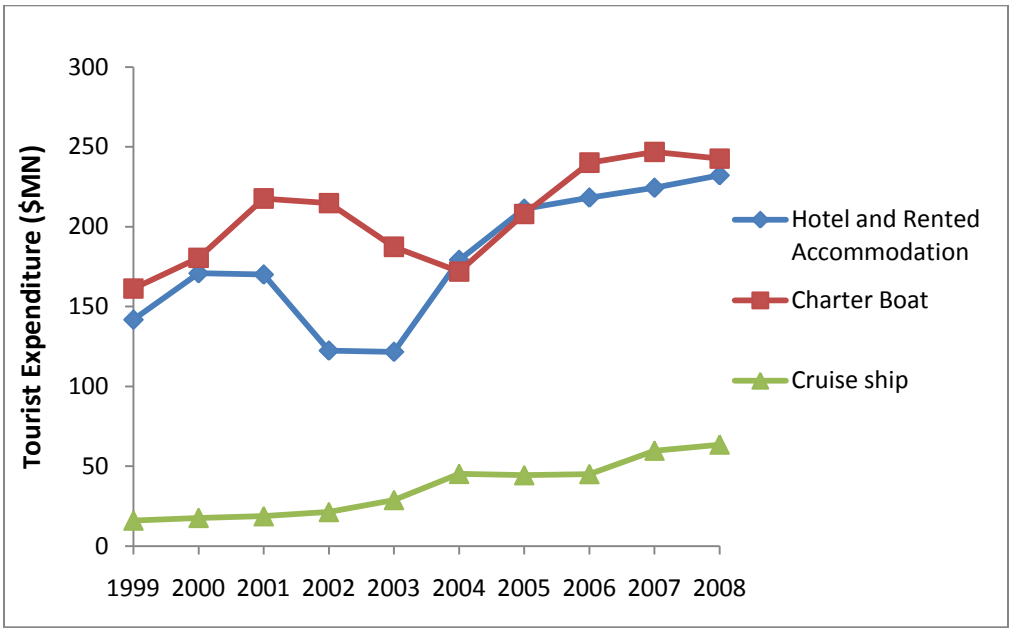


Figure 9. Growth in The Virgin Islands tourist expenditure, 1999-2008. Numbers for 2004 forward are estimates. *(Data source: Development Planning Unit, 2009c)*

1.6 | POPULATION AND INFRASTRUCTURE CENTRES

There are 16 inhabited islands in The Virgin Islands with a total population estimated at 28,882 [DPU, 2009c]. Table 7 shows the distribution of the population among the four main islands. Tortola is the seat of Government and location of the capital, Road Town. Between 1984 and 1994 the population doubled, largely due to migration (CDERA, 2003). Population growth and immigration continue to be rapid.

Topography and a tourism industry built around the "sun, sand, and sea" concept have greatly influenced patterns of settlement and land use (DPU, 1999). The most populous communities and the majority of physical development can be found in low-lying coastal areas. The mountainous nature of the islands has also slowed development on a large percentage of the land – in the late 1990s, approximately 73% of Tortola remained undeveloped, for example (DPU, 1999).

ISLAND	LOCATION OF MAIN SETTLEMENTS	% of TOTAL RESIDENT POPULATION
Tortola	Greater Road Town *low-lying inlands (i.e. separated from coast by the main commercial district), and surrounding foothills* East End *low-lying coastal lands and surrounding hills*	83.3%
Virgin Gorda	The Valley *low-lying coastal lands* North Sound *coastal hills*	13.8%
Anegada	The Settlement *very low-lying coastal lands*	1.1%
Jost Van Dyke	Great Harbour *low lying coastal lands and surrounding hills*	1.1%

Table 7. Estimated distribution of population in The Virgin Islands.
(Data Source: Development Planning Unit, 2009b)

2.0 | PROJECTED AND EXISTING CHANGES IN CLIMATE

Robust global climate models as well as the PRECIS regional climate model - developed by the Hadley Centre for Climate Prediction and Research in the United Kingdom and run by a team of Caribbean scientists from the Cuban Meteorological Institute, the University of the West Indies and the CCCCC - foretell a serious situation.

Key changes projected to *likely* impact the Caribbean, including The Virgin Islands, are:

- **Increasing air and sea surface temperatures by 1°C - 5°C (1.8°F – 9°F) by the 2080s under the Medium-High Emissions Scenario relative to 1961 – 1990 temperatures, with the greatest change expected in the summer** (Taylor et al., 2007).

  The percentage of days in the region having very warm maximum or minimum temperatures has already increased considerably since the 1950s, while the percentage of days with cold temperatures has decreased. For the period 1971 to 2004 regional warming ranged from 0°C - 0.5°C (0°F - 0.9 °F) per decade (Mimura et.al, 2007).

- **Decreasing *overall* rainfall leaving the region up to 25% drier by the 2080s under the Medium-High Emissions Scenario.** The southern Caribbean will be drier than the north (*Taylor et al., 2007).*

  Already, since 1960, the frequency of droughts in the region has increased significantly (Taylor et al., 2007). Currently, since late last year, the majority of Caribbean islands have been experiencing severe drought (BBC, 2010).

- **More frequent heavier rainfall events, increasing the possibility of floods** (Mimura et.al, 2007).

  Already, since the mid 1990s, flood events in the region have increased (Taylor et al., 2007). More frequent heavier rainfall events are possible despite an overall decrease in rainfall due to changes in rainfall patterns, including the seasonal distribution of rain.

- **A shift to stronger, more persistent and devastating hurricanes with maximum wind intensities likely increasing by 5% - 10% by around 2050 and peak rainfall rates increasing by 25%. Stronger hurricanes will result in higher storm surges.** Although the number of "intense" tropical cyclones is likely to increase, the total number of cyclones globally may actually decrease (Mimura et.al, 2007).

Clear evidence exists that the number of categories 4 and 5 storms globally has nearly doubled since 1975-1989. Put differently, categories 4 and 5 storms made up about 35% of tropical cyclones in 1990-2004 versus 25% in the previous period (Henson, 2006). In addition, the intensity and duration of these storms is increasing (Mimura et.al, 2007). In the Caribbean basin, there has been an increase in hurricane activity since 1995 (or over the past 15 years relative to the 1981-2000 baseline), with all except two Atlantic hurricane seasons having above normal activity (Mimura et.al, 2007).

- **Sea level rise, on average, of between 0.19 – 0.58 metres (0.6 - 1.9 feet) by the end of the 21st Century (2090 – 2099) relative to 1980 – 1999 levels.**

  These projections are global; the actual rise experienced by each country in the Caribbean will depend on site-specific temperature, salinity, and ocean circulation considerations as well as island tectonic setting. The Caribbean, on average, experienced a mean relative sea level rise of 1 millimetre per year during the 20th Century (Mimura et.al, 2007).

While the changes described above would be most noticeable later this century, changes are happening continuously and are already being experienced to varying degrees and will continue to intensify.

- January 2000 to December 2009 was the warmest decade on record globally since precise measurements began in 1880 (NASA, 2010).

- The percentage of days in the Caribbean region having very warm maximum or minimum temperatures has increased considerably since the 1950s, while the percentage of days with cold temperatures has decreased (Taylor et al., 2007).

- Many islands across the Caribbean are experiencing generally drier conditions, but more episodes of heavier rain events resulting in flooding (Taylor, et al., 2007). Records show that the frequency of droughts has "increased significantly" since 1960 and flood events have increased since the mid 1990s (Taylor et al., 2007). Currently, since late last year, the majority of Caribbean islands have been experiencing severe drought (BBC, 2010).

- Over the period 1990-2004 compared to the period 1975-1989, the number of categories 4 and 5 storms in the South-West Pacific has more than doubled. While the trend has not been as strong in the Caribbean basin, there has been an increase in hurricane activity since 1995 compared to the 1981-2000 baseline, with all except two Atlantic hurricane seasons having above normal activity (Mimura et.al, 2007).

- Finally, the average global sea level has been rising steadily, at an average rate of 1.8 mm/yr since 1961 and at an increased rate of 3.1mm/yr since 1993 (Pachauri, R.K., Reisinger, A. & Core Writing Team, 2007).

3.0 | Potential and Existing Climate Change Impacts

Small islands will be among the first and worst affected by climate change.
(CANARI, 2008 b; Mimura et al., 2007; UNFCCC, 2007)

This statement is based on two decades of studies by the IPCC, a team of hundreds of scientists from around the world responsible for providing a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences.

Based on the work of the IPCC and local experiences, it is evident that all of the climatic changes outlined above have potentially serious adverse environmental, social, and economic consequences for The Virgin Islands.

In particular, the following aspects of the Territory stand to be greatly impacted:

- Beach and shoreline stability
- Coastal and marine ecosystems
- Critical infrastructure and Human settlements
- Energy security
- Food security: Agriculture and Fisheries
- Forestry and biodiversity
- Human health
- Insurance and banking
- Tourism
- Water resources and hydrological characteristics

Table 8 below summarises the key climate changes, impacts, vulnerabilities and impacted sectors in The Virgin Islands. A detailed discussion of each impact area identified above follows.

LIKELY CHANGES	KEY IMPACTS	KEY VULNERABILITIES	IMPACTED SECTORS
Increasing air and sea surface temperatures *by 1°C - 5°C (1.8°F – 9°F) by the 2080s under the Medium-High Emissions Scenario relative to 1961 – 1990 temperatures.*	↑ incidence of climate controlled illnesses such as dengue fever	Incidence of dengue already at a record high in The Virgin Islands and wider Caribbean region, no vaccine available, mosquito outbreaks difficult to control	Human Health, Tourism
	↑ agricultural pests, weeds, and diseases	Existing food insecurity	Agriculture
	↑ incidence of heat stress	Summer temperatures can already be highly uncomfortable	Human Health, Tourism
	↑ incidence of coral bleaching	High dependence on coral reefs. Past bleaching events have affected over 90% of our coral reefs. Reduced resilience of coral reefs due to several other daily local impacts	Tourism, Fisheries, Coastal and Marine Ecosystems, Human Health
	Milder winters in tourism markets possibly reducing demand for winter getaways	High dependence on winter tourism	Tourism
	↑ spread of invasive species	Open borders and lack of strong standard operating procedures to monitor for invasive species at ports etc.	Agriculture, Forestry & Biodiversity , Human Settlements

Sea level rise *on average, of between 0.19 – 0.58 metres (0.6 – 1.9 feet) by the end of the 21st Century (2090 – 2099) relative to 1980 – 1999 levels.* Note: These projections are global, regional rise may vary as described above.	Permanent inundation or ↑ flood and storm surge risk to low-lying areas	Developments concentrated in low-lying coastal areas	Critical Infrastructure, Human Settlements, Tourism, Agriculture, Financial Services
	↑ beach erosion and loss of turtle nesting sites	↑ coastal and beachfront development, ↓ sand supply as reefs decline	Beach and Shoreline Stability, Tourism, Fisheries
	Mangroves forced into deeper waters or to migrate inland. Landward and alongshore migration of mangroves affected.	Many mangrove areas constricted from inland migration by roads and other hard structures, and are threatened by development.	Coastal and Marine Ecosystems, Fisheries, Tourism
↓in total amount of rainfall *up to 25% drier by the 2080s under the Medium-High Emissions Scenario relative to the 1961 – 1990 baseline.*	↓ supply of rainwater resulting in ↑ reliance on desalination and ↑ cost of water production	Rapidly ↑ population and per capita water demand	Water Resources, Human Settlements, Agriculture, Tourism
	↓ in agricultural production or increased cost of production	Existing food insecurity	

↑ in the frequency of heavier rain events ↑intensity of hurricanes (*wind, rains, and storm surges*)	↑ damage to human settlements, critical infrastructure, and crops and livestock	Limited safe shelters / harbours and emergency services, inadequate drainage systems, existing food insecurity	Tourism, Financial Services, Agriculture, Fisheries, Human Settlements, Critical Infrastructure
	↑ landslide potential	Proliferation of roads and development in steep hillsides	
	↑ damage to coral reefs	High dependence on coral reefs. Reduced resilience of coral reefs due to several other daily local impacts	
	↑ episodes of severe beach erosion	↑ coastal and beach front development, ↓ sand supply as reefs decline	

Table 8. **Key climate changes, impacts, vulnerabilities, and impacted sectors in The Virgin Islands.** Note: All important climate change impacts are not captured in this table.

3.1 | Beach & Shoreline Stability

Rogue's Bay before erosion due to the March 2008 "Big Swell Event" (Photo credit: Wilbert Chambers, Conservation and Fisheries Department)

Rogue's Bay after erosion due to the March 2008 "Big Swell Event" (Photo credit: Shannon Gore, Conservation and Fisheries Department)

Significance of issue

The Virgin Islands has approximately 150 sandy beaches across its collective coastline, 10-15 of which are widely used due to their easy accessibility [CFD & NPT, forthcoming]. Beaches are perhaps the most important tourist attraction, are an important source of recreation for island residents, and are critical habitat for some species, especially marine turtles. Shorelines are significant areas in The Virgin Islands society and economy as most of the Territory's critical infrastructure, commercial activity and traditional villages have evolved in the narrow coastal zone where practically all flat land is concentrated.

Potential climate change impacts

In the near-term, the primary climate change impact to beaches and the shoreline is more intense hurricanes and associated storm surges. Already, observations have shown an increase in the intensity of hurricanes in the Atlantic; as the climate continues to warm, the region can expect a switch to more categories 4 and 5 hurricanes (Henson, 2006; Wilkinson & Souter, 2008).

A single major hurricane can have a significant impact on beaches and the shoreline. Monitoring by the Conservation and Fisheries Department shows that Hurricane Hugo (1989), a category 4 hurricane when it passed 70 kilometres (43 miles) south of Tortola, caused beaches on Jost Van Dyke to erode an average of some three metres (nine feet) in width (cited in Petit & Prudent, 2008). A classic example of shoreline vulnerability to hurricanes and associated storm surges is the significant damage regularly sustained to the main road network between Towers and Pockwood Pond on Tortola.

Over the long-term, sea level rise becomes a climate change impact of significant concern. By the end of the 21st Century, average global sea level is projected to rise between 0.19 – 0.58 metres (0.62 – 1.90 feet) relative to 1980 – 1999 levels (Mimura et.al, 2007).

The implications of this are serious; it would mean that areas of beach and some low-lying areas of shoreline would be at risk of permanent inundation (flooding) (Nicholls et al., 2007). As a regional reference, scientific research indicates that sea level rise of 0.5 metres (1.5 feet) could consume on average up to 32% of beach area in Bonaire with lower, narrower beaches being the most vulnerable (Fish et al., 2005).

In addition, all coastal areas would be more prone to the effects of higher storm surges produced by stronger hurricanes (Mimura et.al, 2007). In this context Anegada, with a maximum height of just 5.5 metres (18 feet) above sea level, is particularly vulnerable and the long-term viability of such islands is questionable (Petit & Prudent, 2008; Mimura et.al, 2007).

With the combination of more severe hurricanes and sea level rise, increased coastal flooding as well as accelerated beach and shoreline erosion are anticipated (Mimura et.al, 2007). This would have implications for continued loss of real estate, the need to relocate or elevate main transport arteries and critical infrastructure / facilities,

investment in defense mechanisms to protect newly established shoreline boundaries, and legislative reform to reflect the changed 'landscape'. The economic impacts would be further felt as the picturesque tourism product would be lessened in value, particularly for high-end tourism, which The Virgin Islands has deemed its main focus.

Complicating factors

The ability of beaches and the shoreline to resist all the impacts described is compromised by secondary climate change impacts such as degradation of near shore coral reefs which currently act as an effective barrier to erosive waves (Sheppard, Dixon, Gourlay, Sheppard, & Payet, 2005). In addition, long-term trends of coastal development with minimum setbacks, removal of natural coastal defenses like mangrove forests and beach berms through sand mining, and hard defensive measures to combat sand loss have led to extensive diminishing in the size and integrity of beaches and shorelines in some areas such as Josiah's Bay and Brandywine Bay.

Records kept by the Conservation and Fisheries Department suggest that beaches in The Virgin Islands have been in a state of net erosion since hurricane Hugo, with beaches being one metre (three feet) narrower on average (cited in Petit & Prudent, 2008). In addition to insensitive development practices and sporadic hurricanes, extreme and highly erosive swells occur along the northern shores of The Virgin Islands on an annual basis from November to April. In March 2008 a slow moving, low-pressure system in the western Atlantic generated a very large swell with an approximate 1:20 year return (Cooper, Jackson, McKenna & Gore, 2008). The "Big Swell Event" generated severe erosion along most north shore beaches from which they are still not recovered.

3.2 | Coastal & Marine Ecosystems

Virgin Islands coral reef. (Photo credit: Shannon Gore, Conservation and Fisheries Department).

Healthy stand of mangroves at Han's Creek, Beef Island. (Photo credit: Shannon Gore, Conservation and Fisheries Department).

Significance of issue

Coral reefs, mangroves and seagrass meadows form a highly interdependent and valuable coastal and marine ecosystem network. This network represents significant potential revenue through fisheries and tourism - from diving and snorkeling especially, sizable savings in coastal defense, and potential medical cures. All three components of the network are, however, threatened by climate change.

Potential climate change impacts

Seagrass meadows

Seagrass distribution, growth, and community composition are influenced by several factors that will be altered by climate change, including salinity, temperature, sea level, carbon dioxide levels, storm intensity, and ultraviolet irradiance (Nicholls et al., 2007).

The primary impacts to seagrass meadows are expected through increased sea surface temperatures which could slow photosynthesis, increase respiration, and dry and burn seagrass near the upper tidal limit, thereby negatively affecting seagrass health and growth rates (Johnson & Marshall, 2007). On the flip side, increased levels of carbon dioxide could stimulate faster growth of seagrass meadows (Nicholls et al., 2007).

Mangrove forests

A mix of positive and negative impacts to mangroves is possible, with the net effect being determined by several country specific factors. On the positive side, warmer temperatures and high levels of carbon dioxide could increase mangrove growth rates. On the flip side, however, mangroves will likely suffer from saltwater intrusion, coastal erosion, and sea level rise (Nicholls et al., 2007). Long-term monitoring would be need to determine the net effect of these potentials locally.

As they inhabit the inter-tidal zone, the mangrove habitat niche is defined by sea level on one hand and hydrology of the land on the other. Mangroves are, therefore, naturally sensitive to predicted chances in long-term sea-level and rainfall patterns, especially in regions like the Caribbean where the tidal range is small (Nicholls et al., 2007). Although mangroves build up sediments that can counter the impact of sea level rise, global assessments have shown that many mangrove shorelines are already subsiding and retreating inland (Nicholls et al., 2007).

To illustrate the consequences of sea level rise, a recent United Nations Environment Programme (UNEP) study has modeled that about 13% of the mangrove area in 16 islands of the South Pacific could disappear with a sea level rise of 0.88 metre (2.9 feet), the worst case scenario proposed by the IPCC for that region (Petit & Prudent, 2008).

In addition, while mangroves are typically regarded as a source of protection in the face of hurricanes, these systems are not immune to high winds and raging seas. Guadeloupe, for example, lost 80% of its Red Mangrove biomass due to widespread damage during Hurricane Hugo (Imbert, 2002). As severe hurricanes become more likely

in the region, mangroves may not have sufficient time (typically ten years) to recover from a serious hit before being subjected to another (Petit & Prudent, 2008).

Coral reefs

Coral reefs are extremely delicate and sensitive ecosystems; they require clear, nutrient poor and relatively shallow waters, and can only tolerate slight deviations from average maximum ocean temperatures (as little as 1-2 °C / 1.8-3.6 °F) (Spalding et al., 2001).

With the advent of climate change, we can expect an increased frequency of coral bleaching events[1] as sea surface temperatures increase; increased physical damage to reefs from more intense hurricanes; and decreased coral skeleton growth rates and weakening of existing skeletons as the ocean becomes more acidic (ocean acidification) due to increased concentrations of carbon dioxide (Mimura et.al, 2007; Wilkinson & Souter, 2008). Ocean acidification not only affects the coral itself, but the "calcareous algae" that is important to cement the reef together (Johnson & Marshall, 2007).

Coral bleaching leaves coral vulnerable to algae overgrowth and diseases such as White Plague and Black Band that have been detrimental to Caribbean reefs (Nicholls et al., 2007). In turn, these combined impacts can seriously affect the abundance and diversity of reef fish that depend directly on the coral for food, protection, and a breeding ground (Petit & Prudent, 2008). Coral bleaching, therefore, affects the reefs much longer than temperatures remain elevated.

In the Fall of 2005 (on average the hottest year on record in the Northern Hemisphere) water temperatures in the Caribbean exceeded 29.5 °C (85.1 °F) for twelve (12) weeks, triggering a region-wide mass-bleaching event (Wilkinson & Souter, 2008). The Virgin Islands was among the worst affected with close to 90% of coral being bleached (Petit & Prudent, 2008; Wilkinson & Souter, 2008). Reef Check-BVI has estimated that 35% of coral has been lost since the bleaching event (cited in Petit & Prudent, 2008).

So far, there is limited evidence to suggest that corals and their zooxanthellae (co-dependent microscopic algae) can adapt to warmer waters; therefore, it is very likely that as ocean temperatures rise 1-3 °C (1 - 5.4 °F), the frequency and mortality rates of bleaching events will increase (Nicholls et al., 2007).

[1]Coral bleaching describes the loss of colour in reef-building corals and the subsequent exposure of their underlying bright white skeleton. Reef-building corals are highly dependent on a symbiotic (co-dependent) relationship with microscopic algae (zooxanthellae) which live within the coral tissues and give the coral its colour and most of its "food" resources. When ocean temperatures get too hot, corals eject their zooxanthellae and or the zooxanthellae lose their chlorophyll, resulting in coral bleaching. Because zooxanthellae supply corals with up to 90% of their energy, corals are weakened and susceptible when they are bleached and can die in extreme cases (Spalding et al., 2001).

Lastly, coral reefs may suffer from increased diseases triggered by the settling of more Sahara dust clouds in the region, which have been implicated in the general decline of reef health since the 1970s (Schmidt, 2001).

Complicating factors

Seagrass meadows have been traditionally undervalued and often seen as a hindrance in obtaining the perfect white sand beach for a beachfront resort. As such, seagrass meadows outside of protected areas are often very vulnerable to destruction by development.

Mangroves, especially Red Mangroves, are frequently regarded as eyesores and impediments by developers and many residents and so are cut down to facilitate coastal developments such as marinas. On Tortola, for instance, at least 47% of the original mangrove area has been destroyed in this way (Dr. Jarecki, 2006). Although mangroves have some capacity to migrate inland to escape the threat of rising seas, in The Virgin Islands it is often the case that mangrove forests are pinned in by hard structures such as roads and are, therefore, relatively helpless.

The ability of coral reefs to adapt to the impacts of climate change rests heavily on the degree of stress imposed locally from other human impacts and the frequency of future bleaching events (Nicholls et al., 2007). In The Virgin Islands, more than 90% of coral reefs are under stress or have already been impacted by human activity, including sedimentation, anchor damage, snorkeler and diver damage, and pollution from sewage outfalls and diffuse land-based run-off (Burke & Maidens, 2004; Petit & Prudent, 2008).

Because coral reefs serve as such an effective shoreline barrier, the pending degradation and or loss of reefs will amplify other climate change impacts, particularly the effect of more intense storm surges on coastal communities and infrastructure. This was demonstrated vividly with the recent passage of hurricane Ivan over the Cayman Islands, for example, where there was a clear relationship between higher levels of coastal erosion and the absence of shallow coastal reefs (Petit & Prudent, 2008).

3.3 | Critical Infrastructure & Human Settlements

Stretch of main road between West End and the capital, Road Town, severely damaged after the passage of hurricane Georges in 1998, a category 2 storm. (Photo credit: Department of Disaster Management).

Hurricane damage to Long Bush, a low-lying inland community on the outskirts of Road Town. (Photo credit: Department of Disaster Management).

Significance of issue

Critical infrastructure is comprised of those assets essential for the functioning of a society and economy. This includes the road network, schools, community and emergency centres, police and fire stations, health facilities, public administration buildings, the financial centre, airports and major hotels; facilities and distribution systems for critical utilities including electricity, telecommunications and water as well as the sewerage system. In addition to existing critical infrastructure, developable lands suited and air-marked for critical infrastructure must be considered. Human settlements describe the variety of towns, villages, and other spaces that human populations inhabit. Adequate, secure, and healthy human settlements are a key indicator of quality of life.

Potential climate change impacts

Climate change poses similar threats to both critical infrastructure and human settlements.

Firstly, there is the elevated threat of serious damage to windows, roofs, other vulnerable points, and entire structures by the stronger wind force and heavier rainfall associated with more intense hurricanes. The degree of vulnerability to this threat is controlled by a number of factors, including the integrity of structures, exposure to strong winds, floodwaters, and landslide debris based on location, and the degree of preparation taken. Figure D2 in Appendix D shows the comparative wind hazard across The Virgin Islands; the hilly interiors tend to experience the strongest winds.

Secondly, there is the threat of temporary and permanent coastal flooding as stronger storm surges occur as a result of more intense hurricanes and sea level rises (Mimura et.al, 2007; Petit & Prudent, 2008). It should be noted that the impact of storm surges of any strength will increase with sea level rise. The degree of vulnerability to these threats is primarily controlled by elevation and setback from the coastline as well as the existence of natural or man-made coastal defences.

Thirdly, there is the increased threat of rainfall-induced flood events as climate models predict more frequent heavier rainfall events for the region, despite an overall decrease in rain; this is due to changes in the patterns of rainfall (Mimura et.al, 2007). The November 2003 flood, in which an average of 20 inches of rain fell in 5 days, as well as the 2006 flood provide insight into the impact of such events (DDM, 2003). Total losses from the 2003 flood (response/relief costs, rehabilitation costs, and reconstruction costs) were extremely high, estimated at US$19,147,898.00 (DDM, 2003). The degree of vulnerability to this threat is primarily controlled by two factors – location and drainage. Some areas (floodplains) are naturally prone to flooding. These are typically low-lying areas at the foothill of one or more major natural drainage pathways (“ghuts”). In other areas the natural drainage ability has been reduced (for example through the removal of wetlands, blockage of ghuts, and intensive development that limits the permeable area for soil absorption) and inadequate or no engineering drainage solutions constructed, thus resulting in flooding.

In addition to the flood potential, more frequent heavier rainfall episodes raise concern for massive slope failure. Landslides can complicate flooding issues by creating substantive rock and sediment flow that can choke ghuts and drainage systems, block roadways, and cover and or damage buildings.

Although natural slope failures in The Virgin Islands are uncommon, they can be triggered by rainfall events that are either very high intensity or very long in duration (Joyce, 2003). The report following the November 2003 flood event warns that "given the present concern over climate change and recent unusual precipitation events in the British and American Virgin Islands the potential hazard and associated risk of slope failure can not be taken lightly" (Joyce, 2003). Studies have determined that areas underlain by colluvial deposits are most vulnerable to slope failures/landslides; these areas are shown for Tortola in Figure D3 in Appendix D and in many cases tend to follow the natural drainage system of ghuts (Joyce, 2003). Figure D4 in Appendix D highlights landslide hazard areas for Tortola; many of these are located in the coastal zone.

The road network

The coastal road network, the primary mode of transport in the Territory, is highly vulnerable to climate change impacts as large segments are low-lying and directly adjacent to or very near the sea.

On Tortola these road segments particularly include those on the western section of the south coast from West End to the Waterfront in Road Town and the coastal villages on the northwest of the island from Long Bay to Brewer's Bay. During hurricanes, significant damage is regularly sustained to the stretch of coastal road between Towers and Pockwood Pond for instance, which is critical for connecting the western communities to the capital. On Virgin Gorda, particularly vulnerable road segments can be found in the South Sound and pockets of The Valley. On Anegada, the road segment on the southern coast from Pomato Point to the Settlement is particularly exposed, and on Jost Van Dyke road segments of most concern are in the Great Harbour and White Bay areas.

The interior road network is also highly vulnerable in some places where its integrity has been undermined by erosion on a continuous basis and during heavy rain events. During the November 2003 flood, the Territory experienced a "significant amount" of slope failures on the "upper hill slopes" and "rock cuts" leaving some hillsides unstable. This resulted in severe erosion and blockage of inland and coastal road systems with some being severely undercut and not safe for two lane vehicular traffic, such as in Anderson Estate (Joyce 2003).

Critical facilities and utilities

As shown in Appendix E, most critical facilities and utilities identified above are located in the low-lying coastal zone - areas highly vulnerable to sea level rise, storm surges, and flooding in some cases. Damage estimates from the November 2003 flood

(US$19,147,898.00) demonstrate that a singular flood event can be extremely costly. The electrical supply and telecommunications systems tend to be sensitive to heavy rains and were severely interrupted, for example, during the November 2003 flood and the far lighter November 2009 rains; damages for the latter totaled $45,000 for instance (DDM, 2009). While efforts have begun to bury electrical lines, the majority of the network remains aboveground where it is highly exposed to wind damage during strong hurricanes.

Regardless of location, all critical facilities and utilities are more vulnerable to stronger hurricanes. Experience with past category 4 and 5 hurricanes show that total Territory-level damages are very expensive and range between $29 million and $40 million (DDM, 2002). The 2005 Quantitative Risk Assessment Project, commissioned by the Department of Disaster Management, assessed the vulnerability of 45 public buildings and shelter facilities to hurricanes. For each building a damage curve was developed that shows the percentage structural damage that can be expected for hurricanes of different intensities according to the standard Safir-Simpson scale. The study shows that for category 4 hurricanes, damages would range from 11% to 70%, with most public building and shelters falling in the upper part of that range (38% to 70% damage). For category 5 hurricanes, damages would range from 31% to 77%, again with most public buildings and shelters falling in the upper part of that range (69% to 77% damage) (Virella Crespo & Young, 2005).

The Sewerage System

The Virgin Islands sewerage system is primarily limited to a collection and discharge system, that is, for the most part there is no treatment component.

According to Mr. Aki Boland, former Deputy Sewerage Operations and Development Officer, Water and Sewerage Department, the sewerage system was built in 1977 (with continued expansion up to the 1990s) and serves the greater Road Town area from Baughers Bay to Prospect Reef, including the highly populous areas of Purcell Estate, Lower Estate, Huntums Ghut, and parts of Horsepath. Today the system is sorely inadequate for its number of users and is largely in a state of disrepair. In 1994 another system was built in Cane Garden Bay, a residential and very popular tourist area. This system includes a treatment component (secondary level) and is in better overall condition, but the lift stations are in need of some works (Boland, A. personal communication, January 28, 2010).

Several characteristics of the existing Road Town system makes it highly vulnerable to climate change impacts, particularly flooding and stronger storm surges.

The existing sewerage system was not designed to cater for stormwater. Already at overcapacity, it can not handle the excess rainwater (stormwater) that naturally infiltrates the system during heavy rain events. When this happens, there is a high risk of an overload on the pump stations (responsible for continuously pumping the sewage

out to sea) resulting in the system "backing-up" and discharging sewage in the streets at vulnerable points along the collection network (Boland, A. personal communication, January 28, 2010).

This reality was played out in November 2003 when the entire Road Town area flooded, including the main sewage pump station that is basically at ground level. The pumping system throughout the sewerage network could not handle the influx of stormwater, resulting in some manholes lifting up and flood waters being contaminated with sewage.

In Cane Garden Bay, flood waters were also contaminated with sewage. Unlike the sewerage system in the greater Road Town area, none of the system there depends on gravity feed to move sewage to the treatment plant. Because the electrical supply was interrupted during the November 2003 flood, the residential pump stations were non-functional, resulting in system overflow. Some pump stations particularly close to the shoreline also incurred physical damage. In addition, the treatment plant flooded, but damage to equipment was minimised as most are elevated. Since the 2003 flood event, some measures have been taken to reduce future flood damage to the system in the Cane Garden Bay area.

While most of the Road Town sewerage collection system is not exposed to the forces of the sea, stronger storm surges can potentially damage lift stations close to the coastline, especially given the weakened state of the infrastructure. In addition, the outfall line itself that runs along the sea-bed and discharges the sewage at sea can be broken or otherwise impaired during strong storm surges.

In 2002 Government finalised a National Sewerage Development Programme that calls for the sewerage collection system to be extended across the entire Territory and identified East End and the business district of Road Town as priority areas for action.

In keeping with the Programme, the current Government has commissioned Biwater to overhaul the existing sewerage system in the Road Town area and construct a sewage treatment plant at Road Reef Marina to serve the area with a capacity suitable for about 15,000 residents with the option of future expansion. Work on the system is expected to begin later this year (2010). The new system will be a strict sewerage system (that is not a combined sewerage/stormwater system), but will be designed with enough capacity to handle excess stormwater in times of heavy rain. Action will also continue to address the issues in East End with the completion of the sewerage collection system, transmission main and installation of a sewage treatment plant at Paraquita Bay to serve the area.

Human settlements

Human settlements particularly vulnerable to the threat of sea level rise and stronger storm surges include those coastal villages on the northern coast of Tortola between

Long Bay and Brewers Bay, such as Cane Garden Bay, as well as Little Elizabeth Bay and Josiah's Bay. Lambert Bay, a potential area for further housing development is among the areas most vulnerable to storm surges. Selected villages on the south coast, including pockets of Sea Cow's Bay, Brandywine Bay, Fat Hog's Bay, and East End, are also vulnerable in this regard.

In the sister islands, areas of concern in terms of sea level rise and stronger storm surges include, for example, Devil's Bay, pockets of The Valley, and the South Sound in Virgin Gorda; Great Harbour, White Bay, and Little Bay in Jost Van Dyke; and all coastal communities in Anegada. Figures C1, C3, C4, and C5 in Appendix C show areas of coastline equal to or less than 2 metres above sea level and provide some rough insight into communities that may be vulnerable to sea level rise and stronger storm surges. Figures D5 to D8 in Appendix D provide storm surge inundation maps for the four main islands under current circumstances.

In November 2003 many residential areas, particularly Purcell Estate, Greenland, Paraquita Bay, Fat Hog's Bay, Josiah's Bay, Tower's, Capoons Bay, Carrot Bay, Cane Garden Bay, and Brewers Bay suffered severe flooding; these areas are among those shaded in Figure D9 in Appendix D and should be considered vulnerable to future flood events (DDM, 2003).

Complicating factors

In The Virgin Islands duplication of critical infrastructure is limited, making the rendering of critical services highly vulnerable to any shock to the system. This, for example, is the case with emergency services and transportation services by air and land. In the event of natural disasters, emergency services may be cut off or severely hampered to several nodes of development due to damage to their singular access roads or other means and modes of access.

Furthermore, the simple reality that most critical infrastructure is concentrated in low-lying coastal areas to service the centres of commercial and residential development makes these facilities particularly vulnerable to the impacts described (Petit and Prudent, 2008). The fast pace of coastal landfill suggests that this pattern of development is set to continue unless there is clear policy intervention.

Human settlements fall into fairly distinct groupings in The Virgin Islands. Traditional family settlements or villages have developed most often in low-lying coastal areas and valleys. Since the rise of the tourism and the financial services sector a number of apartment complexes have sprung up in these villages and surrounding hillsides to accommodate immigrant workers. The wealth generated from these industries has resulted in a new generation of more luxurious homes scattered across the hilltops.

Of these groupings, the low lying traditional villages are perhaps most at risk from the combined threat of sea-level rise and more intense hurricanes and storm surges. Unfortunately, many residences in such villages are uninsured or underinsured and

occupied by lower-income families, making these villages less resilient. A factor that should help negate the impacts associated with increased hurricane intensity is the relatively high standard of construction practiced in The Virgin Islands across the board.

The threat of loss of lands and homes as sea level rises may bring to bear interesting but complicated legal questions of right to compensation and responsible parties. Should a property owner affected by sea level rise simply suffer the loss or is the local Government or some other party responsible for compensating property owners so affected? These questions become even more complicated when the Government is involved in allocating Crown Lands into private ownership as is the case in Anegada.

3.4 | Energy Security

Tanker delivering diesel to the BVI Electricity Corporation power generation station at Pockwood Pond. (Photo source: Conservation and Fisheries Department).

Solar panels on a house roof, a source of clean renewable energy for The Virgin Islands. (Photo credit: EnviroHub.net).

Significance of issue

The Virgin Islands depends heavily on fossil fuels to drive its service-based economy, render critical services, provide modern day comforts, and even power the production of desalinated water upon which the Territory heavily depends. Energy consumption and the associated costs of production are quickly rising in the Territory.

The burning of fossil fuels to produce energy has been recognised by the international scientific community as the primary cause of climate change; carbon dioxide emitted during the process is building up and trapping excess heat in our atmosphere, thereby warming the Earth (Henson, 2006; Pachauri, et al., 2007). Although The Virgin Islands' and the Caribbean's total carbon emissions are insignificant in global terms (accounting for far less than 1% of the global total), our per capita emissions, while relatively low, leave room for improvement (Dr. Trotz, 2009).

Potential climate change impacts

One obvious and direct implication of warmer temperatures, especially in the summer months, is an increase in demand for cooling of buildings and cars, which naturally results in an increased demand for electricity and gasoline. The former puts greater pressure on the electrical generating capacity of the Territory, and increases business overheads and household expenditure (Wilbanks, et al., 2007).

In addition, the Territory's electricity generating and distribution infrastructure is quite exposed to the climate change impacts discussed elsewhere, including a greater risk of coastal and inland flooding, stronger hurricanes and storm surges, and sea level rise. The main power generating plant at Pockwood Pond, for example, sits at the base of a major ghut, making it vulnerable to flooding in heavy rain events without a well-engineered drainage system. Furthermore, the plant is in the low-lying coastal zone with some components very close to the sea, and these may become within the reach of stronger storm surges, especially as sea level rises. Certainly the above ground distribution network (electrical poles and lines) - much of which is found along the main coastal road network - is highly vulnerable to widespread damage during more intense hurricanes and storm surges, and in the long-run to sea level rise.

On a more indirect basis, the advent of climate change will likely cause each country to rethink its energy consumption patterns, regardless of its overall contribution to the problem (Wilbanks, et al., 2007). From a purely economic perspective Caribbean countries, including The Virgin Islands, already spend a significant percentage of their limited foreign exchange earnings (that could be otherwise invested) importing fossil fuels, and climate change is likely to increase fossil fuel bills (Dr. Trotz, 2009).

Additionally, energy policies in small island developing states (SIDS) could fall under scrutiny as the international community tackles climate change and developed and developing countries alike are called on to reduce their emissions. If small island developing states like The Virgin Islands are going to have maximum bargaining power on the global stage in asking for greater emission cuts by the big polluters, these islands must send a positive signal by taking efforts to lower their own emissions.

Complicating factors

As a Territory without any fossil fuel reserves, the energy security of The Virgin Islands is highly vulnerable to global shocks in the production, distribution, and price of fossil fuels. The Virgin Islands is rich in solar and wind energy, however, and based on research and implementation in other tropical regions, these alternatives pose a viable and increasingly affordable option to gradually reduce our dependence on fossil fuel and our carbon emissions (Weisser, 2004; Caribbean Natural Resources Institute (CANARI, 2008 a). The integration of these as an energy source is frustrated, however, by antiquated laws that prevent individuals to produce their own electricity except in very limited circumstances, for example (BVI Electricity Corporation Ordinance Cap. 277).

3.5 | Food Security: Agriculture & Fisheries

Destroyed banana field after the passage of Hurricane Georges. (Photo credit: Department of Disaster Management).

Catch of Red Hind during an annual Fisherman's Day celebration. (Photo credit: Conservation and Fisheries Department).

Significance of issue

The Virgin Islands was traditionally a subsistence economy depending on small-scale agricultural production and fisheries. While both activities have taken a back seat in the post 1960s monetary economy, their economic potential remains and they are still of significant cultural and livelihood value. Expansion of agricultural and fisheries production is imperative for the tourism sector that demands fresh local foods, as well as for the Territory's food security in emergencies, global economic crises and business as usual scenarios. Commercial and sport fisheries have been identified as a potential third pillar of the Territory's economy; they are an important feature in the tourism product, and the former provides a chief source of high quality protein for local consumption.

Potential climate change impacts

Agriculture

The impact of climate change on agriculture will be mixed and varied by region. Some mid-latitude countries, for example, are expected to see increased crop productivity as temperatures and the level of carbon dioxide rise, thereby lengthening the growing season and increasing growth rates. On the other hand, most small island developing states are expected to see a net negative impact on crop productivity (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005).

In The Virgin Islands, climate change threatens to impact agricultural production through reduced rainwater and changing rainfall patterns, decreased soil integrity, increased pests and diseases, and direct damage to crops (Mimura et.al, 2007).

As described earlier, climate change is causing the region to become drier overall (up to 25% drier by the 2080s), but is increasing the frequency of heavier rain events (Mimura et.al, 2007; Taylor et al., 2007). These changes in rainfall patterns increase the potential for drought and flood events, both of which disrupt agricultural production and result in crop damage (Mimura et.al, 2007; St. Lucia Ministry of Physical Development, Environment, and Housing, 2005).

According to Mrs. Arona Fahie-Forbes, Deputy Chief Agricultural Officer of The Virgin Islands, over the last few years, the local farming community has noticed extended dry seasons; this is consistent with observations and measurements elsewhere in the region (Fahie-Forbes, A., personal communication, July 2009; Taylor et al., 2007). An interesting side effect of this locally has been increased ravaging of producer's fields (e.g. tomato beds) by Pearly-eyed Thrashers, Sparrows, Ground Doves and other birds. The theory is that these birds are no longer able to find sufficient food in the wild as the vegetation they typically feed on suffers from the extended dry seasons as well (Fahie-Forbes, A., personal communication, July 2009).

Several studies have shown that, in general, existing agricultural pests, weeds, and disease-causing pathogens will likely become more prevalent in the future due to higher

concentrations of carbon dioxide (CO_2), warmer soil temperatures, and changes in humidity (Backlund et al., 2008). Climate change could also make conditions riper for the introduction of new climate-controlled diseases, as well as invasive (foreign) microbes and pests.

Although not attributable to climate change, the Pink Mealybug that was introduced to The Virgin Islands in 1995 is an example of the significant crop damage that can be done by just one invasive pest (Fahie-Forbes, A., personal communication, July 2009).

As a result of sea level rise, low-lying agricultural lands may be degraded due to soil salinisation (intrusion of saltwater) (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005). Already, some agricultural land adjacent to the public road at Paraquita Bay had to be abandoned due to high salt content in the soil; it is unknown how much of this is due to sea level rise versus historical use of wells in the area. Soil integrity may also be reduced by more frequent heavier rain events that can leach (wash out) important nutrients for crop growth and cause soil erosion (Easterling et al., 2007).

All of the impacts described above will likely result in the decreased production of many important food staples in the region and The Virgin Islands. Regional models have already identified cassava, sweet potatoes, and sugar cane as three crops that could suffer negative impacts (Rivero Vega, 2009).

In addition, stronger hurricane events threaten more widespread and costly damage to crops and agriculture infrastructure from wind damage, flooding, and soil erosion (Mimura et.al, 2007)). Bananas, plantain, and perennial fruit trees (such as mangoes, avocados, and breadfruit) are, of course, naturally very vulnerable to intense hurricanes (Petit & Prudent, 2008; Fahie-Forbes, A., personal communication, July 2009).

Although effects on livestock production may not be as direct, some climate change impacts are expected. A decrease in productivity may arise from physiological stress of the animals due to increased temperatures, decreased water for drinking or to maintain pastures, and increased diseases (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005).

From a global perspective, local food security will be challenged by potential changes in the availability, cost, and quality of imported foods as climate change will have impacts (both positive and negative) on the major breadbaskets (food producing regions) of the world (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005). The World Food Programme has expressed serious concern about what it describes as a "wave of food-price inflation moving across the globe, leaving in its wake drastically increased levels of hunger and poverty" and has identified increased energy costs and increasing climate shocks, such as droughts and floods, as two of the key factors responsible (World Food Programme, 2008). Not only will the Territory have to deal

with increased costs from these factors, but also likely increased shipping costs as an indirect result of climate change.

At the North American continental scale, the vulnerability of food and fiber production is thought to be low; however, there is expected to be variation in losses or gains at the sub regional level (Shriner & Street, 2000). In 2003, for example, drought affecting several states in the United States of America was partly to blame for the decline in cereal production that lead to a shortage of some 93 million tons on global food markets (Petit & Prudent, 2008).

Fisheries

The impact of climate change on commercial and recreational fisheries has not yet been fully assessed and considerable uncertainty remains in this area. Like with agriculture, some positive impacts may occur; for example, warmer waters may increase fish larval growth rate and swimming ability while decreasing the age of metamorphosis; all of which could improve the survival of larval fish (Johnson & Marshall (eds), 2007).

Studies so far, however, also indicate cause for concern. Important commercial species in The Virgin Islands such as Yellowtail Snapper and Red Hind depend heavily on coral reefs and mangroves. As described above, these ecosystems are significantly threatened by climate change. Bleaching, increased incidence of disease, and reduced complexity of coral reefs, for example, will be felt right up the food chain and reflected in reduced abundance of reef-associated fish and changes in fish species composition, favouring smaller generalist species and those lower on the food chain (Mimura et.al, 2007; Johnson & Marshall, 2007). Already scientists are observing a sudden and rapid decline in Caribbean reef fish densities since 1995, on the order of 2.7 – 6% loss per year as a result of coral reef degradation from various sources, including warming waters (Cell Press, 2009).

Also of concern is the ongoing impact of climate change on plankton abundance, community structure, timing of seasonal abundance, and geographical range (Hays et al., 2005). Plankton consists of microscopic plants (phytoplankton) and animals (zooplankton) that drift in the ocean and form the base of the marine food web. All species of fish feed on plankton during their larval (early) stage and some species continue to depend on it into their adulthood. Long-term changes in plankton such as those predicted with climate change can, therefore, have a significant impact on commercial fish stocks (Hays et al., 2005). In The Virgin Islands this would include species such as Blue Runner (Hardnose), Wahoo, Yellow Fin Tuna, Dolphin Fish (Mahi Mahi) and Swordfish.

Rising sea temperatures will also have a significant impact as fish species are very sensitive to slight changes (a few degrees) in ocean temperature and warming will cause migration to new areas or depths with cooler waters (Mimura et al., 2007). The habitat

for Dolphin Fish, for example, will become significantly less favourable with just a 1 °C (1.8 °F) increase in the average temperature of the Caribbean Sea (Dr. Trotz, 2009).

Fish distribution can also be impacted if climate change causes shifts in ocean currents and other oceanographic conditions that help to determine where fish settle out in their larval stages and influence their migration patterns and other dynamics in their adult stages (Johnson & Marshall, 2007). While these changes may result in the loss of established fisheries, they may also give rise to new fisheries.

The rise in ocean temperatures and change in species composition could lead to decreases in spawning opportunities, increased mortality, and increased incidence of disease in favoured commercial species such as Yellowtail Snapper and *Epinephelus striatus* (Nassau Grouper) (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005).

Temperature changes in the ocean could also create more favourable conditions for the establishment of invasive species as natural ecosystem processes are disrupted (IUCN, n.d.). Invasive species tend to out-compete or prey on native species. Although not attributable to climate change, the recent invasion of *Pterois volitans* (Lionfish) in the Caribbean Sea and the effects this has already had on fisheries in the Turks and Caicos Islands demonstrates the damage that just one marine invasive species can do (Schofield, 2009; School for Field Studies, 2009).

Climate change may also trigger changes in the salinity and nutrient content of the Caribbean Sea due to increased river outflows and higher rates of evaporation. Research has shown that the salinity of the surface Atlantic waters between latitudes 25°S and 35°N (the high-evaporation zone within which The Virgin Islands lies) has already increased by +0.1 to +0.4 p.s.u (practical salinity units) over the time period 1985-99 as compared to 1955-69 (Curry et al., 2003). Many studies have shown that fish development and growth is influenced by salinity (Bœuf & Payan, 2001), however, no studies were found that discuss how climate change induced increases in salinity may affect fisheries in the region.

Based on practical experience, even short term changes in water quality (salinity and nutrient content) have an impact on local fisheries. In April 2009 The Virgin Islands and Lesser Antilles waters experienced a strong influx of high nutrient freshwater runoff from the Orinoco River in Venezuela. According to Mr. Ken Pemberton, Fisheries Assistant at the Conservation and Fisheries Department, this influx temporarily impacted water quality, impairing fishing conditions and reducing catch (Pemberton, K., personal communication, October, 2009). As climate change causes increased heavier rain events in the region, the influence of the Orinoco River runoff on regional waters and their fisheries may increase.

Finally, more severe hurricane events and sea level rise could easily result in near and long-term damages to landing sites and other on-shore fisheries facilities with implications for productivity, and insurance and construction costs (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005).

While not discussed in this section, climate change is predicted to increase rates of ciguatera (fish poisoning). More details on this are provided in the Human Health section of this Paper.

Complicating factors

Several characteristics of the local agricultural sector reduce its resilience to anticipated changes in climate. Many agricultural producers are directly dependent on rainfall as a freshwater supply. While most have personal containers (up to 500 gallons) to collect and store rainwater, successful efforts to engineer dams or holding ponds to capture and store water on a larger scale have not materialised on a sustained basis (Fahie-Forbes, A., personal communication, July, 2009). While access to desalinated water has prevented water shortages so far, this means of supply is not favoured as it is chlorinated and expensive.

Existing impacts on the fisheries, including degradation of coral reefs and episodes of overfishing, particularly by foreign vessels, complicate the climate change impacts described above. Interestingly among the impacts, while minimal compared to others, is runoff from insensitive agricultural practices, such as excessive use of fertilisers and pesticides that pollute the near shore fisheries habitat. Whatever the current impact, increased water temperatures will potentially amplify the situation.

3.6 | Forestry & Biodiversity

Typical Virgin Islands dry forest. (Photo credit: Conservation and Fisheries Department).

The Magnificent Frigatebird has a globally significant colony in The Virgin Islands. (Photo credit: Darwin Initiative - Anegada).

Significance of issue

Biodiversity describes the variety of flora and fauna (plant and animal life) and the ecosystems that support them. The biodiversity of The Virgin Islands is rich and includes several rare, endemic, and or endangered species of plants, reptiles, birds, bats, and sea turtles.

All biodiversity has value, both intrinsic and from a socioeconomic perspective. When properly preserved and interpreted, the Territory's biodiversity represents a considerable untapped tourist attraction that could support a new brand of eco-tourism. Moreover, our terrestrial (land) and marine biodiversity provide priceless ecosystem services and could hold valuable medicinal properties. In the terrestrial environment, moist and dry forests are a critical ecosystem, providing habitat for many bird and reptilian species, as well as essential functions such as water and soil conservation. In the marine environment, mangroves, seagrass beds, and coral reefs provide a range of tourism, food, recreational, and protective services and support a diversity of fish and other marine life.

Potential climate change impacts

Climate change is projected to have a profound effect on biodiversity globally. The IPCC reports that global warming exceeding 1.5 - 2.5 °C / 2.7 – 4.5 °F (in relation to 1980 – 1999 temperatures) would likely put 20-30% of plant and animal species accessed so far at greater risk of extinction (IPCC, 2007). If average global warming exceeds 3.5 °C / 6.3 °F the situation becomes far more grave, with models predicting the extinction of 40-70% of known species (IPCC, 2007). Climate change can result in species extinction through many mechanisms, including accelerated habitat loss, introduction of invasive species, and direct impact from more severe weather events.

The impacts of climate change on marine biodiversity have mainly already been discussed in the Coastal and Marine Ecosystems and Food Security: Fisheries sections. The discussion below focuses on the impacts to terrestrial biodiversity through consideration of impacts to forests, birds, and bats. Sea turtles, not discussed earlier, are also given special treatment here.

Forest habitats in hilly volcanic islands like The Virgin Islands are inherently vulnerable to climate change. Forests tend to be divided into several bio-climate zones controlled in large part by moisture availability, with drier vegetation dominating at the coast and moist forests at the mountain peaks (Petit & Prudent, 2008). Climate change will result in higher temperatures and will likely reduce overall rainfall, the combination of which would force bio-climatic zones to "migrate" to higher altitudes in search of cooler and moister conditions (Petit & Prudent, 2008). This poses a problem for moist forests already at the mountain peaks with essentially nowhere to migrate. Unfortunately, it is the moist forests that are typically most biodiverse (Petit & Prudent, 2008). More severe hurricanes would exasperate forest habitat loss. Studies in Puerto Rico, for example, demonstrate that hurricanes significantly elevate tree mortality rate, up to seven times the background level (Mimura et.al, 2007).

Stronger hurricanes packing violent winds and torrential rains pose a heightened risk to all biodiversity for obvious reasons, with bats and birds among those particularly vulnerable. After Hurricane Hugo, for example, bat populations in Montserrat declined by 20 times and changes in population composition were recorded (cited in Petit & Prudent, 2008). Hurricanes can force birds to deflect from their regular migration route leading to physical exhaustion and can disrupt feeding and reproductive cycles (cited in Petit & Prudent, 2008). As birds are inherently highly climate sensitive, small changes in temperature and rainfall patterns can also greatly affect these cycles (Petit & Prudent, 2008).

Sea turtles depend on healthy sandy beaches with the right temperature and texture for nesting. Sea turtles are expected to be greatly impacted by climate change through two primary mechanisms: a) warming of beach sand which would skew the sex ratio of hatchings (at greater than around 30 °C / 86 °F only female turtles are produced) resulting in future breeding issues (Lovich, J.E. (n.d.), and b) sea level rise and more intense hurricanes which are steadily diminishing turtle nesting habitat as beach erosion becomes more dramatic and prolonged.

Studies in Bonaire predict up to a 32% reduction in beach area by 2100 with a sea level rise of 0.5 metres (1.6 feet), near the upper limit of the IPCC predictions (Fish et al., 2005). In 2009, as a result of the 2008 Big Swell Event that significantly eroded all north shore beaches, leatherback turtles attempting to nest in The Virgin Islands experienced difficulty finding a secure sandy area far enough inland.

While climate change may threaten some cherished native species and ecosystems, it may provide ripe conditions for the proliferation of invasive species introduced accidently or purposely through trade. Invasive species tend to out-compete or prey on native species, thereby reducing biodiversity (Petit & Prudent, 2008).

Complicating factors

Compounding the climate change impacts discussed above are the numerous longstanding stressors which are affecting the biodiversity of The Virgin Islands, including rapid habitat loss, relatively weak legal protections, and low populace knowledge and appreciation of the significance of biodiversity.

3.7 | Human Health

The Aedes aegypti mosquito, carrier of the dengue fever virus. (Photo credit: James Gathany)

Woman using an asthma inhaler. Asthma is likely to become more prevalent with climate change. (Photo credit: Getty Images).

Significance of issue

Health is a critical indicator of quality of life and is one of the foundations of sustained economic growth. Concerns over human health also significantly influence decisions to visit countries. A study by the University of East Anglia conducted in Bonaire revealed that low health risk ranks with warm temperatures and clear waters as the top three environmental factors influencing choice of vacation destination (Uyarra, et al., 2005).

Potential climate change impacts

Climate change will likely have a number of human health implications, including increased likelihood of infectious diseases, respiratory diseases, and water and food-borne illnesses, as well as increased risk of heat stress (Mimura et.al, 2007).

With warmer temperatures, changes in humidity, and more episodes of heavier rainfall, the frequency and severity of Dengue Fever outbreaks is expected to increase (Mimura et.al, 2007). Currently the number of Dengue cases in the Caribbean increases in warm ENSO years and during the annual rainy season (Mimura et.al, 2007).

Over the last twelve (12) years Central America, South America, and the Caribbean have seen a marked increase in the incidence of Dengue Fever with 2008 being a record-breaking year in which close to 909,000 cases were recorded, of which 12,398 were from the Caribbean (PAHO, 2008). In 2009 the number of recorded cases increased to 34,997 (PAHO, 2009). Regional data for 2010 so far suggests that this year will be another record breaking year. In 2008 The Virgin Islands recorded 87 suspected cases of which 23 were confirmed; this is the largest outbreak recorded and represents a significant increase compared to other years earlier this decade. The 2009 figures were not available at the time of publication.

According to Mr. Minchington Israel, Programme Manager for Vector Control at the Environmental Health Division, in The Virgin Islands most dengue cases occur in the coastal communities. This is especially true for those that are more densely populated and highly reliant on the frequently interrupted public water supply; interruption encourages a pattern of water hoarding, making breeding conditions more available to mosquitoes. Also, rainfall in excess of 2 inches over a few days causes a dramatic upsurge in Aedes aegypti (and other species) mosquito breeding due to the abundance of containers that householders make available to them (Israel, M., personal communication, November 23, 2009).

The increased threat of respiratory diseases such as Asthma is due to expected increases in the prevalence of allergenic plant pollens, soil fungi, and toxic mold as temperature warms, the level of carbon dioxide increases, and flooding becomes more common (Epstein & Mills, 2005). Another significant contributing factor is increasing Sahara Desert dust clouds reaching the Caribbean since the 1960s as a result of desertification and changes in the Atlantic Trade Winds. Already the Caribbean and South and Central America receive an annual dose of several hundred million tons of African dust (Gyan et al., 2005). A study out of Trinidad, which experiences one of the highest Asthma rates in

the world, shows that there is an association between pediatric asthma hospital admission rates and Saharan dust cover (Gyan et al., 2005).

Increased flooding and more severe hurricane events raise the concern for infectious diseases such as Leptospirosis (a bacterial infection transmitted by rodents and contracted by humans through ingestion of contaminated food or water or contact of broken skin or mucous membranes with contaminated water or soil), and diarrheal diseases such as Cryptosporidium, transmitted by water (Mimura et.al, 2007). Leptospirosis and Cryptosporidium are both endemic to the Caribbean region; semi-arid islands like The Virgin Islands are least vulnerable, but this may change as heavier rainfall events become more common (Everard & Everard, 1993).

While the threat of heat waves is somewhat negated by the cooling effect of the Northeast Trade Winds, with temperatures potentially rising by up to 9°F by 2100, with greatest warming occurring in the summer months, this is nonetheless a concern, especially for the more vulnerable young and elderly populations. Already, evidence from the Caribbean shows that the percentage of days with very warm maximum and minimum temperatures has increased considerably since the 1950s with a simultaneous decrease in the number of colder days (Mimura et.al, 2007; Taylor et al., 2007).

Of further concern is the proliferation of Ciguatera (fish poisoning) as the climate changes. Increased ocean temperatures better support the dinoflagellate (photosynthetic micro-algae) *Gambierdiscus toxicus* that causes ciguatera, and bleached coral reefs provide a ripe habitat for its proliferation (Petit & Prudent 2008; Mimura et al., 2007).

Finally, in addition to these familiar illnesses and diseases, health experts are warning that climate change (especially changes in temperatures and rainfall patterns) could trigger the spread of foreign existing and emerging pathogens into new regions. Avian Influenza, Babesia, Cholera, Ebola, intestinal and external parasites, Plague, Lyme Disease, illnesses associated with Red Tides, Tuberculosis, and Yellow Fever are among the illnesses of particular concern globally (Wildlife Conservation Society, 2008).

The capacity of the health care system to respond to these illnesses and other health issues will also be impacted by climate change as the health care infrastructure is vulnerable to stronger hurricanes and storm surges, and floods and sea level rise in some cases.

Complicating factors

The regional health issues amplified by climate change tend to be fairly complex. Dengue Fever has no vaccine and it is difficult to control mosquito populations, in part due to relatively poor community participation. Asthma, while treatable, cannot be cured. Ciguatera may result in serious health complications including impacts to the nervous system and can easily go undetected without a strict system of inspection.

3.8 | Insurance & Banking

Office of the Financial Services Commission that regulates the insurance and banking sector. (Photo credit: Legis).

Property insurance is critical in The Virgin Islands where there is a high risk of climatic disasters, now exasperated by climate change.

Significance of issue

As The Virgin Islands is prone to major natural disasters, including earthquakes, hurricanes, and increasingly floods, property insurance is imperative to protect critical infrastructure and private investments. “Insurance is a major, time-tested method for adapting to change and any phenomenon that jeopardises the ability of the global insurance industry to play this role will have a major disruptive effect” (Epstein & Mills, 2005). Banks are important facilitators of development in The Virgin Islands; virtually all residential and commercial buildings, for example, are constructed on the strength of bank loans.

Potential climate change impacts

As explained by one well-known insurance executive, “It’s the clients who buy insurance who insure each other. The insurance industry provides the expertise and capacity to absorb and spread the risk, and reinsurers are vulnerable if those insurers that they insure are vulnerable” (Epstein & Mills, 2005).

Climate change poses multiple threats to the built environment including sea level rise, more intense hurricanes and storm surges, and more frequent flood and landslide events. All of these increased threats will undoubtedly result in increased damages which could potentially drive up insurance rates to unaffordable levels for some property owners, including in the important tourism sector (Nicholls et al., 2007).

This was the case, for example, in neighbouring Antigua during the 1990’s following the passage of numerous hurricanes (Motavalli, 2004; d’Auvergne et al., 2001). Part of Antigua’s reality during this time was the relocation of many of its yachts to Trinidad, an island outside of the hurricane belt and, therefore, not affected by the advent of unaffordable insurance premiums (Motavalli, 2004). The general result of this hike in insurance rates may be many uninsured and even more vulnerable properties.

Furthermore, climate induced damage to commercial properties such as apartment complexes, may cause some property owners to default on bank loans or banks to be more wary in giving such loans. The banking sector may also become strained by demand for reconstruction as well as retrofitting and other measures to adapt to climate change. The combination of these impacts may drive up interest rates to cover the inherent risks involved.

Complicating factors

In The Virgin Islands, insurance companies and banks are branches of large international companies based outside of the Territory and controlled by global forces. In addition, for reinsurance purposes, the Caribbean is lumped into the same zone as Florida and neighbouring USA states (Motavalli, 2004; d’Auvergne et al., 2001). This means that damages incurred in the USA affect insurance rates in the Caribbean. In essence, therefore, in the insurance and banking sectors, there is limited scope for local control over rates or policies.

3.9 | Tourism

Cane Garden Bay Beach, a popular tourist centre on Tortola. (Photo credit: Conservation and Fisheries Department).

Fleet of yachts seeking shelter at the Paraquita Bay Lagoon. (Photo credit: Department of Disaster Management).

Significance of issue

The Virgin Islands in large part owes its modern economic growth to the success of its tourism industry, which is primary owned by foreign investors from North America. From modest beginnings in the 1960s, the tourism industry has enjoyed continuous strong growth and development. In 2008, tourist expenditure was estimated at some $552.43 million; the industry accounts at least half of gross domestic product (GDP) and a significant percentage of employment (DPU, 2009c; DPU, 2009a).

These figures speak clearly to the heavy dependence of The Virgin Islands on tourism. The gravitation towards tourism is not by chance; given the small size, geography, and absence of mineral resources, alternative avenues for high economic growth are severely limited. Thus, it is predictable that the Territory will continue to look towards tourism as one of its primary economic pillars.

Potential climate change impacts

Climate change has many direct and indirect consequences for tourism demand and supply of tourism services and, therefore, the health and viability of the industry. These consequences result from degradation of tourist attractions, changes in visitor perceptions, property damages, and increases in operating costs.

Impacts on tourism demand

Climate change will degrade key visitor attractions and thus likely reduce visitor demand for the destination. A report commissioned by The World Bank titled "Assessment of the Economic Impact of Climate Change in CARICOM Countries," found that reduced tourism demand could account for 15% - 20% of rough estimates of total losses across all sectors by 2050 – 2080 (1999 US$1.4 - $9.0 billion) under low impact and high impact climate change scenarios respectively (Margaree Consultants, 2002).

The Virgin Islands' fundamental tourism product is our natural environment - beautiful beaches, pristine waters, colourful coral reefs, a rich fishery and marine life, and scenic, biodiverse landscapes - marketed under the slogan "Nature's Little Secrets" and offering tourists the "sun, sand, and sea" experience they crave.

Through the climate change impacts described above (accelerated beach erosion, stronger hurricanes, sea level rise, increased flooding, coral bleaching, ocean acidification and warming, and species extinction) all of these iconic attractions are at serious risk of degradation (Petit & Prudent, 2008.). As described before, the high revenue potential sport fisheries industry and the fresh local food provided by the commercial fisheries and agricultural sectors are also at risk. A survey of tourists in Barbados and Bonaire showed that 80% would be unwilling to revisit the destination at the same price should there be coral bleaching as a result of increased sea surface temperatures or reduced beach area as a result of sea level rise (Uyarra, 2005). A similar Tourist Perception Survey is currently being conducted in The Virgin Islands under the ECACC Project.

While often taken for granted, The Virgin Islands climate - known in particular for its constant cooling Northeast Trade Winds and predictability, with relatively few interruptive heavy downpours - is a critical element of our tourism product, especially our yachting sector, which is inherently threatened by climate change. In particular, it is certain that average temperatures will rise; already a warm destination, tourists may find an average temperature increase of a few degrees uncomfortable or intolerable (UWI, 2008).

The climate in our temperate tourism markets (the northeast United States, for example) is also changing (Shriner & Street, 2000). As these mainstay source markets become warmer and more comfortable in winter months, the demand for winter getaways that drive the tourism high season will likely decrease, especially as potential visitors seek cheaper vacation options closer to home or explore new destinations previously unattractive because temperatures were too cold (UWI, 2008).

Climate change may also create a number of perceptions that could potentially deter some visitors to the Territory and the region as a whole. According to the survey of tourists in Barbados and Bonaire, low health risk is among the top three most important environmental features in selecting a vacation destination (Uyarra, 2005). The rising incidence of Dengue Fever, therefore, may cause the region to be perceived as "unsafe."

Secondly, as the public in source markets becomes more aware of climate change and its serious consequences and the contributions of air travel, many may feel morally persuaded to travel less in order to reduce their carbon emissions; this could equate to a reduced demand for relatively distant destinations like The Virgin Islands (UWI, 2008). These more conscious tourists may also weigh the impacts of the tourism industry itself and tend to support "green" or environmentally responsible destinations (Chafe, 2004).

Thirdly, climate change will likely increase the cost of air travel (through increased fuel prices or taxes or both) and many overheads in the tourism sector, described further below (UWI, 2008). These increases may lead to the Territory being perceived as an "expensive destination" which could limit the market to higher-end tourists in the over-night segment. This could work in the Territory's favour as such tourists have a higher expenditure and reduced visitor numbers would put less pressure on fragile environmental resources. At the same time, however, degradation of key tourist attractions could result in the market share of the cruise sector increasing as these tourists may not be as sensitive as overnight visitors to changes in environmental quality.

Finally, there exists a powerful external perception of the Caribbean as a sun, sand, and sea destination, with little differentiation in the minds of tourists between the various islands. Because of this "mental lumping," climate impacts affecting one island or part of the region (severe Dengue Fever or Malaria outbreaks, for example) will tend to taint all islands in the region).

Impacts on tourism supply

Tourism supply is defined by EuroStats as "the supply of all assets, services and goods to be enjoyed or bought by visitors and occasioned by the journeys of visitors" (UWI, 2008).

To supply a worthwhile tourism product, tourist attractions and accommodations must be of high quality, certain critical infrastructure and amenities must be available, and the cost of supplying services must be kept to a minimum to maximise profits.

The impacts to tourist attractions have already been discussed. Climate change poses a number of risks to critical infrastructure and accommodations essential to tourism as well as basic services that the industry depends on, including electricity, transport and communication systems.

Practically all of the tourism infrastructure and facilities of The Virgin Islands - ports of entry, hotels, marinas, and ancillary services - are located in the coastal zone where they are highly vulnerable to damage from climate change induced sea level rise, stronger hurricanes and higher storm surges, and increased flooding. The World Bank report roughly estimates that the Caribbean could spend up to $1.3 billion dollars by 2050-2080 to replace hotel rooms lost as a result of sea level rise alone if no adaptation measures are taken (Margaree Consultants, 2002). The actual financial impact would extend beyond replacement costs to include revenue lost during and after the reconstruction period due to several factors, including stigma.

Tourism centres that may be particularly vulnerable to sea level rise and stronger storm surges include: Cane Garden Bay, Sopers Hole, Wickhams Cay I and II, and Trellis Bay on Tortola and Beef Island; North Sound, the vicinity of the Virgin Gorda Yacht Harbour, The Baths, and the many high-end waterside vacation villages on Virgin Gorda; White Bay and Great Harbour on Jost Van Dyke; all centres of tourism on Anegada such as Loblolly Beach, Keel Point, and Setting Point. Smaller outer islands with tourism stock located in highly vulnerable areas include Cooper Island, Peter Island, Marina Cay, Saba Rock, and Scrub Island.

Climate change will also subject the tourism industry to rising overheads, thereby increasing the cost of supplying tourism services and reducing potential profits. As the region warms, tourists will likely use more air conditioning, take more frequent baths, and use facilities such as pools more often, thus increasing energy and water demand and associated costs. Insurance costs are also likely to increase as the industry finds its clients at greater risk to natural disasters and sea level rise, and the insurance industry adjusts itself to the realities of climate change. Other basic costs such as food may increase as local and global agricultural systems are affected. Finally, depending on the extent to which there is a decrease in demand for the region and or Territory, the tourism industry may find itself spending far greater money and effort in advertising.

Complicating factors

The tourism industry itself generates many far-reaching environmental impacts that serve to reduce the resilience of the natural resources at risk and has development in manner that increases its overall vulnerable to climate change impacts. Over the course of the industry's development, countless acres of mangrove have been lost to accommodate tourism developments, the yachting sector in particular has been extremely polluting to the coastal and marine environment, coral reefs have suffered from diver and anchor damage, beaches have been undermined by beachfront developments with inadequate setbacks, and the list of impacts goes on.

Adaptation to climate change requires a long-term planning / development approach that typically does not align with tourism investors who often primarily consider the shorter-term life cycle of their development. This mismatch of horizons calls for purposeful intervention to ensure that the industry adapts to climate change. Furthermore, as the industry is primarily owned by foreign investors there is a heightened risk of investor pullout and relocation if the combined risk from climate change impacts is perceived as too high.

3.10 | Water Resources & Hydrological Characteristics

Water storage facility on Anegada. (Photo credit: Water and Sewerage Department).

Port Purcell under water during the November, 2003 floods. (Photo credit: Department of Disaster Management).

Significance of issue

A reliable and safe freshwater supply is vital to The Virgin Islands tourism economy and has many implications for other commercial activity and socio-economic conditions.

The Virgin Islands has limited freshwater resources. Because of its geography and limited rainfall, The Virgin Islands has watersheds comprised of extensive networks of ghuts (transient freshwater streams) and brackish ponds referred to as salt ponds which filter water runoff before it reaches the sea.

Individual household harvesting and storage of rainfall in cisterns continues to be a primary source of freshwater for domestic purposes. In the past Virgin Islands subsistence economy, groundwater from what is thought to be a very extensive freshwater lens, accessible from natural springs and man-made wells, was used as the main public water supply (Fahie-Forbes, A.; Lettsome, B., personal communication, July, 2009). Mr. Bernard Grant, Head of Sewerage Operations and Development, Water and Sewerage Department, explained that by the 1980s most wells were over-drawn and salinated, and today many have been reclaimed by development. As a result and as the population continued to grow rapidly, The Virgin Islands turned to desalination as the sole source of public water supply over approximately the last 23 years (Grant, B. personal communication, March 15, 2010).

Potential climate change impacts

Climate change stands to make the challenge of meeting growing freshwater demand in The Virgin Islands even greater. The PRECIS Caribbean climate model projects that the Caribbean region could be up to 25% drier by the 2080s (Taylor et al., 2007). The seasonality and distribution of rainfall in the Caribbean is also changing; the number of uninterrupted dry days is decreasing while the number of heavy rainfall events is increasing (Mimura et.al, 2007). These changes could easily result in increased drought and flood events that would each have a number of far reaching implications (St. Lucia Ministry of Physical Development, Environment, and Housing, 2005).

Recent models of the current and future water supply in several Caribbean islands conclude that most will experience severe “water stress” under all scenarios considered in the IPCC Special Report on Emissions Scenarios (Mimura et.al, 2007). Currently, since late last year, the majority of Caribbean islands have been experiencing severe drought (BBC, 2010). Given The Virgin Islands existing water scarce status, the Territory would face the same challenges were it not for the desalinated public supply on which climate change will likely cause us to depend more heavily. On the other extreme, the topography of The Virgin Islands combined with poor drainage easily results in severe flooding of low-lying coastal lands, especially our capital. This was recently played out in the heavy November 2003 floods.

Groundwater and desalinated water resources also stand to be impacted. The exact extent and position of The Virgin Islands groundwater table is relatively unknown and parts of it may be highly prone to saltwater intrusion as sea level rises, and the freshwater lens would experience a reduced rate of recharge as total rainfall decreases

(Mimura et.al, 2007). In addition, the growth of development throughout the Territory will decrease the infiltration and recharge rate of groundwater aquifers. Lastly, the price of fossil fuel is predicted to continue to rise as the international community tries to combat climate change and we near "peak oil" (Campbell, 2001). With this being the case, desalinating water may become an increasingly expensive process.

Complicating factors

Statistics from the Water & Sewerage Department show that water demand in The Virgin Islands is growing rapidly. Despite being a water scarce island group, water conservation is not a wide practice, nor is sufficient care taken to protect the quality of the limited water resources. According to Mr. Michael Davis, Head of Operations and Maintenance, Water and Sewerage Department, although efforts are being made to address the situation, the public water distribution system suffers from "high unaccounted for water" due to surface and hidden leaks as well as illegal connections (WSD, 2008; Davis. M., personal communication, July 2009). There is also insufficient storage capacity for water; facilities are only capable of storing about one day's worth of water supply as opposed to the three day international standard (Grant. B., personal communication, March 15, 2010).

Heavy investment in desalination may have allowed the ground water supply to recharge, however, sea-level rise and decreased rainfall compromise the future security of this water source. Also, while it can be argued that the desalination capacity of The Virgin Islands offers an effective buffer against changes in rainwater and groundwater availability, increased dependence on desalination could pose a significant economic toll. Already, in 2007 the Government expended $15 million to various desalination plants to produce the 427,660,195 imperial gallons of water consumed in the Territory (WSD, 2008). As noted above, although desalination efficiency is steadily improving, the global cost of desalination would likely increase as the cost of fossil fuel does.

Water quality in The Virgin Islands can not be effectively monitored or protected due to an absence of recognised standards and a lack of strong environmental legislation. Groundwater is vulnerable to a range of harsh chemicals used in mechanics and agriculture, and leaching from old landfills. Coastal water quality is compromised by sewage from land point sources, the cruise and boating community, siltation/sedimentation from erosion and run-off, and HAZMAT spills (primarily oil/petroleum products, but sewage and agro-chemical spills are on the rise) (Lettsome, B., personal communication, July, 2009). Rising temperatures further compound the issue by making the marine environment riper for bacterial proliferation (Petit & Prudent, 2008).

COMBINED IMPACTS

It is not enough to consider the impacts of climate change across the impact areas discussed in isolation, rather the total or combined impact must be weighed. By degrading natural resources, increasing the vulnerability of human settlements and critical infrastructure, adding stress to water and energy supplies, reducing food security, and threatening the economic base, climate change will have a sizable negative impact on the carrying capacity of The Virgin Islands.

The carrying capacity refers to the population level the Territory can effectively sustain given its natural, land, food, and water resources, its economic viability, and ability to provide critical services. In the case of The Virgin Islands the ability to import goods factors heavily into its carrying capacity. While not discussed extensively above, the increased vulnerability of seaports and likely increase in shipping costs, directly and indirectly due to climate change, will be an important consideration for the future cost of living and quality of life.

The Virgin Islands' population is rapidly increasing, largely due to migration. Given the current annual growth rate of 2.98%, the population will double by 2033. Population growth must be carefully monitored and managed considering the declining carrying capacity of the Territory due to climate change and other impacts.

4.0 | Prioritising Climate Change Impacts

Given limited financial and technical resources it will be impossible to address all climate change impacts at once, if at all. Therefore, for the practical purposes of allocating resources and action timeframes, the climate change impacts identified in Chapter 3.0 were prioritized.

Prioritisation was based on stakeholder input (representatives from the tourism, agriculture, fisheries, renewable energy and development sectors, relevant Government departments, and NGOs) during the Territory's second climate change stakeholder consultation held October 2009.

During the consultation, a matrix was used to determine priority climate change impacts across all impact areas by rating the *national significance*, *certainty*, *severity*, and *urgency* of each. In all cases, 1 represented the highest rating and 5 the lowest rating.

The *national significance* of impacts was broken down into 4 dimensions: social, environmental, economic, and cultural. Climate change impacts that affected all four dimensions were given the highest priority rating of 1 for that indicator, while impacts that affected none of the dimensions was given the lowest priority rating of 5 and so forth, as shown in the key to the matrix.

The total score across all indicators of priority was calculated for each impact. Those impacts with the highest priority rating (that is, the lowest total score) were identified and grouped into three tiers/clusters of priority for action, with tier 1 impacts having the absolute highest priority and so forth. These results are shown in Table 9 below.

The priority impacts that were isolated from the rating exercise fell under the following impact areas:

Coastal & Marine Resources	–	tier 1
Forestry & Biodiversity	–	tier 1
Tourism	–	tiers 1, 2, & 3
Water Resources & Hydrological Characteristics	–	tier 1 & 3
Food security: fisheries	–	tiers 2 & 3
Beach & Shoreline Stability	–	tier 3

Climate Change Impact Area	Climate Change Impact	National Significance [a]	Certainty [b]	Severity of threat/impact [c]	Urgency [d]
1st Tier Priority Impacts (total score of 4 across all priority indicators) ★ ★ ★					
Natural Resources *(Coastal & Marine Resources / Forestry & Biodiversity)*	Coral reefs experiencing increased bleaching, structural damage, disease and death	1	1	1	1
	Biodiversity threatened by habitat loss, invasive species, and hurricanes	1	1	1	1
Tourism	Diminished natural tourist attractions, e.g. coral reefs, beaches and wildlife	1	1	1	1
Water Resources and Hydrological Characteristics	Changes in water quality and quantity	1	1	1	1
2nd Tier Priority Impacts (total score of 5 across all priority indicators) ☆ ☆					
Tourism	Loss of or more costly damage to tourism infrastructure and properties from floods, stronger hurricanes and storm surges, and sea level rise	1	1	1	2
Food Security: Fisheries	Degradation of critical fish habitat, such as coral reefs, mangroves, and seagrass beds	1	1	1	2

3rd Tier Priority Impacts (total score of 6 across all priority indicators) ☆					
Tourism	Rising overheads in energy, water, and insurance	3	1	1	1
Food Security: Fisheries	Migration of some fish species to cooler waters	1	2	2	1
Beach and Shoreline Stability	Increased beach and shoreline erosion from sea level rise, and stronger hurricanes and storm surges	1	1	2	2
Water Resources and Hydrological Characteristics	Decreased rainwater (as the region becomes up to 25% drier and rainfall patterns change) leading to greater dependency on the desalinated public water supply and an increased threat of water shortages in emergencies.	1	1	3	1

Other Impacts (total score of 7 or more across all priority indicators)					
Natural Resources (Coastal & Marine Resources / Forestry & Biodiversity)	Decreased growth of seagrass beds and increased stress and mortality.	1	2	2	3
	Shrinking upland forests and reduction of associated biodiversity (as a result of warmer temperatures, drought, and stronger hurricanes)	1	3	3	4

	Increased invasive species which tend to out-compete or prey on native species	3	1	2	3
	Degradation of turtle nesting habitat (sandy beaches) and creation of unbalanced sex ratios	2	1	3	2
Critical Infrastructure and Human Settlements	Homes, critical facilities, roads, and developable lands (both inland and in low-lying coastal areas) at great risk of damage from flooding from heavy rain events and sea level rise	1	2	2	3
	Increased landslide damages to roads, retaining walls and buildings, and interruption of electricity and communication services	2	2	2	2
	Increased damage to homes, critical facilities, roads and electricity and communication systems due to stronger hurricanes and storm surges	1	3	3	3
Energy Security	Increased demand for electricity and gasoline as warmer temperatures trigger increased demand for cooling of buildings and cars	2	1	2	2

	Electricity system at great risk of damage from floods, stronger hurricanes and storm surges, and seal level rise	2	2	3	2
	Switch to smarter energy production and consumption patterns as international pressures to “green” mount, and the cost of importing fossil fuels increases	2	3	4	4
Food Security: Agriculture	Crop damage and disruption in agricultural production from stronger hurricanes, droughts and floods	1	3	2	2
	Increase in agricultural pests, weeds, diseases and invasive species due to increased concentrations of carbon dioxide (CO_2), warmer soils and changes in humidity.	1	3	3	4
	Soil degradation from saltwater intrusion and soil erosion / leaching, resulting in decreased yields.	2	3	3	2
	Increased stress to livestock from heat, drought, and disease	3	2	4	3
	Changes in imported food availability, cost and quality	2	2	2	2

Food Security: Fisheries	Changes in plankton, a crucial source of food for fish	1	3	2	3
	Potential changes in spawning opportunities and rates of mortality and disease	1	2	2	2
	Increased damage to landing sites, on-shore facilities, boats and equipment from stronger hurricanes and storm surges and sea level rise.	1	3	3	3
Human Health	Increase in Dengue Fever outbreaks (frequency and severity) due to warmer temperatures, changes in humidity, and more, heavier rain events	3	2	3	1
	Increase in respiratory diseases, such as asthma, due to increased plant pollen, mold, flooding, and thicker Sahara Desert dust clouds	2	2	3	1
	Increase in risk of diarrhea and other water, food and rodent borne illnesses	2	3	3	2
	Increase in potential for heat stress as temperatures potentially rise by up to 10.4°F by 2100	2	3	3	5

	Increase in prevalence of ciguatera (fish poisoning) as warmer waters and degraded reefs support the ciguatoxin	1	3	2	4
	Greater threat of epidemics and pandemics as warmer temperatures and changing rainfall patterns trigger the spread of pathogens into new regions	3	2	2	4
Insurance & Banking	Increased insurance rates, potentially leading to uninsurance or underinsurance as damages from natural disasters increase and sea level rise occurs	3	1	2	2
	Increased strain on banking system. Increased interest rates and difficulty in obtaining construction loans due to increased risk	2	1	2	2
Tourism	Sport fisheries and fresh produce at risk from warmer waters, stronger hurricanes, and changes in rainfall patterns	2	2	3	3
	Changes to our alluring climate - hotter, less predictable, more frequent heavier rain events	2	1	2	4

	Decreased demand for winter getaways as winters in tourism source markets become warmer	2	3	1	3
	Potentially reduced demand for long distance flights as international pressures to reduce carbon emissions increase	2	4	1	3
Water Resources and Hydrological Characteristics	Groundwater resources shrinking as rainfall decreases and saltwater intrudes with sea level rise	3	1	4	2
	Increased cost of desalinated water as the price of fossil fuels rises in response to climate change and depleting resources	3	1	2	1

Table 9. "Priority" and "Other" climate change impacts as determined at the Second Public Stakeholder Climate Change Consultation.

[a] **National Significance** *(Dimensions = Social, Environmental, Economic, Cultural)*
1= Four dimensions 2=Three dimensions 3=Two dimensions 4=One dimension 5= None

[b] **Certainty**
1 = Absolutely 2 = Very Likely 3 = Likely 4 = Less Likely 5 = Unlikely

[c] **Severity of threat/impact**
1 **=** Extreme 2 = Very High 3 = High 4= Low 5**=**Very Low

[d] **Urgency**
1 = Happening regularly 2 = Happening now *(once per season)*
3 = Happening <5yrs *(immediate threat)* 4 = Happening 5-10yrs *(short-term threat)*
5 = Happening 10-50yrs *(long-term threat)*

5.0 | Institutional, Legal & Management Arrangements for Responding

Since the Caribbean as a whole emits minimal "greenhouse gases" in a global context (less than 1%), but is one of the regions that will be most affected by climate change, our focus must be on adaptation to impacts. Mitigation actions can not, however, be ignored.

Climate change ***adaptation*** refers to any action to minimise or adjust to the local impacts (as described above) of climate change (UNFCCC, 2009 a). While there is some overlap, it is distinct from climate change ***mitigation*** which refers to efforts to tackle the cause of climate change, that is, efforts to reduce the amount of "greenhouse gases" in our atmosphere (UNFCCC, 2009 b).

5.1 | INSTITUTIONAL FRAMEWORK

Climate change adaptation will require an ongoing collaborative effort between Government, the private sector, and communities. There are at least seventeen (17) Government Departments, Statutory Bodies, or associated Agencies amongst all five Ministries and the Governor's Office that will be integral in the Territory's adaptation to climate change.

The generic functions of each of these are summarised in Appendix G. In addition, there are several Territory-level inter-agency committees and bodies whose portfolios allow them to have a direct influence on policies and decisions relevant to climate change adaptation. These are the Inter-agency Planning Review Committee (Pre-Planning Authority), Planning Authority, Building Authority, Technical Review Committee, Health Services Authority, and Disaster Management Council.

Constraints facing these important players tend to be similar:

- Insufficient funding and equipment to carry out tasks (especially in the environment which historically has been least funded);
- Insufficient highly trained technical officers to handle the volume of work or the level of analysis (as a result, a small circle of senior officers tends to be overcommitted and certain important processes, such as the development review process, are not as thorough and well managed as they could be);

- Limited law enforcement powers and personnel;
- Data collection and management issues;
- Poor communication, information flow, and collaboration between Departments

Environmental management, in particular, suffers from a fragmented institutional framework where functions are spread across several Departments and Statutory Bodies under multiple Ministries, including primarily the Conservation and Fisheries Department, the BVI National Parks Trust, Solid Waste Department, Water and Sewerage Department, Environmental Health Department, and the Town and Country Planning Department.

Future Outlook

The future vision as expressed in the National Environmental Action Plan (NEAP) (2004) and outlined in the draft comprehensive Environmental Management and Conservation of Biodiversity Bill is for a "restructured and strengthened environmental management agency" to coordinate and manage all issues and matters related to the environment and natural resources (Law Reform Commission, 2008). According to the draft Bill, such an Agency would be formed by the joining of the Conservation and Fisheries Department and the BVI National Parks Trust, the two main agencies that deal with environmental management, to form a statutory Environmental Management Trust (Law Reform Commission, 2008).

5.2 | LEGAL FRAMEWORK

There is a lot to be desired in the legislative framework, especially that governing the environment and physical development.

The existing environmental legislative framework is diffuse. While there are several pieces of legislation on the statute books, weak penalties and enforcement are major constraints that inhibit their effectiveness (DPU, 1999). Noticeable gaps are in the areas of coastal resources protection and waste management.

The Law Reform Commission notes that most of the environmental laws need minor amendments to improve their enforcement provisions, or may require appropriate subsidiary laws to make them more effective (Law Reform Commission, 2008).

The existing environmental laws are summarised in Appendix F. In addition to local environmental laws, the Territory is signatory to a number of regional and international treaties and agreements such as the St. Georges Declaration, the Cartagena Convention, the Specially Projected Areas and Wildlife (SPAW) Protocol, the Pollution from Land-Based Sources and Activities (LBS) Protocol, the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Bonn

Convention, the World Heritage Convention, and the Ramsar Convention on Wetlands (DPU, 1999).

The passage of the 2004 Physical Planning Act represented a significant improvement in the laws governing the physical development process, especially as it relates to the environmental impact assessment (EIA) process.

Schedule 3 of the Act specifies types of development that require an EIA including the following: a) hotels of more than twelve rooms, b) any industrial plant which in the opinion of the Authority is likely to cause significant adverse environmental impact, c) quarrying and other mining activities, d) marinas, e) airports, ports and harbours, f) dams and reservoirs, g) hydro-electric projects and power plants, h) desalination plants, i) water purification plants, j) sanitary land fill operations, solid waste disposal sites, toxic waste disposal sites and other similar sites, k) gas pipeline installations, l) any development projects generating or potentially generating emissions, aqueous effluent, solid waste, noise vibration or radioactive discharges, m) any development involving the storage and use of hazardous materials, n) coastal zone developments, and o) development in wetlands, marine parks, national parks, conservation areas, environmental protection areas or other sensitive environmental areas.

The Development Control Guidelines of 1972, however, are still in use and need to be updated to reflect the new legislation. The Buildings Ordinance, 1955 and Building Regulations, 1999 are also outdated and in need of an overhaul.

Systems of enforcement for both planning and building legislation are in need of improvement.

In regards to planning legislation, for example, enforcement officers of the Town and Country Planning Department have powers to issue Stop Orders and Compliance Notices to address construction in violation of the law or the conditions of planning approval. If, however, developers do not comply with these measures, enforcement officers have to wait on an often long and convoluted court process to unfold before any tangible action is taken against the developer, in which time irreversible damage may be done.

Future outlook

The Law Reform Commission has identified environmental law as one of the priority areas for reform. In their 2008 review of existing environmental laws, the Commission agreed that what is direly needed in the Territory is a comprehensive environmental management law.

Towards this end, the Commission drafted the Environmental Management and Conservation of Biodiversity Bill, 2008 still up for review by Cabinet. The Bill addresses environmental management (environmental impact assessments, natural resources and species protection, trade in species, hazardous substances, air and noise pollution, water pollution, wastes), the

coastal zone (beach and coral reef protection), protected areas, and multilateral environmental agreements.

In terms of physical development, new planning regulations are currently being formulated to accompany the Physical Planning Act of 2004.

While new Building Regulations are not currently under draft, work is being done towards this end.

5.3 | MANAGEMENT FRAMEWORK

Existing management plans, policies, and processes in the areas of the environment, physical planning, and disaster management are summarised below, followed by an identification of key management gaps in these areas.

Generally, the environment is not managed as effectively as possible. While a number of initiatives are underway to address environmental concerns, they are generally underfunded and uncoordinated, and are being implemented without adequate institutional capacity and human resource capability (DPU, 1999).

There has never been a formally approved comprehensive physical development plan for the Territory, although several drafts have been made. The most recent draft is Territory wide and was prepared in 2009 by the Town and Country Planning Department. As a result of this gap, rapid development over the last twenty plus years does not fully reflect an integrated approach to planning. In addition, coastal development in The Virgin Islands has been significantly influenced by large tourism developments by foreign investors (DPU, 1999).

The Territory has a strong and comprehensive disaster management programme and was singled out as possessing "the most comprehensive disaster management programme of all UK Caribbean Overseas Territories" (CDERA, 2003).

NATIONAL INTEGRATED DEVELOPMENT STRATEGY (NIDS)

The National Integrated Development Strategy (NIDS) was adopted by the Government of The Virgin Islands as a framework to promote the sustainable development of the Territory for the period 1999–2003.

The NIDS represents the first formal attempt at national planning in The Virgin Islands. Its major purpose is to establish the broad strategies, policies, and the implementation framework to promote integrated development.

One of the eleven development objectives of the strategy is to ensure environmental sustainability. This is to be achieved through a broad policy thrust to enhance the overall development potential by human resource development, improved management of the environment, physical space improvement, and sound economic management (Orion Consultancy Services Ltd, 2004).

National Environmental Action Plan (NEAP)

NEAP (2004) provides the framework within which The Virgin Islands' environment can be managed in a responsible and sustainable manner. The objectives of NEAP were as follows:

- Identify, prioritise and quantify (where possible) environmental problems;
- Provide a state-of-knowledge overview of the environmental conditions in the Territory;
- Propose solutions to immediate environmental problems in the form of programmes and projects, studies, issues and actions, strategies and activities, institutional and legislative reform, funding requirements and human resources capacity building needs;
- Establish a clear indication of Government's priorities with respect to the environment so as to guide and give proper orientation to donor intervention in this field;
- Establish a framework for environmental information management and dissemination;
- Provide a framework for continuous development and environmental policy dialogue within the Territory and with donor partners;
- Establish a framework which provides coherent directions for the process of environmental management, monitoring, action planning in the future; and
- Identify human resources needs for the effective review and efficient implementation and management of the NEAP.

Protected Areas System Plan 2007-2017

The Protected Areas System Plan (approved by Cabinet January 2008) consolidates in one document, all of the areas which are to be managed for sustainability and provides the policy framework for the management of protected areas in The Virgin Islands. It provides:

- the goals for the system of protected areas;
- the institutional arrangements to be established for protected area management;
- the support systems needed for system development and management during the Plan Period;
- priorities in protected area management for the next ten (10) years; and
- a process for evaluating progress in protected areas system development over the next five (5) years.

PHYSICAL DEVELOPMENT APPROVAL PROCESS

The Town and Country Planning Department (TCPD), the Inter-agency Planning Review Committee (Pre-Planning Authority), Planning Authority (formally the Development Control Authority), and the Building Authority oversee land development in the Territory. In development matters concerning the seabed, the Technical Review Committee under the Ministry of Natural Resources and Labour is also involved. The Committee makes recommendations to the Minister regarding the granting of seabed licenses that are requisite for any development on or over the seabed.

The Physical Planning Act, 2004 together with the Development Control Guidelines, 1972, the Building Ordinance, 1955 and the Building Regulations, 1999 regulate the entire development process. The Physical Planning Act makes provision for "the orderly and progressive development of land in both urban and rural areas and for the protection of the environment and improvement of the amenities therefore."

By order of the Physical Planning Act, before any development (whether private or commercial) can begin, the developer must seek approval.

Applications are screened by the TCPD and the Pre- Planning Authority and forwarded to the Planning Authority for a final decision. In the case of tourism developments valued over $10 million the Premier has the final decision making power.

An overview of the development control process is provided in Figure 10. Part of the screening process by the TCPD is to determine if the proposed development would require an environmental impact assessment (EIA) under the Physical Planning Act, 2004. Applications requiring an EIA go through a more detailed approval process.

The Planning Authority is comprised of civil servants from diverse agencies, including the TCPD, Conservation and Fisheries Department, Department of Disaster Management, the Tourist Board, Survey Department, Public Works Department, Royal Virgin Islands Police Force, and Fire and Rescue Services, as well as stakeholders from the private sector. The Planning Authority meets on average once per month as member schedules allow. In any one sitting, the Authority may review and decide upon up to fifty (50) development applications.

There is some concern that more contextual information should be provided about each development proposal in a user-friendly format in order to improve the decision making process. There is further concern that the current review process looks at each application in isolation and does not consider the overall impact that developments in a given area make. The process can, therefore, be improved if a more holistic approach is taken and if a comprehensive physical development plan with zoning were in place. In the case of large-scale tourism developments, there is still a concerning level of confusion and interference in the development review and approval process by the practice of signing "development agreements" between the Government and the developer granting approval in principle for the project before the relevant planning approvals have been granted.

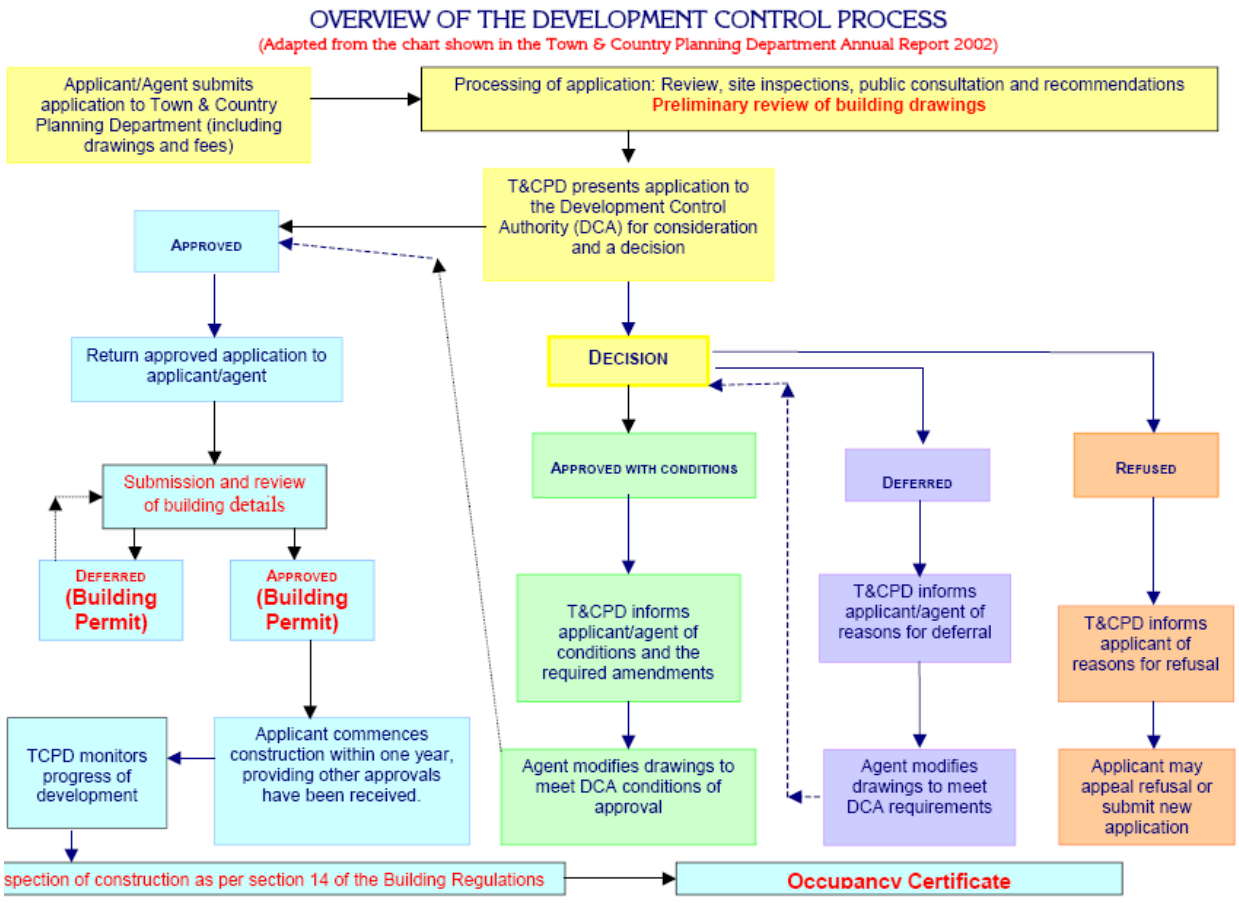


Figure 10. Overview of the development control process.
(Source: Tony Gibbs Consulting Engineers Partnership & Wason, 2004)

NATIONAL DISASTER MANAGEMENT PLAN

The National Disaster Management Plan (NDMP) was originally approved by the Executive Council (now called Cabinet) in 1997 and details the framework and responsibilities of disaster recovery operations in the event of a disaster.

The NDMP was updated in 2008 and approved in 2009. It has been redesigned to include support functions, hazard indexes, and a new National Disaster Organisation structure. National Emergency Operating Centre standard operating procedures were also updated in keeping with the Incident Command System structure.

MITIGATION AND DEVELOPMENT PLANNING FRAMEWORK

The Mitigation and Development Planning Framework developed in 2002 is meant to provide the framework within which Government agencies, the private sector and communities can work together to reduce the impact of natural hazards and unnecessary damage during a disaster event.

This Plan is a first in a series for integrating hazard mitigation activities into the development process. It provides the conceptual framework for the reduction of losses from disasters. The major thrust of this Plan is to bring together the public sector agencies to ensure that:

- they work together as a cohesive group;
- public sector related mitigation activities are coordinated; and
- public sector agencies have a well developed approach to mitigation so that community actions and activities can be supported.

The second phase of the Plan development will be the preparation of community hazard mitigation plans.

There is a need to revise the 2002 edition of the Mitigation and Development Planning Framework in keeping with the Physical Planning Act, 2004. This will ensure better definition of mitigation goals, objectives, strategies and programmes for the next 5-10 years. There is also a need for the revision of the Disaster Management Act 2003, which will take place in 2010, including the development of regulations to support the Act.

IMPORTANT MANAGEMENT GAPS

A comprehensive land use and physical development plan inclusive of zoning

Steps taken towards filling gap:

- The preparation of a draft plan in 2009 inclusive of basic zoning;
- The establishment of a National Geographical Information System (NGIS) across the Town and Country Planning Department, Survey Department, Conservation and Fisheries Department, and Department of Disaster Management to improve the management and analysis data relevant to the planning process; and
- Institutional strengthening of the Town and Country Planning Department through recruitment, training, and reorganisation.

A comprehensive coastal zone management plan

Steps taken towards filling gap:

- Development of a GIS based Coastal Resources Inventory System (CRIS) in 1992.
- Ongoing coral reef monitoring and updating of CRIS data layers

Specific management plans for beaches

Steps taken towards filling gap:

- Work towards re-starting of beach monitoring programme;
- Thesis by Shannon Gore (marine biologist at Conservation and Fisheries Department) on a beach management framework for The Virgin Islands and continued PhD research on Virgin Islands beaches.
- Establishment of a Cabinet sanctioned Beach Commission and formation of a multi-agency Beach Management Working Group.

Sustainable management programme for fish stocks

Steps taken towards filling gap:

- Continuous collection of fisheries catch data.
- Current efforts to develop management plans for fisheries protected areas

Management plans for Fisheries Protected Areas

Steps taken towards filling gap:

- Development of a standard rapid assessment protocol for Fisheries Protected Areas

6.0 | Towards an Adaptation Strategy

Since the Caribbean as a whole emits minimal "greenhouse gases" in a global context, but is one of the regions that will be most affected by climate change, our focus must be on adaptation. Mitigation actions can not, however, be ignored.

Adaptation refers to any action aimed at reducing the local impacts of climate change; it is distinct from climate change ***mitigation*** efforts that attempt to reduce carbon emissions, the primary cause of climate change. In some instances, mitigation and adaptation actions may overlap. For instance mangrove reforestation serves as both an adaptation and mitigation action – mangroves provide important coastal protection against sea level rise and stronger storm surges while also serving as a carbon sink.

The extent of international carbon mitigation measures directly affects the degree of adaptation required.

Many institutions, a body of legislation, policies and programmes already exist and can be built upon and strengthened to ensure that the Territory adapts to climate change. In large part, climate change adaptation boils down to seriously implementing the measures and taking the precautionary steps long identified, and in some cases already integrated in policies and legislation, to protect ecosystems, build resilience in key industries and develop wisely, especially in the coastal zone (CANARI, 2008 a).

The adaptation strategies presented, therefore, are by no means novel and are based on long standing best management practices and actions that have successfully been taken or that are proposed in similar countries.

In many cases implementation of the adaptation strategies outlined will require technical cooperation and support on a regional and wider basis. Options for financing adaptation actions are discussed below in section 6.5 *Funding Adaptation*.

6.1 | THE REGIONAL PERSPECTIVE

On July 4 2009, CARICOM heads signed the Liliendaal Declaration on Climate Change and Development. The Declaration sets forth these important regional positions on climate change (CARICOM, 2009):

- **Adaptation and capacity building must be prioritised** and a formal and well financed framework established within and outside of the UNFCCC to address immediate as well as long-term adaptation needs;

- **Adaptation measures have inherent limits, both in terms of their financial feasibility and their ability to protect critical resources and industries**. Even with the best adaptation measures, climate change is likely to have significant impacts. The Declaration, therefore, makes a strong urgent call for international climate change mitigation measures to ensure the "long-term stabilisation of atmospheric greenhouse gas concentrations at levels which will ensure that global average surface temperature increases will be limited to well below 1.5° C (2.7°F) of pre-industrial levels" – the upper limit determined by leading scientist to avoid the worst impacts of climate change, especially in small islands;

- **Mitigation must be an important part of the region's climate change adaptation strategy**. As a local example, climate change is predicted to make rainwater less reliable, therefore, increasing our dependency on desalination. Because desalination is so energy intensive and the cost of fossil fuels continues to rise, finding ways to reduce the Territory's overall energy use and bill will be important to afford these adaptation measures;

  To this end the Declaration "supports the approach of harmonising climate change mitigation and economic development," and expresses "strong determination to overcome technical, economic and policy barriers to facilitate the development, diffusion and deployment of appropriate and affordable low and zero-emission technologies and renewable energy services. "

- **Improved land management and better risk management must be an important part of the region's climate change adaptation strategy.**

6.2 | THE ADAPTATION STRATEGY DEVELOPMENT PROCESS

The Virgin Islands Climate Change Adaptation Policy and Strategy is intended to be a living document (updated according to changing circumstances) created "for the people, by the people."

In that spirit, it is being crafted with wide stakeholder input gathered through a series of public consultations in 2009 and 2010 attended by relevant branches of Government; representatives from the tourism, agriculture, fisheries, construction, energy and water sectors; and civil society. Through these consultations, stakeholders will help to crystallise specific sectoral impacts, prioritise impacts and develop appropriate measures for responding.

Thus far, through stakeholder input, an initial *Climate Change Country Vulnerability Profile* has been developed into a full-fledge *Climate Change Issues Paper* which has been further refined into the present *Climate Change Green Paper*.

Based on further public consultation, the *Green Paper* will be developed into the draft *Virgin Islands Climate Change Adaptation Policy and Strategy* (White Paper) that will be submitted to Cabinet for approval after a final round of public consultation. The approved *Climate Change Adaptation Policy and Strategy* should affect all relevant Government decision making processes.

6.3 | PUBLIC KNOWLEDGE AND THE ADAPTATION PROCESS

Heightened populace knowledge about ecosystems and their value, as well as climate change and how it impacts life in The Virgin Islands will be key in building support for proactive adaptation measures at the individual and policy levels.

Currently, populace knowledge about climate change remains relatively low, in part because the issue is new to the Territory and public education efforts are still in their infancy. Unawareness, disbelief and apathy exacerbate all climate change impacts. Despite consensus in the scientific community, skepticism still exists in some quarters over the issue. Therefore, rather than being able to focus limited resources educating about climate change impacts and adaptation options, efforts will have to be put into legitimising the issue first.

Climate change provides an important platform through which to increase populace knowledge and engagement on environmental issues in general. The result will hopefully be better community, private and public sector stewardship of our natural resources. This in turn should serve to enhance the resilience of ecosystems to climate change threats.

6.4 | A VISION FOR THE VIRGIN ISLANDS - SUCCESSFUL ADAPTATION TO CLIMATE CHANGE

The *Climate Change Adaptation Policy and Strategy* developed should be able to deliver on the following long-term vision of sustainable development for The Virgin Islands, considering the new realities of climate change and its impacts on the areas discussed.

- Healthy natural beaches and mangroves that have survived sea level rise through inland migration and, therefore, able to continue to provide habitat for turtles and birds, shoreline protection, and recreational value;

- Enough live coral reefs to support key fisheries, and provide coastal protection and recreational value;

- A healthy forest cover and associated biodiversity;

- Human settlements and development centres that are located and built to withstand category 4 and 5 hurricanes, heavy rain events, strong storm surges, and sea level rise;

- A primary road network that is resilient to storm surges and sea level rise;

- An energy economy that is more diverse and efficient – including a high mix of renewable energies;

- An agricultural sector that, through improved technology and best management practices, meets the maximum feasible percentage of local demand and is not limited by new climatic conditions;

- A fisheries sector that is able to meet the majority of local demand through sustainable management, changes in target species, and new technologies;

- Minimal levels of Dengue Fever, Ciguatera, Asthma, Diarrheal illnesses and other climate controlled/affected illnesses through better environmental management, enhanced resilience of the population, and improved diagnosis and treatment;

- An insurance industry that is more suited to regional circumstances, offers improved protection against natural disasters, and that incentivises better building practices;

- A more diverse and resilient tourism product that is oriented around the concepts of high value, low density, and minimal impact;

- A public water supply that is sufficient for the population demand, affordable, reliant, meets international standards, and is used in the most efficient manner.

6.5 | APPROPRIATE ADAPTATION OPTIONS

The science of adapting to climate change is still developing, but there are some established principles. Adaptation measures should:

- **Be SMART** (specific, measurable, achievable, realistic, and time bound);
- **Consider the many interacting issues** (environmental, developmental, economic, and social);
- **Be in harmony with each other**, such that measures to reduce impacts in one area or sector do not increase impacts in another area or sector;
- Preferably **be "no regrets" measures**; that is, actions that are necessary and or beneficial and increase the Territory's resilience whether or not climate change impacts occur. Adhering to the "no regrets" principle means that lack of 100% scientific certainty and precision on climate change impacts is no excuse for inaction;
- **Take an ecosystem-centred approach** – that is, recognise the value of healthy natural ecosystems in buffering climate change impacts and favour natural engineering solutions over hard engineering solutions wherever practical;
- **Promote the integration of new technologies** that can increase efficiencies and reduce impacts;
- **Be integrated and mainstreamed** into existing and newly formulated sectoral and national management plans/development strategies so that climate change impacts are considered in all relevant decision making processes.

Appendix A contains a series of tables by impact area that represent the beginnings of a climate change adaptation strategy for The Virgin Islands. Adaptation options have been developed in collaboration with respective Government agencies and refined with input from the public stakeholder consultation process.

For each climate change impact area described in Chapter 3.0, the tables suggest general guiding adaptation principles, as well as a selection of specific adaptation options for each impact identified. Each specific adaptation option is further assigned a category, rating (preferred action, acceptable alternative, and last resort action), supporting activities, and an implementation timeframe. Adaptation opportunities and constraints are discussed in Appendix B.

The preferred adaptation options for the priority impacts identified above in Table 9 have been isolated below in Table 10. More details about these actions are provided in the detailed adaptation tables in Appendix A.

PRIORITY CLIMATE CHANGE IMPACTS	PREFERRED ADAPTATION OPTIONS
1st Tier Priority Impacts ★ ★ ★ *(total score of 4 across all priority indicators)*	
IMPACT AREA Natural Resources *(Coastal & Marine Resources / Forestry & Biodiversity)* **IMPACT** **Coral reefs experiencing increased bleaching, structural breakdown, disease and death due to increased ocean temperatures, ocean acidification, and more intense hurricane events and storm surges**	*1. Expand and improve management of Marine Protected Areas (MPAs)* - declare proposed MPAs in the approved Protected Areas System Plan 2007-2017, clearly demarcate MPAs, improve monitoring and enforcement of MPA rules and regulations, and educate the public about MPAs. Revisit protected areas overtime to ensure that they are extensive enough and rules and regulations are strong enough to accomplish management goals (esp. as climate change creates new dynamics, such as fish migration to cooler waters). 2. *Implement a rotating system of closure (recovery periods) for reefs* in which all human impacts are temporarily removed from select reefs – e.g. no boats allowed for a 5 yr period etc. 3. *Decrease recreational damage from divers and snorkelers* - introduce a mandatory orientation for persons going to dive or snorkel with charter boats or dive operators. Orientation would ensure persons have the requisite skills and knowledge that would prevent damage to reefs. 4. *Decrease anchor damage* – introduce a mandatory orientation for skippers and persons chartering a yacht. Orientation would ensure persons have the requisite skills and local knowledge that would minimise damage to reefs. Increase control of mega yacht and small cruise ship industry - stricter policing of anchoring etc. In short term, designate areas where mega yachts and small cruise ships can anchor; in long term have moorings for mega yachts. Increase the capacity and maintenance of the existing buoy system and make its use mandatory (use is already mandatory in the Wreck of the Rhone Marine Park). Increase monitoring at popular anchorages to ensure use of the buoy system.

	5. *Decrease sedimentation* Require that roads and driveways be paved within a short timeframe of cutting, especially where there are steep slopes that would require frequent grading. (To make more feasible, less expensive methods can be encouraged where practical, such as paving the edges of roads and maintaining grass growth in the centre strip); Require a permit for the regrading of roads and clearing of land; Strictly limit the footprint of vegetation clearing to the minimum needed for construction and require landscaping of cleared land within a short timeframe of clearing; Improve control, capture and reuse of stormwater. 6. *Decrease nutrient pollution in coastal waters* by improving sewage management at land and sea and decreasing agricultural run-off. On land – invest in a tertiary level municipal sewage treatment facility to serve the capital and major settlements. Upgrade and enforce regulations related to septic tank construction and maintenance. At sea – require yachts to have and use holding tanks and require marinas, public docks, and ports to have pump-out stations. 7. *Increase monitoring of coral reefs* so that changes in water temperatures and pH, and responses in coral health can be detected early and feed into adaptive management frameworks. 8. *Develop coral nurseries* to repair damaged reefs and encourage the growth of species more resilient to bleaching. 9. *Increase public education about coral reefs* (including integration into the school system) to force political will for better protections.
IMPACT **Biodiversity threatened by habitat loss, invasive species, and hurricanes**	1. Pass the draft Environmental Management and Conservation of Biodiversity Bill. *The Bill has been prepared through public consultation and would go a long way to create the protections and institutions necessary to protect biodiversity from climate change impacts.*

	2. Expand and improve management of Marine Protected Areas (MPAs) - declare proposed MPAs in the approved Protected Areas System Plan 2007-2017, clearly demarcate MPAs, improve monitoring and enforcement of MPA rules and regulations, and educate the public about MPAs. Revisit protected areas overtime to ensure that they are extensive enough and rules and regulations are strong enough to accomplish management goals (esp. as climate change creates new dynamics, such as fish migration to cooler waters). 3. Work with neighboring islands to *create protected migration corridors* in the Caribbean basin as a whole (through a regional network of protected areas). Create joint management plans for overlapping Exclusive Economic Zones (EEZ). 4. *Minimise beach development, beach erosion and marine habitat loss.* 5. *Conduct a forest/terrestrial biodiversity inventory* to determine what there is and what is vulnerable to climate change. Expand protected areas to target these vulnerable species and sensitive areas. 6. *Strictly limit the footprint of vegetation clearing* to the minimum needed for construction and require landscaping of cleared land with primarily native species within a short timeframe of clearing. 7. *Enhance legal protection and management of remaining forested areas.* Expand protected areas and migration corridors (to as close to recommended 30% as possible). Update management plans for areas as climate change impacts are experienced. 8. *Start serious reforestation programme.* 9. *Enhance protection of bird stopover habitats* such as salt ponds, mangroves, and rocky coastlines. 10. *Control populations of introduced bird egg predators* such as cats, rodents and mongoose. 11. *Development of invasive species reporting and early warning systems* as well as a standard protocol for responding to invasive species.

IMPACT AREA Tourism **IMPACT** **Natural tourist attractions degraded - beaches, pristine waters, coral reefs, and biodiversity**	*1. Enhance protection of natural tourist attractions* and supporting ecosystems through strengthening of environmental laws, improved development control, expanded protected area system, and **adequate waste disposal systems**. 2. *Diversify base of tourism industry* by developing and promoting less vulnerable land-based attractions (such as national parks, historical sites) and activities (such as sightseeing, bird watching, hiking, and cultural events). Develop niche tourism markets such as health tourism. (Some of these strategies are already being explored and implemented by the Tourist Board).
IMPACT AREA Water Resources and Hydrological Characteristics **IMPACT** **Changes in water quality and quantity**	1. *Develop a sustainable freshwater, watershed, and coastal waters management and pollution prevention plan* to best manage use of and protect available sources of freshwater – rainfall, groundwater, and desalination. Plan would also help to ensure that population growth and development remain within the bounds of the Territory's carrying capacity in regards to water resources. 2. *Repair and expand public infrastructure for water capture, storage, and delivery* (storage capacity should meet three day international standard). This would include continuing and expanding the leak detection programme to eliminate leaks in the water distribution system. 3. *Improve methods of household capture, storage and use of rainwater through*: - improving enforcement to ensure that buildings meet cistern area requirements in accordance with the building regulations; - encouraging regular cleaning and maintenance of cisterns and spouting to maximise usability of water. 4. *Implement concerted water conservation and efficiency programmes* in Government facilities and offices, businesses, and households (these might vary) by: - encouraging/requiring use of water saving devices through financial incentives and legislation; - changing public perception about the value and true cost of water; - improving water metering and billing system to ensure that customers pay the full price for water used (including eliminating illegal water connections), thus creating financial incentives for conserving water; - improving control, capture and reuse of stormwater and gray water.

	5. *Invest in infrastructure to allow capture, basic treatment, and reuse of stormwater for specific purposes* e.g. toilet flushing in major commercial/business districts and public landscaping. This might include, for example a) converting sections of some impervious parking lots and roads to pervious areas using interlocking permeable unit pavers, pervious concrete or porous pavement, and other technologies/techniques, and b) collection of stormwater in ghuts and engineered drainage systems using sump basins inclusive of a layered filtration bed and a pump to direct filtered water to an offsite storage area. 6. *Plan for the future expansion of desalination production capacity* to meet projected water demand in the Territory. This would also include planning for increased capacity of water storage facilities (to international standard of three days) to ensure a continuous delivery of water in the event of disasters or production failures. 7. *Increase competition in the bidding process to produce desalinated water*. 8. Explore possibility of using *solar-powered desalination technology*.
2nd Tier Priority Impacts ☆ ☆ ***(total score of 5 across all priority indicators)***	
IMPACT AREA Tourism **IMPACT** **Loss of or more costly damage to tourism infrastructure and properties from floods, stronger hurricanes and storm surges, and sea level rise**	1. Improve *drainage around critical tourism infrastructure and properties*. 2. *Ensure "climate-proof" structures* by improving construction standards: - Overhaul the outdated Building Regulations, 1999, with future climate hazards a major consideration; - Ensure that existing structures meet new regulations through systematic retrofitting; - Improve surveillance and enforcement of planning and building laws/regulations and approval conditions. 3. *Work towards enhanced insurance coverage* of critical tourism infrastructure and properties. 4. *Enhance industry hurricane preparedness and resilience*, including through developing and approving hurricane/flood preparation, evacuation and recovery plans. 5. *Increase setback and elevation requirements* for coastal tourism infrastructure/facilities. (Currently, development sites must have an average elevation of no less than 4 feet above mean sea level. The setback requirement is 50ft from the high water mark for main buildings. Ancillary buildings can be closer. The 50 ft requirement can be relaxed at the discretion of the Planning Authority. These provisions are weak. In the Caribbean, most islands have a setback requirement of 30m (98ft) from the high water mark with some islands having setbacks up to 81m (265 feet).

	6. *Where feasible, in highly vulnerable areas to sea level rise, stronger storm surges and flooding, establish "no build areas" for critical tourism infrastructure and properties*. 7. *Educate developers about the increasing risk of building in low-lying coastal areas* and the impact to surrounding areas (e.g. 100 yr events are now happening within the space of a few years). 8. *Develop best practice guidelines* for developers for responding to climate change impacts and protecting their properties. 9. Avoid move towards higher risk tourism development styles, e.g. building villas in the ocean (that is, in or over the seabed) 10. *Where appropriate, invest in "soft" measures* (such as mangroves and near-shore reefs) to help protect existing vulnerable tourism infrastructure and properties.
IMPACT AREA Food Security: Fisheries **IMPACT** **Degradation of critical fish habitat , such as coral reefs, mangroves and seagrass beds**	1. Enhance protection of mangrove forests and seagrass beds. 2. *Stricter controls on fishing techniques and marine recreational activities that impact coral reefs. (*In addition to all adaptation measures identified above for mangroves and coral reefs). 3. *Tighter enforcement against illegal fishing and overfishing* (this is mainly done by outsiders illegally fishing in The Virgin Islands waters).
3rd Tier Priority Impacts ☆ *(total score of 6 across all priority indicators)*	
IMPACT AREA Tourism **IMPACT** **Rising overheads/costs in energy, water, and insurance**	1. *Increase energy and water conservation and efficiency in tourism properties* by developing conservation tips and efficiency standards. 2. *Encourage use of renewable energies* in tourism properties. 3. *Incorporate "green" design in tourism properties*. E.g. natural cooling systems and designs that maximise natural lighting. 4. *Encourage use of more efficient cooling systems* (and proper maintenance of systems).

	5. Reduce insurance claims by *ensuring "climate-proof" structures* (able to withstand stronger hurricanes, storm surges, and flood events) by overhauling the outdated Building Regulations, 1999, systematically retrofitting existing structures, improving construction standards, and improving surveillance and enforcement practices.
IMPACT AREA Food Security: Fisheries **IMPACT** **Migration of some fish species to cooler waters**	1. *Develop fisheries that are less temperature sensitive or that will become more favourable as climate changes.*
IMPACT AREA Beach and Shoreline Stability **IMPACT** **Increased beach and shoreline erosion from stronger hurricanes and storm surges, and sea level rise**	1. *Develop and implement beach management plans* for all major recreational and turtle nesting beaches. 2. *Increase beach-monitoring activities* to detect sand mining and other extractive activities that violate the Beach Protection Ordinance, and to better understand seasonal and long-term changes in beaches. 3. *Increase fines* for violations of the Beach Protection Ordinance. 4. Improve and strictly enforce planning and building laws/regulations, especially increasing coastal development setbacks. 5. *Educate the architects, developers, and contractors about environmentally-friendly building practices* for the coastal zone. 6. *Offer incentives and assistance in finding "soft" versus "hard" ways of developing lands* close to beaches and vulnerable shorelines. 7. *Increase protection and rehabilitation of shallow coastal reefs* that act as an effective defence against beach and shoreline erosion. Where beaches are not naturally protected by reefs or pre-existing reefs have died, artificial reefs can be created where suitable. 8. *Strongly protect all remaining significant mangrove stands*. 9. *Invest in "soft" protective measures* (such as mangroves) along vulnerable areas of shoreline to help create additional land and buffer existing land from erosion.

IMPACT AREA Water Resources and Hydrological Characteristics **IMPACT** **Rainwater less reliable as the region becomes up to 25% drier and rainfall patterns change**	Same as above under *Water Resources and Hydrological Characteristics: Changes in water quality and quantity*

Table 10. Preferred adaptation actions for priority climate change impacts.

6.6 | FUNDING ADAPTATION

The full cost of adapting to climate change will vary for each country and is still being assessed for the Caribbean. The Economic Commission for Latin America and the Caribbean (ECLAC) is currently spearheading a *Review of the Economics of Climate Change in the Caribbean* (RECC) in which The Virgin Islands is included. What is already known from previous assessments, however, is that climate change impacts will be extremely costly and that it is more cost effective to adapt than to accept losses.

As noted in the CARICOM Liliendaal Declaration on Climate Change and Development, "the estimated total annual impact of potential climate change on all CARICOM countries is US$9.9 billion in the total Gross Domestic Product (GDP) in 2007 US$ prices or about 11.3% of the total annual GDP of all 20 CARICOM countries (Member States and Associate Member States), according to the World Bank estimates." (CARICOM, 2009)

It is also well established that adaptation measures should be taken as early as possible to minimise associated costs and maximise effectiveness (CANARI, 2008 a; Stern, 2007). Analysis from the Caribbean has shown that reconstruction costs can be as much as 40% of the original investment (CANARI, 2008 a). A World Bank report, for example, roughly estimates that the Caribbean could spend $1.3 billion by 2050 replacing hotel rooms lost as a result of sea level rise alone (Margaree Consultants, 2002).

Adaptation to these impacts will also be costly and will require a sustained input of resources (financial, technological and capacity building) above that which can be provided by economies like that of The Virgin Islands. This is a position supported by CARICOM in the international community.

At the 15th Conference of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC COP15), held December 2009, developed countries committed to providing "fast start financing" to developing countries to help them adapt to the impacts of climate change and invest in clean development pathways under the Copenhagen Accord. The financing should start in 2010 on the scale of $10 billion a year for the first three years with the goal of reaching $100 billion a year by 2020.

The constitutional status of The Virgin Islands and other United Kingdom Overseas Territories, however, excludes our access to funds, capacity building, and technology transfer assistance provided under the UNFCCC for climate change adaptation and mitigation.

There is, therefore, a need for the United Kingdom to support a long-term programmatic approach to addressing climate change in the Territories versus the "one-off" project approach

that currently exists. Such a long-term programme should continue and expand on the work started under the ECACC Project and provide the resources (financial and otherwise) to implement the Climate Change Adaptation Policy and Strategy being developed.

The Virgin Islands, however, should be proactive in its own interest by looking inward for adaptation financing opportunities. Such opportunities may be the significant cost savings that can be realised over time from the integration of alternative energies in our energy portfolio, or the revenues from an environmental tax.

7.0 | SUMMARY AND CONCLUSIONS

In basic terms, climate change (also known as global warming) is exactly what it sounds like – a significant change in the Earth's climate, the long term average weather conditions for given regions. For the first time since modern civilization, the Earth's climate is changing in a profound way – the average global temperature is warming at an unprecedented rate, triggering other fundamental changes including: sea level rise, stronger hurricanes, and rainfall extremes – that is, a greater chance of drought and flood events. These physical changes are creating a full spectrum of impacts for the ecosystems that support human life, our built environment, the provision of critical services, our economy, food and water security, health and way of life.

The Virgin Islands has a number of inherent characteristics that make it more vulnerable to climate change impacts, including small size and difficult geography, fragile natural ecosystems, existing high environmental impacts and development pressures, limited human and financial resources, limited access to technology, an open economy, and a propensity to natural disasters.

It can not be overemphasised that climate change is not just an environmental issue, it is equally an economic issue, a disaster management issue, a food security and human health issue, and a quality of life issue – this makes climate change everyone's business and a cause for concern and action at the individual, community, organisational, and country level.

The *Green Paper* has identified and discussed the primary impact areas that should be on The Virgin Islands climate change agenda. The priority climate change impacts, as identified through public consultation, fall under the following impact areas: Coastal & Marine Resources, Forestry & Biodiversity, Tourism, Water Resources & Hydrological Characteristics, Fisheries, and Beach & Shoreline Stability.

While the impacts of climate change are diverse and costly they are also manageable.

In most cases this involves implementation of well established best management practices and strengthening of existing legislation, policies, institutions and programmes. Studies, including the Stern Review, have proven that early adaptation to climate change impacts is more cost effective and, of course, minimises impacts.

Common threads can be found among the adaptation strategies proposed for various climate change impact areas.

Most importantly, preferred adaptation measures attempt to increase the underlying resilience of natural ecosystems and infrastructure to climatic hazards. This typically entails strengthening legal protections and enforcement. In the case of natural systems it also typically involves minimising existing local impacts, and in the case of infrastructure involves improving building standards and the planning process. In other cases, adaptation requires diversification to maximise traditionally under-tapped resources that may be impacted less by changes in climate. Regardless of the adaptation options on the table, public education and outreach is a critical supporting activity.

There is tremendous synergy between the twelve (12) climate change impact areas identified so that gains made in addressing one impact area can have a positive effect elsewhere. Taking some of the top impact areas for example, adaptation measures to protect coastal and marine ecosystems, especially coral reefs and mangroves, will help to maintain the tourism product, ensure beach and shoreline stability, support a sustainable fishery, and protect critical infrastructure such as the coastal road network from the impacts of sea level rise and storm surges.

Finally, although climate change poses significant challenges to The Virgin Islands and we are constrained in our ability to respond, adaptation to climate change presents some important opportunities.

Firstly, it provides a new forum through which to educate the public and change attitudes and behaviours regarding the environment and sustainable development. It also provides the much needed impetus to implement “no regrets” measures to reduce our inherent vulnerabilities to natural disasters and external shocks and to improve environmental management and the physical planning process. In a similar vein, climate change will force us to diversify our tourism and energy portfolios, ultimately increasing our security and long-term viability.

If The Virgin Islands continues to take sustained and early actions to address climate change, although impacts will be sustained, they can be minimised.

Appendix A | Climate Change Adaptation Options

The tables presented here represent the beginnings of a *Climate Change Adaptation Policy and Strategy* for The Virgin Islands. Adaptation options have been developed in collaboration with respective Government agencies and refined with input from the public stakeholder consultation process.

For each key climate change impact area discussed in Chapter 3.0, the tables suggest general guiding adaptation principles, as well as a selection of specific adaptation options for each impact identified. Each specific adaptation option is further assigned a category, rating, supporting activities, and an implementation timeframe as outlined in Tables A1 to A3 directly below. Impacts highlighted with 3, 2, and 1 yellow stars have been identified by stakeholders as first, second, and third tier priorities for action, respectively. Adaptation opportunities and constraints are discussed in Appendix B.

PREVENT LOSS	Reduce vulnerability to climate change through engineering or other measures
CHANGE THE ACTIVITY	Replace current activities with more sustainable ones
SPREAD LOSS	Distribute the burden of losses through property insurance, Government emergency relief and other measures
RELOCATION	Shift current activities or structure to another location
ACCEPT LOSS	Implement no vulnerability measure and bear the burden of loss

Table A1. Climate change adaptation options categories. (Adapted from d'Auvergne et al., 2001).

PREFERRED ACTION	1
ACCEPTABLE ALTERNATIVE	2
LAST RESORT ACTION	3

Table A2. Rating system for climate change adaptation options.

IMMEDIATE	Start within 1 year of Adaptation Strategy being approved by Cabinet
NEAR-TERM	Within 2 - 5 years of Adaptation Strategy being approved by Cabinet
MID-TERM	Within 6 - 10 years of Adaptation Strategy being approved by Cabinet
LONG-TERM	After 10 years or more of Adaptation Strategy being approved by Cabinet

Table A3. Implementation timeframes for climate change adaptation options.

Beach & Shoreline Stability

General Guiding Adaptation Principles:

- ✓ Avoid activities and development policies that undermine the stability of existing beaches and shorelines or that create man-made beaches and shorelines that are vulnerable.
- ✓ Protect beaches and vulnerable shorelines with natural defences where practical.
- ✓ Allow for natural adjustments in beaches/shorelines as sea level rises, unless it would pose danger or too significant loss.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
☆ **Sea level rise, stronger hurricanes and storm surges causing:** - **Increased beach erosion and shrinkage ;** - **Shoreline erosion and increased flood risk to low-lying coastal areas.**	*Develop and implement beach management plans* for all major recreational and turtle nesting beaches.	Prevent Loss/Change the Activity *Preferred Action (1)*	Creation of a Beach Commission (inter-sectoral committee that represents all key stakeholders – Government and private) and an overarching beach policy; Identification of beach uses, stakeholders and issues; Involvement of the community/stakeholders in devising a management plan; Pilot project to develop a beach management plan (ongoing in Cane Garden Bay); Monitoring, enforcement and ongoing revision of plan. *(A framework for developing beach management plans has been published by Ms. Shannon Gore,*	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
			Marine Biologist, Conservation and Fisheries Department – Gore, S., 2007)	
	Increase beach-monitoring activities to detect sand mining and other extractive activities that violate the Beach Protection Ordinance, and to better understand seasonal and long-term changes in beaches as we experience stronger hurricanes and sea level rise.	Prevent Loss *Preferred Action (1)*	Public education and outreach; Institutional strengthening; Formation of community watch groups.	Immediate
	Increase fines for violations of the Beach Protection Ordinance.	Prevent Loss *Preferred Action (1)*	Amendments to environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill.	Immediate
	Improve and strictly enforce planning and building laws/regulations and approval conditions, especially increasing coastal development setback and elevation requirements. (Currently development sites must have an average elevation of no less than 4 feet above mean sea level. The setback requirement is 50ft from the high water mark for main buildings. Ancillary buildings can be closer. The 50 ft requirement can be relaxed at the discretion of the Planning Authority. These provisions are weak. In the Caribbean, most islands have a setback requirement of 30m (98ft) from the high water mark with some islands having setbacks up to 81m (265 feet).	Prevent Loss *Preferred Action (1)*	Storm surge and sea level rise coastal inundation maps and beach assessments to determine appropriate building setbacks; Amend planning and building laws/regulations; Build institutional capacity to improve monitoring and enforcement activities; Land compensation programme for affected land owners within setback area; Public education and outreach; Build political will; Integrate Hazard Vulnerability Assessments into the development planning process.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
	(Enforcement of planning and building laws/regulations can be improved by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle violations of planning and building laws/regulations).			
	Educate architects, developers, and contractors about environmentally-friendly building practices for the coastal zone.	Prevent Loss *Preferred Action (1)*	Ongoing research on best practices in use around the region, other small islands, and coastal regions; Training workshops; Production of user-friendly reference manuals.	Immediate
	Offer incentives and assistance in finding "soft" versus "hard" ways of developing lands close to beaches and vulnerable shorelines.	Change the Activity *Preferred Action (1)*	Amend tax laws/regulations to provide incentives; Work with insurance companies to provide financial incentives; Integrate hazard vulnerability assessments into the development planning process; Partner with the Trade Department to carry out long-term public education and outreach - Target landowners of developable coastal lands; Build political will.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
	Increase protection and rehabilitation of shallow coastal reefs that act as an effective barrier against beach and shoreline erosion. Where beaches are not naturally protected by reefs or pre-existing reefs have died, artificial reefs can be created where suitable.	Prevent Loss *Preferred Action (1)*	Amendments to environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Institutional strengthening; Public education and outreach; Develop close partnerships with stakeholders, e.g. diver and charter yacht operators; Formation of community watch groups; Scientific studies and long term monitoring; Build political will.	Immediate to Near-term
	Strongly protect all remaining significant mangrove stands.	Prevent Loss *Preferred Action (1)*	Amend environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Public education and awareness about the value of mangroves; Build political will.	Immediate
	Invest in "soft" protective measures (such as mangroves) along vulnerable areas of shoreline to help create additional land and buffer existing land from erosion.	Prevent Loss *Preferred Action (1)*	Vulnerability analysis to determine priority areas and extent of fortification necessary; Scientific research and monitoring;	Immediate (mangroves take many decades to mature)

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
			Institutional strengthening - build local capacity in coastal zone management and engineering; Public education and outreach; Formation of volunteer programme to plant mangroves.	
	If necessary, invest in 'hard" engineering structures (such as sea walls, breakwaters, and bulkheads etc.) to buffer existing areas of vulnerable shoreline from erosion and flooding due to sea level rise and stronger hurricanes and storm surges.	Prevent Loss *Last Resort Action (3)*	Vulnerability analysis to determine priority areas and extent of fortification necessary; Environmental impact assessments; Significant capital investment; Institutional strengthening - build local capacity in coastal zone management and engineering.	Long-term *(as necessary)*
	Beach re- nourishment (mechanically replacing beach sand that has eroded).	Prevent Loss *Last Resort Action (3)*	EIA and studies to determine correct grain size etc. to use in re-nourishment; Institutional strengthening - build local capacity in coastal zone management and engineering.	Long-term (as necessary)
	Where practical, elevate critical, undeveloped, low-lying areas of shoreline to buffer them from erosion and flooding due to sea level rise and stronger hurricanes and storm surges.	Relocation / Prevent Loss *Last Resort Action (3)*	Feasibility studies; Environmental impact assessments; Significant capital investment; Institutional strengthening - build local capacity in coastal zone management and engineering.	Long-term (as necessary)

Coastal & Marine Ecosystems

General Guiding Adaptation Principles:

- ✓ Enhance the resilience and natural adaptive capacity of coastal and marine ecosystems by increasing protections and reducing local impacts.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
☆☆☆ ***a) Coral Reefs*** **Coral reefs experiencing increased bleaching, structural damage, disease and death due to increased ocean temperatures, ocean acidification, and more intense hurricane events and storm surges.**	*Expand and improve management of Marine Protected Areas (MPAs)* - clearly demarcate MPAs, improve monitoring and enforcement of MPA rules and regulations, and educate the public about MPAs. Revisit protected areas overtime to ensure that they are extensive enough and rules and regulations are strong enough to accomplish management goals (esp. as climate change creates new dynamics, such as fish migration to cooler waters).	Change the Activity *Preferred Action (1)*	Declaration of proposed marine protected areas included in the approved British Virgin Islands Protected Areas System Plan 2007-2017; Institutional strengthening; Public education and outreach; Formation of community watch groups; Building political will.	Immediate to Near-term
	Implement a rotating system of closure (recovery periods) for reefs in which all human impacts are temporarily removed from select reefs – e.g. no boats allowed for a 5 yr period etc.	Change the Activity *Preferred Action (1)*	Amendments to environmental laws/regulations to enable enforcement of such a system; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Stakeholder involvement and baseline data to ensure the development of a workable and scientifically sound rotation system;	Long-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Public education and outreach to secure buy-in and increase adherence to the system; Continuous monitoring and responsive management; Build institutional capacity to handle increased monitoring and enforcement requirements.	
	Decrease recreational damage from divers and snorkelers - introduce a mandatory orientation for persons going to dive or snorkel with charter boats or dive operators. Orientation would ensure persons have the requisite skills and knowledge that would prevent damage to reefs. *(This is done successfully in Bonaire).*	Change the Activity *Preferred Action (1)*	Amendments to environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Targeted education and outreach; Develop close partnerships with stakeholders in the yachting and dive industry; Build political will.	Immediate
	Decrease anchor damage – introduce a mandatory orientation for skippers and persons chartering a yacht. Orientation would ensure persons have the requisite skills and local knowledge that would minimise damage to reefs. Increase control of mega yacht and small cruise ship industry - stricter policing of anchoring etc. In short term, designate areas where mega yachts and small cruise ships can anchor; in long term moorings for mega yachts	Change the Activity *Preferred Action (1)*	Amendments to environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Targeted and public education and outreach; Develop close partnerships with stakeholders in the yachting industry; Significant capital investment (get benefiting private sector companies involved in funding);	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Increase the capacity and maintenance of the existing buoy system and make its use mandatory (use is already mandatory in the Wreck of the Rhone Marine Park). Increase monitoring at popular anchorages to ensure use of the buoy system.		Development and approval of a mega yacht / small cruise ship policy; Institutional strengthening to enhance monitoring and enforcement.	
	Decrease sedimentation Require that roads and driveways be paved within a short timeframe of cutting, especially where there are steep slopes that would require frequent grading. (To make more feasible, less expensive methods can be encouraged where practical, such as paving the edges of roads and maintaining grass growth in the centre strip); Require a permit for the regrading of roads and clearing of land; Strictly limit the footprint of vegetation clearing to the minimum needed for construction and require landscaping of cleared land within a short timeframe of clearing; Improve control, capture and reuse of stormwater.	Change the Activity *Preferred Action (1)*	Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Public education and outreach; Expand the erosion control component in The Virgin Islands Safer Building Course and make course a requirement for operators of earth moving machinery; Partner with banks to ensure that cost of road paving is included in construction costs when approving construction loans; Improve the drainage system;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Institutional strengthening.	
	Decrease nutrient pollution in coastal waters by improving sewage waste management on land and at sea and decreasing agricultural run-off. On land – invest in tertiary level municipal sewage treatment facilities to serve the capital and major settlements. Upgrade and enforce regulations related to septic tank construction and maintenance. At sea – require yachts to have and use holding tanks, and require marinas, public docks and ports to have pump-out stations.	Change the Activity / Prevent Loss *Preferred Action (1)*	Amendments to building and environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Revision of 1999 National Sewerage Plan reflecting new population projections, development plans, and build-out scenarios; Institutional strengthening to improve monitoring and enforcement of septic tank requirements; Substantial capital investment; Adaptation of best agricultural practices.	Near-term
	Increase monitoring of coral reefs so that changes in water temperatures and pH, and responses in coral health can be detected early and feed into adaptive management frameworks.	Prevent Loss *Preferred Action (1)*	Institutional strengthening (additional dedicated officers, training and financial resources); Encouragement and growth of volunteer monitoring programmes, e.g. Reef Check, working in collaboration with Government agencies ; Public education and outreach.	Immediate
	Develop coral nurseries to repair damaged reefs and rear species more resilient to bleaching.	Prevent Loss *Preferred Action (1)*	Follow experiments at coral nurseries in the Caribbean e.g. Belize and Saint Croix to determine pros and cons before implementation; Significant capital investment;	Mid-term (as necessary)

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Build local capacity in marine biology and research.	
	Increased public education about coral reefs (including integration into the school system) to force political will for better protections.	Prevent Loss *Preferred Action (1)*	Baseline survey to determine existing knowledge, attitudes, and perceptions, and best educational approaches; National Environmental Education Strategy (being developed by National Environmental Education Committee) Development of educational materials; Revision of school curricula; Education of teachers.	Immediate
	Create artificial reefs - using ecologically sensitive approaches such as done in the Cayman Islands.	Relocation *Acceptable Alternative (2)*	Scientific studies to determine suitable areas for placement; Long-term monitoring to measure success; Build local capacity in marine biology and research.	Mid-term (as necessary)
	Use low-voltage electrical current to stimulate coral reef regrowth in badly damaged areas. *(Method conceived by Dr. Tom Goreau and Wolf Hilbertz and being experimented with in Bali, Indonesia under the Karang Lestari Project).*	Prevent Loss *Acceptable Alternative (2)*	Follow experiments in Indonesia to determine pros and cons before local implementation; Long-term monitoring and research; Build local capacity in marine biology and research.	Mid-term (as necessary)

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
b) Mangroves **Landward migration or inundation of mangroves.** **Increased physical stress from stronger hurricanes and storm surges, making it easier for mortality of mature mangroves and more difficult for young mangroves to mature.**	*Strongly protect all remaining significant mangrove forests.*	Prevent Loss *Preferred Action (1)*	Declaration of proposed marine protected areas included in the approved British Virgin Islands Protected Areas System Plan 2007-2017; Amend environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Public education and awareness about the value of mangroves; Build political will.	Immediate
	Expand and enhance mangrove reforestation programme.	Prevent Loss *Preferred Action (1)*	Public education and outreach about the value of mangroves; Formation of volunteer programme to plant mangroves; Institutional strengthening.	Immediate
	Through smart land-use planning, allow room for landward migration of mature mangrove forests by protecting the land behind these areas from development. The Government can seek to acquire these lands and place them in permanent protection through the National Parks Trust or create incentive programmes to encourage "soft" developments in these areas as opposed to "hard" developments.	Prevent Loss *Preferred Action (1)*	Amend environmental laws/regulations; Pass the Draft Environmental Management and Conservation of Biodiversity Bill; Public education and outreach; Financing mechanisms for land acquisition and incentive programmes; Build political will.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Shelter young mangroves from storm surges by protecting natural coral reefs and, where suitable, constructing artificial reefs in priority areas.	Prevent Loss *Preferred Action (1)*	Scientific studies to determine needed areas for artificial reefs; Long-term monitoring to measure success; Institutional strengthening.	Mid-term (as necessary)
c) Seagrass Beds **Decreased growth of seagrass beds and increased stress and mortality.** **Mechanical damage from stronger hurricanes and storm surges.**	Enhance protection of seagrass by placing significant seagrass beds in MPAs and enhancing their legal protections in remaining areas.	Prevent Loss *Preferred Action (1)*	Declaration of proposed marine protected areas included in the approved British Virgin Islands Protected Areas System Plan 2007-2017; Amendments to environmental laws/regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Public education and outreach.	Near-term
	Protect seagrass beds from high-energy wave action by protecting existing coral reefs and, where suitable, constructing artificial reefs in priority areas.	Prevent Loss *Preferred Action (1)*	Scientific studies to determine suitable areas for placement; Long-term monitoring to measure success; Institutional strengthening.	Mid-term (as necessary)

Critical Infrastructure

General Guiding Adaptation Principles:

- ✓ Enhance the resilience of existing critical infrastructure to climate change impacts.
- ✓ Avoid building new infrastructure in areas or with materials vulnerable to climate hazards.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Road network **(especially coastal) at greater risk of damage from floods, stronger storm surges and sea level rise.**	*Improve drainage* along roads, in human settlements and in commercial districts through the following measures: - Improving road drainage design and construction; - Improving land use planning (e.g. tighten controls on development within a certain proximity of ghuts, especially in regards to erosion (this may be done through requiring limited EIAs for these developments); - Utilizing pervious concrete or porous pavement instead of the traditional imperious concrete and asphalt (these offer the inherent durability and low life cycle costs of typical concrete pavement while retaining stormwater runoff and replenishing local watershed systems);	Prevent Loss *Preferred Action (1)*	Include the Water and Sewerage Department or a hydrologist in drainage design; Flood hazard mapping; Rigorous analysis of the current drainage problem and possible solutions, including study of the impact of extreme rain events on the ghut drainage system; Comprehensive Land Use and Physical Development Plans with zoning; Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	- Minimizing land clearing and creation of impervious surfaces during development to limit runoff and soil erosion; - Developing a maintenance and monitoring system for the natural drainage system (ghuts) instead of lining them with concrete. This would include, for example, regular (more than once per year and based on an assessment) clearing and pruning of vegetation and monitoring and removal of sediment build up; - Reducing littering and garbage disposal in the ghut drainage system to minimise blockage in flood events.		violations; Institutional strengthening (more experienced engineers); Reforestation programme; Build political will; Public education and outreach.	
	Start serious reforestation programme to reduce stormwater run-off and erosion.	Prevent Loss *Preferred Action (1)*	Native and endemic plant species nursery. Organisation of community, school, and tourism based reforestation groups; Creation of legitimate and reputable carbon offsetting programmes for the tourism sector to help fund reforestation efforts; Public education and outreach.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Improve the integrity of the road network by strengthening roads that have been undermined by continuous erosion and past flooding / landslide events; Improve road cutting techniques to reduce potential of undermining.	Prevent Loss *Preferred Action (1)*	Significant capital investment; Institutional strengthening (more experienced road engineers).	Immediate to Long-term (as necessary)
	Continue to build safe alternative road network through the interior of the islands that would not be vulnerable to sea level rise and storm surges. Network design should consider environmental sensitivity, and areas prone to landslides and erosion as to minimise future vulnerabilities during flood events.	Relocation *Preferred Action (1)*	Comprehensive Land Use and Physical Development Plans to ensure alternative transport network meets future development needs; Integrate Hazard Vulnerability Assessment into the development planning process; Environmental Impact Assessments; Significant capital investment.	Near-term to Mid-term
	Where alternatives exist, *avoid building new roads in areas vulnerable* to stronger storm surges and sea level rise.	Change the Activity *Preferred Action (1)*	Storm surge and coastal inundation mapping; Amend planning laws/regulations; Comprehensive Land Use and Physical Development Plans to a) minimise the extension of the main road network to vulnerable areas to serve ad hoc developments and b) to preserve lands for safe location of new roads in developable areas; Integrate Hazard Vulnerability Assessments into the	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			development planning process.	
	Where appropriate invest in "soft" measures (such as mangroves) to help protect existing vulnerable coastal roads.	Prevent Loss *Preferred Action (1)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary; Monitoring of effectiveness; Institutional strengthening - build local capacity in coastal zone management and engineering; Public education and outreach; Formation of volunteer programme to plant mangroves.	Immediate *(to allow these natural protections time to mature)*
	Where necessary *invest in 'hard" engineering structures* (such as sea walls and bulkheads) to help protect existing vulnerable coastal roads.	Prevent Loss *Last Resort Action (3)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary; Environmental impact assessments and coastal engineering studies; Significant capital investment; Institutional strengthening - build local capacity in coastal zone management and engineering; Significant capital investment.	Long-term *(as necessary)*
	Where no alternative route exists or is feasible,	Relocation	Storm surge and coastal inundation mapping;	Long-term *(as*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	elevate critical areas of the coastal road network that are particularly low-lying or exposed making them vulnerable to higher storm surges and sea level rise.	*Last Resort Action (3)*	Environmental Impact Assessments / Hazard Vulnerability Assessments; Significant capital investment; Institutional strengthening - build local capacity in coastal zone management and engineering.	*necessary)*
Critical facilities and developable lands **(especially those in the coastal zone) at greater risk of damage from floods, stronger hurricanes and storm surges, and sea level rise.** **(E.g. schools, community and emergency centres, health facilities, public administration buildings, the financial centre, airports etc.)**	*Improve and enforce planning and building laws/regulations,* especially in regards to elevation and coastal development setback requirements. (Currently development sites must have an average elevation of no less than 4 feet above mean sea level. The setback requirement is 50ft from the high water mark for main buildings. Ancillary buildings can be closer. The 50 ft requirement can be relaxed at the discretion of the Planning Authority. These provisions are weak. In the Caribbean, most islands have a setback requirement of 30m (98ft) from the high water mark with some islands having setbacks up to 81m (265 feet).	Prevent Loss *Preferred Action (1)*	Storm surge maps, coastal inundation maps, and beach assessments to determine appropriate building setbacks from the coast; Amend planning and building laws/ regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Public education and outreach; Build political will.	Near-term
	Improve drainage around critical facilities and developable lands through the measures	Prevent Loss	See activities above under improving drainage of roads and surrounding areas.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	described above for roads.	*Preferred Action (1)*		
	Ensure "climate-proof" structures by improving construction standards: - Overhaul the outdated Building Regulations, 1999 with future climate hazards a major consideration; - Ensure that existing structures meet new regulations through systematic retrofitting. - Improve surveillance and enforcement of planning and building laws/ regulations and approval conditions.	Change the Activity / Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.	Near-term
	Ensure adequate insurance of critical facilities against climate hazards.	Spread Loss *Preferred Action (1)*	Valuations of critical infrastructure; Measures to increase security and reduce the costs of insurance schemes; Public education and outreach.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Enhance hurricane preparedness of critical facilities.	Prevent Loss *Preferred Action (1)*	Development of protocols for preparing critical public buildings; Education and outreach to public officers.	Immediate
	Improve management of and increase the Disaster Relief Fund.	Spread Loss *Preferred Action (1)*	Approve drafted guidelines to govern how monies can be spent.	Immediate
	Develop an overarching policy on coastal land reclamation to prevent unnecessary proliferation of reclamation and reclamation in sensitive or vulnerable coastal areas, etc. Increase the minimum height above high water mark required for coastal reclamations (currently 5ft) to a height determined sufficient to minimise loss given the projections of sea level rise of up to 1.9 feet and stronger storm surges.	Prevent Loss / Change the Activity Preferred Action (1)	Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number and capacity of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Comprehensive Coastal Zone Development Plan as a part of a Comprehensive Land Use and Physical Development Plan; Assessment to determine safe minimum height for reclamation based on sea level rise mapping and improved storm surge maps.	Immediate to Near-term
	Plan for the future relocation of critical facilities that vulnerability assessments predict will be permanently inundated by sea level	Relocation *Preferred*	Coastal inundation mapping; Purchase private lands or reserve public lands for	Near-term (given rapid rate of

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	rise or seriously at risk to stronger storm surges.	*Action (1)*	the relocation of threatened critical public facilities; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process.	development and scarcity of suitable land) *Actual relocation would be in the long-term as necessary*
	Where appropriate invest in "soft" measures (such as mangroves) to help protect existing vulnerable facilities and developable lands.	Prevent Loss *Preferred Action (1)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary; Monitoring of effectiveness; Institutional strengthening - build local capacity in coastal zone management and engineering; Public education and outreach; Formation of volunteer programme to plant mangroves.	Immediate *(to allow these natural protections time to mature)*
	Where feasible, establish "no build areas" for public critical facilities in areas highly vulnerable to sea level rise, stronger storm surges, and flooding.	Change the Activity *Preferred Action (1)*	Flood hazard mapping; Storm surge and coastal inundation mapping; Amend planning laws/regulations; Improve enforcement of planning and building laws	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			and regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process; Public education and outreach to encourage support of no build areas; Build political will.	
	Where "no build areas" are unfeasible, *mandate proper elevation of buildings' foundations and other safeguards* in flood prone areas and waterfront lots to deal with heavy rain events and stronger storm surges. *(Currently the Building Regulations require that all development sites be at least on average 4 feet above mean sea level).*	Prevent Loss *Acceptable Alternative (2)*	Flood hazard mapping; Storm surge and coastal inundation mapping; Amend building laws/regulations; Integrate Hazard Vulnerability Assessments into the development planning process; Capacity building in construction for flood resistance through the established Virgin Islands Safer Building Course offered at HLSCC.	Near-term
	If necessary *invest in 'hard" engineering*	Prevent Loss	Storm surge and coastal inundation mapping;	Long-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	structures (such as sea walls and bulkheads) to help protect existing vulnerable critical facilities.	*Last Resort Action (3)*	Vulnerability analysis to determine priority areas and extent of fortification necessary; Environmental impact assessments and coastal engineering studies; Significant capital investment; Institutional strengthening - build local capacity in coastal zone management and engineering; Significant capital investment.	*(as necessary)*
***Critical utilities* at greater risk of damage from floods, stronger hurricanes and storm surges, and sea level rise.** **(E.g. electricity generation plant and distribution system, desalination plants, telecommunication substations and lines)**	*Improve the drainage* around critical utilities, e.g. the main electricity generation plant at Pockwood Pond	Prevent Loss *Preferred Action (1)*	Develop master drainage plan for Pockwood Pond area; Secure stakeholder buy-in from landowners in area; Build political will.	Near-term
	Continue to improve construction standards through revision of the Building Regulations, 1999, retrofitting of existing buildings, enhanced enforcement of planning and building laws/regulations and approval conditions, and capacity building programmes.	Prevent Loss *Preferred Action (1)*	Amend building laws/regulations; Improve enforcement of planning and building laws and regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.	
	Bury electrical lines where determined to be strategic. E.g. population / development centres prone to high winds, but not flooding and storm surges. *(Lines have already been buried in the Road Town financial district.)*	Relocation *Preferred Action (1)*	Study to determine areas where overall vulnerability would be reduced by burying lines; Significant capital investment; Increased budget for underground line maintenance; Upgrade of diagnostic equipment/methods to find problems underground.	Near-term to Mid-term
	Plan for the future relocation of critical utilities (buildings and network cables, lines and pipes) that vulnerability assessments predict will be permanently inundated by sea level rise or put at high risk of damage from stronger storm surges.	Relocation *Preferred Action (1)*	Storm surge and coastal inundation mapping; Purchase private lands or reserve public lands for the relocation of threatened critical public facilities; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process.	Near-term to Mid-term (given rapid rate of development and scarcity of suitable land)

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Avoid siting buildings for critical utilities in areas vulnerable to floods, stronger storm surges and sea level rise.	Prevent Loss *Preferred Action (1)*	Flood hazard mapping; Storm surge and coastal inundation mapping; Amend planning laws/regulations; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process; Build political will.	Immediate
***Sewerage system* at greater risk of damage from stronger storm surges and floods.**	*Improve the drainage system of roads and surrounding areas* as to minimise stormwater entering the sewerage collection system through the measures described above for roads.	Change the Activity *Preferred Action (1)*	See activities above under improving drainage of roads and surrounding areas.	Near-term
	Implement the National Sewerage Development Programme. This would include an overhaul of the sewerage collection and discharge system in the greater Road Town area and construction of a treatment plant. The new system should be designed to handle large volumes of storm water associated with flood events, use water-tight manholes, and use materials able to withstand stronger storm surges in the coastal zone.	Prevent Loss *Preferred Action (1)*	Revision of 2002 National Sewerage Plan to reflect new population projections, development plans, and build-out scenarios; Significant capital investment; Build political will.	Immediate to Mid-term

Energy Security

General Guiding Adaptation Principles:

- ✓ Enhance the resilience of the electricity generation and distribution system.
- ✓ Implement policies to reduce energy use and encourage greater energy independence.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
Electricity system at greater risk of damage from floods, stronger hurricanes and storm surges, and sea level rise.	*Plan for the future relocation or retrofitting of electricity generation stations and sub-stations* (that vulnerability assessments predict will be permanently inundated by sea level rise or put at high risk of damage from stronger storm surges; Improve the drainage around the main electricity generation plant at Pockwood Pond; Ensure existing and new energy facilities are "climate-proof;" Bury electrical lines where determined to be strategic. E.g. population and development centres prone to high winds, but not flooding and storm surges; *(Lines have already been buried in the Road Town financial district).*	Relocation / Prevent Loss *Preferred Action (1)*	Coastal inundation mapping; Integrate Hazard Vulnerability Assessments into the development planning process; Purchase private lands or reserve public lands for the future relocation of threatened facilities; Comprehensive Land Use and Physical Development Plans with zoning; Develop master drainage plan for Pockwood Pond area and secure stakeholder buy-in from landowners in area; Overhaul the outdated Building Regulations, 1999 with future climate hazards a major consideration and ensure that existing facilities meet new regulations through systematic retrofitting; Improve enforcement of planning and building laws and regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each	Near-term to Mid-term (given the rapid rate of development and scarcity of suitable land)

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
			period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Build political will; Study to determine areas where overall vulnerability would be reduced by burying lines; Significant capital investment; Increased budget for underground line maintenance; Upgrade of diagnostic equipment/methods to find problems with underground electrical lines.	
Increase in fossil fuel derived energy costs as international efforts are made to reduce carbon emissions.	*Diversify the Territory's energy portfolio* to include alternative energies (especially solar and small wind).	Change the Activity *Preferred Action (1)*	Formation of a Renewable Energy Committee; Amendments to energy laws/regulations; Feasibility studies to determine the most suitable renewable energy technologies and models – i.e. centralised or individual (household by household, business by business) production; Financing mechanisms and incentive programmes to encourage use of renewable energies, including reversible metering; Study option of revising energy institutional structure to separate functions of electricity	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
			generation, distribution and sales to encourage smaller generators of renewable energy to feed into the grid; Capacity building in solar and wind installation; Public education and outreach; Build political will.	
	Start a Territory wide solar water heater programme to encourage large-scale conversion from electrical water heaters. *(Barbados provides an excellent example of this in the region with over 50% of households using solar water heaters).*	Change the Activity *Preferred Action (1)*	Formation of a Renewable Energy Committee; Review of Barbados approach and suitability for the Territory; Creation of suitable Government/private incentive programmes and financing mechanisms; Public education and outreach; Build political will. Capacity building in solar water heating technologies.	Immediate
	Implement energy conservation policies and programmes. This would include, for example, turning off lights, machinery and appliances when not in use.	Change the Activity *Preferred Action (1)*	Formation of a Renewable Energy Committee; Public education and outreach.	Immediate
	Develop and enforce energy efficiency standards for Government facilities and	Change the Activity	Amend building laws/regulations to mandate certain efficiency standards, i.e. integrate energy	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time- frame
	offices, businesses, and households (these may vary).	*Preferred Action (1)*	efficiency into the Building Regulations; Financial incentives for purchasing / upgrading to energy efficient appliances.	
	Incorporate "green" design into buildings – e.g. natural cooling systems and designs that maximise natural lighting.	Change the Activity *Preferred Action (1)*	Amendments to building laws/regulations to mandate certain "green" building standards; Incorporate green design into the HLSCC Safer Building Course or offer a separate course or other opportunities for capacity building in green design; Public education and outreach.	Near-term
Increased energy use for cooling in the summer time.	Encourage use of more efficient cooling systems (and proper maintenance of systems).	Change the Activity *Preferred Action (1)*	Government-led incentives for purchasing energy efficient appliances; Public education and outreach.	Immediate

Food Security: *Agriculture*

General Guiding Adaptation Principles:

- ✓ Expand and increase resilience of local agricultural production (with policies that encourage water efficiency, environmental sensitivity, technology and local capacity building).

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Increase in agricultural pests, weeds, diseases and invasive species due to increased concentrations of carbon dioxide (CO_2), warmer soil temperatures and changes in humidity. **Increased stress to livestock from heat, drought and disease.**	*Develop standard protocol for responding to pests, diseases and invasive species*, including a good reporting and alert system between producers (farmers), the wider public and the Agricultural Department.	Change the Activity *Preferred Action (1)*	Monitoring of pests, diseases and invasive species; Targeted (agricultural producers) and public education and outreach; Amend laws/regulations if necessary.	Immediate to Near-term (JNCC funding potentially currently available for developing invasive species protocol)
	Develop and practice methods of integrated pest management (IPM), including encouraging producers to diversify their crops to impart resilience to the agro-ecosystem.	Change the Activity *Preferred Action (1)*	Ongoing research and monitoring programmes to develop locally suitable IPM techniques; Practical training programmes to build capacity in integrated pest management.	Immediate
	Insurance of crops, livestock and poultry against outbreaks of pests and diseases etc.	Spread Loss *Preferred*	Improve insurance coverage and access for the agricultural sector;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
		Action (1)	Improve record keeping among producers to facilitate insurance claims; Training in agricultural damage assessment; Development and strengthening of agricultural associations.	
	Introduction of organic recirculation hydroponics for high value garden vegetables such as tomatoes, cucumbers, salad crops and culinary herbs. *(Hydroponics aids by isolating crops from the soil thus reducing exposure to diseases, pests, weeds, etc. and has additional advantages such as reduced water, fertiliser, pesticide, and land area demand).*	Prevent Loss *Preferred Action (1)*	Stakeholder involvement and buy-in; Heavy investment in local capacity building; Enhancement of financing options for producers; Change in market / consumer preferences; Investment in new technologies/ infra-structure, making sure that they are structurally suited to local climate and changing conditions (greenhouse construction already underway); Improvement in reliability of water supply; Integration of renewable energies to help power greenhouse production.	Near-term
	Depend more heavily on agriculture in controlled environments (e.g. greenhouses, organic recirculation hydroponics, poultry units, small stock units, feedlots and dairy units). (PA)	Prevent Loss *Preferred Action (1)*	Stakeholder involvement and buy-in; Heavy investment in local capacity building; Enhancement of financing options for producers; Change in market / consumer preferences;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Investment in new technologies/ infrastructure, making sure that they are structurally suited to local climate and changing conditions (greenhouse construction already underway); Improvement in reliability of water supply; Integration of renewable energies to help power greenhouse production.	
	Development or introduction of more pest resistant crop varieties, combined with continued utilization of traditional varieties that have proven to be resistant over time.	Change the Activity *Acceptable alternative (2)*	Research, education, and controls to ensure that new crop varieties do not pose a threat to native wildlife.	Mid-term (as necessary)
Decrease in agricultural produce (or increased cost of production) due to decreased overall rainfall.	*Increase the efficiency of irrigation systems / techniques.* Application of water conservation measures and utilization of assorted mulching practices to reduce evaporation losses.	Prevent Loss / Change the Activity *Preferred Action (1)*	Investment in new technologies such as drip irrigation systems; Enhancement of financing options for producers; Targeted education and outreach.	Immediate
	Enhance infrastructure for water capture and storage for agricultural purposes, including continued distribution of water tanks under The Department of Agriculture's Water Tank Initiative.	Prevent Loss *Preferred Action (1)*	Assessment of best options for enhancing water capture and storage on large and small scales; Measures to prevent mosquito breeding in water storage systems; Substantial capital investment; Build political will.	Immediate - Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Integration of less water intensive methods of agriculture, such as use of greenhouses and organic recirculation hydroponic systems in the case of high value garden vegetables such as tomatoes, cucumbers, salad crops and culinary herbs. *(greenhouses cut down water demand by significantly reducing evapotranspiration)*	Prevent Loss *Preferred Action (1)*	Stakeholder involvement and buy-in; Heavy investment in local capacity building; Enhancement of financing options for producers; Change in market / consumer preferences; Investment in new technologies/ infra-structure, making sure that they are structurally suited to local climate and changing conditions (greenhouse construction already underway); Improvement in reliability of water supply; Integration of renewable energies to help power greenhouse production.	Near-term
	Focus on drought-resistant crop species and varieties. *Focus on high value crops* to offset any revenue declines from potential decreases in productivity.	Change the Activity *Acceptable Alternative (2)*	Research, education, and controls to ensure that new crop varieties do not pose a threat to native wildlife.	Mid-term (as necessary)
	Continued and enhanced use of groundwater resources for farming (including infrastructure development and tighter monitoring and control over resources).	Change the Activity *Acceptable Alternative (2)*	Scientific exploration of groundwater resources; Development of sustainable groundwater management plan; Targeted education and outreach.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Soil degradation from saltwater intrusion in low-lying coastal areas and soil erosion / leaching in hillsides, resulting in decreased agricultural yields.	*Encourage best management practices for erosion control*, such as terracing, crop rotation, minimum tillage, mulching, and proper drainage.	Change the Activity *Preferred Action (1)*	Continuing research and information sharing on best practices; Targeted education and outreach.	Immediate
	Start serious reforestation programme.	Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations (to minimise land clearing and require landscaping during development); Institutional strengthening; Native and endemic plant species nursery. Organisation of community, school, and tourism based reforestation groups; Creation of legitimate and reputable carbon offsetting programmes for the tourism sector to help fund reforestation efforts; Public education and outreach.	Immediate
	Introduce greenhouses and organic recirculation hydroponics for high value garden vegetables such as tomatoes, cucumbers, salad crops and culinary herbs.	Prevent Loss *Preferred Action (1)*	Stakeholder involvement and buy-in; Heavy investment in local capacity building; Enhancement of financing options for producers; Change in market / consumer preferences; Investment in new technologies/ infrastructure,	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			making sure that they are structurally suited to local climate and changing conditions (greenhouse construction already underway); Improvement in reliability of water supply; Integration of renewable energies to help power greenhouse production.	
	Where feasible, *introduce more salt-tolerant species of crops.*	Change the Activity *Acceptable Alternative (2)*	Studies to determine areas vulnerable to saltwater intrusion; Monitoring of soil salinities in vulnerable areas; Research, education, and controls to ensure that new crop varieties do not pose a threat to native wildlife. Targeted education and outreach.	Long-term
	Abandon unproductive or flooded agricultural lands.	Accept Loss *Last Resort Action (3)*	Reserve "safe" lands for expansion of agricultural activity	Long-term *(Allocation of reserve lands must be done in the immediate to near-term).*
Crop damage and disruption in agricultural production from stronger hurricanes, droughts and	*Insure crops against natural disasters.*	Spread Loss *Preferred Action (1)*	Improve insurance coverage and access for the agricultural sector; Improve record keeping among producers to	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
floods.			facilitate insurance claims; Training in agricultural damage assessment; Development and strengthening of agricultural associations.	
	Diversify crops to include those less vulnerable to wind damage. *Implement changes in planting schedules*, where feasible. (E.g. focus on root crops in the hurricane season as they are very important for food security and least vulnerable to hurricane damage). Continue use of the McDonald Almanac Guide.	Change the Activity *Preferred Action (1)*	Support to producers entering new crop markets; Targeted education and outreach; Change in consumer preferences.	Immediate
	Utilise hurricane resistant tree species as natural windbreaks in agricultural fields and around livestock shelters.	Prevent Loss *Preferred Action (1)*	Targeted education and outreach; Community nursery programmes to propagate hurricane resistant tree species.	Immediate
	Heavier dependence on agriculture in controlled environments [e.g. greenhouses, organic recirculation hydroponics, poultry units, small stock units (sheep, goats, pigs), feedlots and dairy units]; Invest in hurricane resistant storage facilities for produce and equipment.	Prevent Loss *Preferred Action (1)*	Stakeholder involvement and buy-in; Heavy investment in local capacity building; Enhancement of financing options for producers; Change in market / consumer preferences; Investment in new technologies/ infra-structure, making sure that they are structurally suited to	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			local climate and changing conditions (greenhouse construction already underway); Improvement in reliability of water supply; Integration of renewable energies to help power greenhouse production.	
	Improve drainage of agricultural lands, especially those prone to flooding like the Agricultural Station.	Prevent Loss *Preferred Action (1)*	Studies of drainage problem and best solutions; Targeted education and outreach; Enhancement of financing options for producers.	Immediate
	Improve hurricane preparedness measures among the producer community (crops and livestock).	Change the Activity *Preferred Action (1)*	Targeted education and outreach; Invest in any infrastructure needed to improve preparations.	Immediate
Potential changes in imported food availability, cost, and quality.	Work towards greater agricultural self-sufficiency, including setting production targets and meeting targets through utilization of advanced technology and traditional best practices, and introduction of agro-processing.	Change the Activity *Preferred Action (1)*	Public education and outreach to change perceptions about the desirability and quality of local produce; Training opportunities in agriculture and agro-business and promotion of the field as a career; Implementation of adaptation strategies above and others identified that are compatible; Development and strengthening of agricultural associations.	Immediate to Mid-term

Food Security: *Fisheries*

General Guiding Adaptation Principles:

- ✓ Place greater emphasis on protection of fisheries habitat and sustainable fisheries practices.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
☆☆ **Degradation of critical fish habitat (coral reefs and mangroves) and changes in plankton food resources that support important commercial fish species.**	*Enhance protection of mangrove forests and seagrass beds.*	Change the Activity *Preferred Action (1)*	Amendments to existing fisheries laws/regulations; Pass draft Environmental Management and Conservation of Biodiversity Bill; Targeted education and outreach; All other activities listed above under Coastal & Marine Ecosystems.	Near-term
	*Stricter controls on fishing techniques and marine recreational activities that impact coral reefs. (*In addition to all adaptation measures identified above for mangroves and coral reefs).	Change the Activity *Preferred Action (1)*	Amendments to existing fisheries laws/regulations; Pass draft Environmental Management and Conservation of Biodiversity Bill; Targeted education and outreach.	Near-term
	Introduction of slot sizes as a means to better regulate catch size and ensure the sustainability of fisheries.	Change the Activity *Preferred Action (1)*	Amendments to existing fisheries laws/regulations; Institutional strengthening to enhance marine surveillance and enforcement;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Targeted education and outreach.	
	Tighter enforcement against illegal fishing and overfishing.	Change the Activity *Preferred Action (1)*	Amendments to existing fisheries laws/regulations; Pass draft Environmental Management and Conservation of Biodiversity Bill; Institutional strengthening to enhance marine surveillance and enforcement.	Near-term
	Introduce sustainable aquaculture and aquaponics to reduce stress on natural habitats and fish stocks. *(There is currently a lobster farm being developed – but still a lack of interest from local fisherpersons).*	Prevent Loss *Acceptable Alternative (2)*	Development of regulations to ensure that activities are sustainable; Implementation of pilot/demonstration projects; Secure buy-in from local fishermen through education and shared positive experiences from fishermen in other islands; Build demand among consumers through education, new recipes etc. to change market / consumer preferences; Substantial capital investment.	Near-term
	Reduce stress on Billfish by introducing a moratorium or a closed season that would allow the populations to recover. *Catch sizes of Billfish, e.g. Blue Marlin, have decreased significantly over the last 25-30 years (from 1400 lbs to 400 lbs), a clear indicator that the fishery pressure is too great.*	Prevent Loss *Preferred Action (1)*	Build political will; Amend fishery laws/regulations; Institutional strengthening to enhance marine surveillance and enforcement; Enhanced monitoring of stocks to detect changes in	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			abundance and size.	
☆ **Forced migration of highly temperature sensitive fish species out of The Virgin Islands waters or into deeper waters as the average ocean temperature rises.**	*Invest in the development of fisheries that may be less temperature sensitive or become more favourable as climate changes.*	Accept Loss / Change the Activity *Preferred Action (1)*	Enhanced monitoring of key fish stocks to detect changes in abundance and distribution; Data collection and research to identify potential fisheries; Training in new fishing techniques; Targeted education and outreach.	Near-term to Mid-term (as necessary)
Potential increase in opportunities for the establishment of marine invasive species as climate change could disrupt natural ecosystem processes.	*Development of invasive species reporting and early warning systems* as well as a standard protocol for responding to invasive species.	Change the Activity *Preferred Action (1)*	Amendments to relevant laws/regulations e.g. shipping; Enhanced controls at ports for invasive species; Targeted training in vessel inspection and invasive species ID; Tighter controls of ballast water, including requiring infrastructure to accommodate cleaning of ballast water before discharge; Institutional strengthening; Monitoring for presence of invasive species; Public education and outreach.	Immediate to Near-term
Damage to landing sites (docks and boat ramps), other on-shore fisheries	*Construct new fisheries landing sites and onshore facilities with appropriate design and materials* to withstand stronger hurricanes	Prevent Loss *Preferred*	Assessment of most appropriate construction design and materials.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
facilities (e.g. processing plants), fishing vessels, and equipment from stronger hurricanes and sea level rise.	and storm surges, and sea level rise.	*Action (1)*		
	Retrofit existing fisheries landing sites and onshore facilities with appropriate materials and sufficient elevation / landward extent to withstand stronger hurricanes and storm surges and sea level rise.	Relocation *Preferred Action (1)*	Assessment of sites to determine need and prioritization of works; Assessment of most appropriate construction design and materials. Substantial capital investment	Mid-term to Long-term *(as necessary)*
	Insure fishing vessels and equipment against natural disasters.	Spread Loss *Preferred Action (1)*	Improve insurance coverage and access for the fisheries sector; Development and strengthening of fisheries associations.	Near-term
	Improve hurricane preparedness measures among the fisherperson community. This would include preserving mangrove shelter areas and protecting the rights of fisherpersons to access these areas.	Change the Activity *Preferred Action (1)*	Targeted education and outreach; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Develop management plans for mangrove storm shelters and ensure that fisherpersons have adequate right of access; Invest in any infrastructure needed to improve preparations.	Immediate

Forestry & Biodiversity

General Guiding Adaptation Principles:

- ✓ Enhance protection of wildlife and associated habitats. Engage in habitat restoration.
- ✓ Add value to wildlife preservation through tourism.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
☆☆☆ **Decline in health and abundance of mangroves, seagrass beds, coral reefs, and associated fishes and other marine life.**	*Pass the draft Environmental Management and Conservation of Biodiversity Bill.* The Bill has been prepared through public consultation and would go a long way to create the protections and institutions necessary to protect biodiversity from climate change impacts.	Prevent Loss *Preferred Action (1)*	Public education campaign about the Bill; Substantial capital investment to create the institutions and programmes called for by the Bill. Build political will.	Immediate
	Expand and improve management of Marine Protected Areas (MPAs) - clearly demarcate MPAs, improve monitoring and enforcement of MPA rules and regulations, and educate the public about MPAs. Revisit protected areas overtime to ensure that they are extensive enough and rules and regulations are strong enough to accomplish management goals (esp. as climate change creates new dynamics, such as fish migration to cooler waters).	Change the Activity *Preferred Action (1)*	Declaration of proposed marine protected areas included in the approved British Virgin Islands Protected Areas System Plan 2007-2017; Pass the draft Environmental Management and Conservation of Biodiversity Bill. Institutional strengthening; Public education and outreach; Formation of community watch groups; Build political will.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Work with neighboring islands to create protected migration corridors for key marine species in the Caribbean basin as a whole. Create joint management plans for overlapping Exclusive Economic Zones (EEZ).	Change the Activity *Preferred Action (1)*	Declaration of proposed marine protected areas included in the approved British Virgin Islands Protected Areas System Plan 2007-2017; Regional buy-in and cooperation (build on existing initiatives such as the Caribbean Challenge supported by The Nature Conservancy); Substantial capital investment and sustained financing; Institutional strengthening; Build political will.	Near-term
Degradation of turtle nesting habitat (sandy beaches) and creation of unbalanced sex ratios as increased sand temperatures favour female hatchlings.	*Minimise beach development, beach erosion and marine habitat loss* using strategies identified above under the Beach & Shoreline Stability section.	Prevent Loss *Preferred Action (1)*	See Beach & Shoreline Stability section above.	Immediate to Mid-term
	Develop contingency plan to rescue turtle nests that could be inundated by swells as beaches erode (e.g. protocol for re-locating nests or ex-situ incubation).	Relocation *Last Resort Action (3)*	Capacity building and institutional strengthening in turtle biology, research, and monitoring; Scientific research and monitoring; Public education and outreach; Continuous community-based turtle monitoring.	Near-term *(as necessary)*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
☆☆☆ **Shrinking upland forests and reduction of associated biodiversity.**	*Conduct a forest/terrestrial biodiversity inventory* to determine what there is and what is vulnerable to climate change. Expand protected areas to target these vulnerable species and sensitive areas.	Prevent Loss *Preferred Action (1)*	Institutional strengthening; Terrestrial habitat mapping; Extensive literature review on inventoried species; Build political will.	Near-term
	Strictly limit the footprint of vegetation clearing to the minimum needed for construction (and working space) and require landscaping of cleared land with primarily native species within a short timeframe of clearing. *Currently the Land Development Control Guidelines limits the footprint/coverage of buildings to a certain percentage of the plot area (e.g. 33% in the case of residential buildings), however there is no limit on the percentage of the plot area that can be cleared.*	Change the Activity *Preferred Action (1)*	Amend environmental and planning laws/ regulations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Develop Earth-Change Permit System; Institutional strengthening to enhance development monitoring and enforcement; Public education and outreach.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Enhance legal protection and management of remaining forested areas. Expand protected areas and migration corridors (to as close to recommended 30% as possible). Update management plans for areas as climate change impacts are experienced.	Prevent Loss *Preferred Action (1)*	Comprehensive Physical Development Plan (to minimise conflicting planned land-uses and help identify areas feasible for protection); Enhanced capacity in forestry and wildlife management; Enhance local weather monitoring and trend analysis; Build political will.	Near-term
	Start serious reforestation programme.	Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations (to minimise land clearing and require landscaping during development); Institutional strengthening; Native and endemic plant species nursery. Organisation of community, school, and tourism based reforestation groups; Creation of legitimate and reputable carbon offsetting programmes for the tourism sector to help fund reforestation efforts; Public education and outreach.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Develop bird watching trails and lookouts as a key tourist attraction.	Change the Activity *Preferred Action (1)*	Enhanced legal protection and management of remaining forested areas. Reforestation programme; Survey to determine key areas for trail development; Development of interpretation materials; Training of tour guides; Advertisement of bird watching attractions.	Near-term
Bird migration and reproduction patterns disrupted. **Resident bird populations negatively impacted by tendency towards stronger hurricanes, potentially resulting in increased mortality.**	*Enhance protection of bird stopover habitats* such as salt ponds, mangroves, and rocky coastlines.	Prevent Loss *Preferred Action (1)*	Amend environmental laws/regulations; Pass draft Environmental Management and Conservation and Biodiversity Bill; Public education and outreach about birds and the value of these habitats.	Near-term
	Control populations of introduced bird egg predators such as cats, rodents and mongoose.	Prevent Loss *Preferred Action (1)*	Encourage domestication and castration of wild cats; Improve community sanitation to reduce rodents; Public education and outreach.	Immediate
Increase in invasive	*Develop invasive species reporting and early*	Change the	Institutional strengthening;	Immediate to

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
species	*warning systems* as well as a standard protocol for responding to invasive species.	Activity *Preferred Action (1)*	Monitoring for presence of invasive species; Targeted training in vessel inspection and invasive species ID; Amend laws/regulations if necessary; Enhanced controls at ports for invasive species; Tighter controls of ballast water, including infrastructure to accommodate cleaning of ballast water before discharge; Public education and outreach.	Near-term *(JNCC funding potentially currently available for developing invasive species protocol)*

Human Health

General Guiding Adaptation Principles:

- ✓ Emphasise preventative versus treatment approach for impacted health issues.
- ✓ Increase the resilience of the population to health impacts.
- ✓ Enhance the capacity of the health care sector.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Increase in Dengue Fever outbreaks (frequency and severity).	*Reduce sources of standing water* for mosquito breeding; *Encourage the incorporation of mosquito screens* and nets in homes.	Change the Activity / Prevent Loss *Preferred Action (1)*	Continuous monitoring to indentify mosquito breeding places; Enhance management of indentified breeding places with a combination of physical, biological and chemical control methods as appropriate for site characteristics; Proper design of drainage systems to minimise collection of stagnant water; Build strong community participation in breeding reduction efforts through: public education and outreach, promoting country-wide clean up campaigns to remove open containers that collect water, and teaching householders how to conduct their own weekly premise inspections to maintain good sanitation; Mosquito net distribution programme. Training on options for installing mosquito screens. Public education and outreach.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Strengthen dengue fever reporting systems (from the public to the health care community and among the health care community) to aid in the establishment of a dengue fever outbreak early warning system.	Change the Activity *Preferred Action (1)*	Public education and outreach; Institutional strengthening; Develop standard operating procedures for data collection, flow and analysis; Establish anonymous hotline for reporting sources of standing water.	Immediate
	Increase fumigation of mosquitoes.	Prevent Loss *Last Resort Action (3)*	Identify vulnerable populations e.g. immigrants, low income etc.; Public education and outreach (to avoid dangerous interactions with fumes).	Immediate *(as is deemed necessary)*
Potential increase in prevalence of ciguatera (fish poisoning).	*Increase testing of local and imported fish catch* (esp. of species popularly known for carrying the toxin such as barracuda, horse eye, bar jack, amber jack, and dog teeth snapper). *Studies to identify high risk fishing grounds and conditions.*	Prevent Loss *Preferred Action (1)*	Proper data management, analysis, and reporting systems for ciguatera test results; Monitoring of the prevalence of the ciguatoxin in the marine environment (esp. a few months after heavy storms and hurricanes).	Immediate to Long-term (to track trends)
	Increase reporting of ciguatera cases (from the public to the health care community and among the health care community). *Improve diagnosis and treatment of ciguatera.*	Change the Activity *Preferred Action (1)*	Enhance primary health care delivery system; Development of public education / outreach materials about ciguatera symptoms, high risk fish species, and the importance of reporting and treating cases;	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Development of standard protocols for diagnosing, reporting, and treating suspected ciguatera cases.	
Increased respiratory diseases, such as asthma.	*Early detection and improved treatment* of asthma patients.	Change the Activity *Preferred Action (1)*	Enhance primary health care delivery system; Patient education to improve recognition of triggers and symptoms and to build self care knowledge and skills; Public education and outreach about symptoms and signs and the importance of early treatment; Outreach campaigns to improve the attitude and behaviour of the population towards asthma and its management; Increased focus on proper diet, weight control, stress management and avoidance of triggers.	Immediate
	Reduce prevalence of and exposure to irritants that trigger asthma attacks.	Prevent Loss *Preferred Action (1)*	Amendments to laws/regulations and upgrades in technology to reduce sources of air pollution; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Public education and outreach about increase in environmental triggers due to climate change and tips on how to reduce exposure.	Near-term
Increased risk of diarrhea and other illnesses transmitted by rodents	*Increase community resilience to hurricanes and flood events*;	Prevent Loss *Preferred*	Public education and improvement of public infrastructure to prevent contamination of water sources during hurricanes and flood events.	Immediate – Long term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
and contaminated water and food, as we experience more flooding and severe hurricane events.		*Action (1)*		
	Reduce and control rodent populations	Change the Activity / Prevent Loss *Preferred Action (1)*	Improve and enforce litter law and environmental health law; Public education and enforcement to improve cleanliness of public places e.g. parks and beaches where scrap food may be available; Improved public sanitation system (e.g. replace open-air public bins with closed bins and improve conditions around bins); Public education and enforcement to improve sanitation within and around food establishments; Promote and enforce rodent-proofing of buildings that store food; Make rodent control a clear mandate of the Environmental Health Unit as is the case for mosquito control; Strengthen rodent control programme and extend it to the entire territory; Strengthen health and inspection programmes at ports to improve the safety of imported foods.	Immediate – Near term
Increased potential for heat stress.	*Increase public awareness* about heat stress and coping strategies.	Prevent Loss *Preferred Action (1)*	Education and outreach materials, especially targeted at the young and elderly populations and care-takers of such populations.	Long-term *(as necessary)*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Incorporate "green" design into buildings to maximise natural light and ventilation.	Prevent Loss *Preferred Action (1)*	Amendments to building laws/regulations to mandate certain "green" building standards; Increase capacity in "green" design, e.g. through the HLSCC Safer Building Course and architectural courses.	Near-term
	Install backup air-conditioning units in critical public buildings, especially those occupied by vulnerable populations (children, elderly, sick).	Prevent Loss *Acceptable Alternative (2)*	Incorporation of renewable energies in public buildings and energy efficiency standards to offset increased demand and cost for cooling.	Mid-term *(as necessary)*
Greater threat of epidemics and pandemics.	*Focus on increased wellness of the population* to increase resilience to communicable diseases.	Prevent Loss *Preferred Action (1)*	Enhance primary health care delivery system; Public education and outreach (including through the school system) about proper nutrition, exercise, hygiene, stress management etc.	Immediate
	Encourage continuous good hygienic practices among the population.	Change the Activity *Preferred Action (1)*	Public education and outreach.	Immediate to Long-term *(esp. during epidemics and pandemics)*
	Develop standard operating procedures to respond to epidemics and pandemics (including procedures for public alert, border control, public controls, prioritization of treatment etc.)	Prevent Loss *Preferred Action (1)*	Institutional strengthening; Enhanced surveillance to create early warning systems for epidemics; Public education and outreach about procedures.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Enhance capacity of emergency response services.	Prevent Loss *Preferred Action (1)*	Expand network of and services available at community clinics (primary care centres); Training of health care professionals to function under crisis situations.	Near -term
Increased risk of damage to health care facilities from stronger hurricanes and storm surges, floods and sea level rise.	Improve the structural integrity of health care facilities by improving construction standards: - Overhaul the outdated Building Regulations, 1999 with future climate hazards a major consideration; - Ensure that existing structures meet new regulations through systematic retrofitting; - Improve surveillance and enforcement of planning and building laws/regulations and approval conditions.	Prevent Loss *Preferred Action (1)*	Amend building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.\	Near-term to Long-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Avoid building new facilities in high risk areas;	Relocation *Preferred Action (1)*	Storm surge and coastal inundation mapping; Flood mapping; Amend planning laws/regulations; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process.	Immediate to Near-term
	Relocate facilities located in areas at high risk of damage from stronger storm surges and sea-level rise. Where necessary and practical, *elevate existing facilities* located in flood prone areas.	Relocation *Last Resort Action*	Amend building laws/regulations; Storm surge and coastal inundation mapping; Flood mapping; Integrate hazard risk assessment in the development planning process; Purchase private lands or reserve public lands for the future relocation of threatened facilities; Comprehensive Physical Development Plan.	
Combination of impacts detailed above.	Establish observatories and information centres on climate change and human health within the Ministry of Health; Strengthen existing health surveillance systems.	Prevent Loss *Preferred Action (1)*	Enhance primary health care delivery system; Establish a focal point within the Ministry of Health to focus on issues of climate change and health; Develop or adopt vulnerability indicators;	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Gap analysis to determine what data is present, what is needed; Develop national centralised health database / atlas where all data can be stored and analyzed (will require technical assistance); Develop protocol for reporting data; Determine the degree of current vulnerability and monitor advances and progress based on the implementation of adaptation strategies; Carry out quantitative and qualitative studies of the effects of climate change on health; Information sharing with similar centres in other countries.	
	Strengthen human resources in the health field to address climate change concerns.	Prevent Loss *Preferred Action (1)*	Development of a climate change education strategy; Expert presentations to policy makers and seminars for health care professionals; Identify training needs; Continue to participate in environmental health training organised by WHO/PAHO and other organisations.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Increase awareness among the public.	Prevent Loss *Preferred Action (1)*	Development of a climate change education strategy; Integrate climate change and health issues into the established school curriculum; Targeted education for vulnerable groups.	Immediate
	Strengthen the national regulatory framework by including climate change in health sector policies in a cross-cutting manner.	Change the Activity *Preferred Action (1)*	Review of existing health laws, regulations, and policies to determine what already exists to address climate change impacts, where there needs to be harmonization, and what is needed; Amendments to health laws, regulations, and policies.	Near-term
	Enhance emergency response of health care system in natural disasters and epidemics.	Prevent Loss *Preferred Action (1)*	Enhance primary health care delivery system; Strengthen early warning systems for hurricanes and floods; Training of health care professionals, including simulation drills; Strengthen evacuation plans; Enhance capacity in damage assessment; Improve access of persons to health facilities during and after disasters – multiple access roads, ferry and airlift services.	Immediate

Human Settlements

General Guiding Adaptation Principles:

- ✓ Enhance resilience of existing human settlements to climatic disasters and sea level rise.
- ✓ Avoid developing new settlements in areas highly vulnerable to climate change impacts.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Homes and developable lands (especially those in the coastal zone) at greater risk of damage from floods, stronger storm surges and sea level rise.	*Improve and strictly enforce planning and building laws/regulations,* especially increasing coastal development setback and elevation requirements. (Currently development sites must have an average elevation of no less than 4 feet above mean sea level. The setback requirement is 50ft from the high water mark for main buildings. Ancillary buildings can be closer. The 50 ft requirement can be relaxed at the discretion of the Planning Authority. These provisions are weak. In the Caribbean, most islands have a setback requirement of 30m (98ft) from the high water mark with some islands having setbacks up to 81m (265 feet).	Prevent Loss *Preferred Action (1)*	Storm surge maps, coastal inundation maps, and beach assessments to determine appropriate building setbacks from the coast; Amend planning and building laws/regulations; Increase the number of enforcement officers, implement a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or provide resources to have assigned dedicated lawyers to handle violations of planning and building laws/regulations; Integrate Hazard Vulnerability Assessments into the development planning process; Public education and outreach; Build political will.	Near-term
	Improve drainage in settlements through:	Prevent Loss	Inclusion of the Water and Sewerage Department or hydrologist in drainage design;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	- Improving road drainage design and construction; - Improving land use planning (e.g. tighten controls on development within a certain proximity of ghuts, especially in regards to erosion (this may be done through requiring limited EIAs for these developments); - Utilizing pervious concrete or porous pavement instead of the traditional imperious concrete and asphalt (these offer the inherent durability and low life cycle costs of typical concrete pavement while retaining stormwater runoff and replenishing local watershed systems); - Minimizing land clearing and creation of impervious surfaces during development to limit runoff and soil erosion; - Developing a maintenance system (clearing and pruning more than once per year based on an assessment) and a monitoring system for sediment of the natural drainage system (ghuts) instead of lining them with concrete; - Reducing littering and garbage disposal in the ghut drainage system	*Preferred Action (1)*	Flood hazard mapping; Rigorous analysis of the current drainage problem and possible solutions, including study of the impact of extreme rain events on the ghut drainage system; Comprehensive Land Use and Physical Development Plans with zoning; Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Institutional strengthening (more experienced engineers); Reforestation programme; Build political will; Public education and outreach.	

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	to minimise blockage in flood events.			
	Start serious reforestation programme to reduce stormwater run-off, erosion and landslide potential.	Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations (to minimise land clearing and require landscaping during development); Institutional strengthening; Organisation of community, school, and tourism based reforestation groups; Creation of legitimate and reputable carbon offsetting programmes for the tourism sector to help fund reforestation efforts; Public education and outreach.	Immediate to Near-term
	Collaborate with agencies in the United States Virgin Islands and Puerto Rico to enhance local weather monitoring and modeling to provide an early flood warning system with the following basic elements: *Prediction* – Weather forecasts and news releases *Detection* – Observation of rainfall and flood events *Communication* – Relay of information to flood response teams and disaster agencies *Decision making* – Decision to evacuate by flood response teams *Mobilization* – Evacuation of community	Prevent Loss *Preferred Action (1)*	Expand network of commercial grade weather stations; Encourage community weather monitoring; Human capacity development / training in meteorology; Continued testing of and education about the siren emergency alert system; Public education and outreach about how to respond to flood warnings; Creation of evacuation plans and drills.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Start flood prevention programmes in low-lying areas that not only plan for the impacts of excess water runoff, but also excess mass of flowing sediment and rock; Develop and approve flood preparation, evacuation and recovery plans for communities.	Prevent Loss/Spread Loss *Preferred Action (1)*	Flood hazard mapping; Rigorous analysis of the current drainage problem and possible solutions; Community buy-in and participation to develop plans; Public education and outreach to ensure awareness and compliance; Evacuation drills; Enhance management of and increase the *Disaster Relief Fund.*	Near-term
	Encourage homeowners to *purchase adequate flood insurance.*	Spread Loss *Preferred Action (1)*	Valuations of homes; Measures to increase security and reduce the costs of insurance schemes; Public education and outreach.	Near-term
	Improve management of and increase the Disaster Relief Fund.	Spread Loss *Preferred Action (1)*	Approve drafted guidelines to govern how monies can be spent.	Immediate
	Develop an overarching policy on coastal land reclamation to prevent unnecessary proliferation of reclamation and reclamation in sensitive or vulnerable coastal areas, etc.	Prevent Loss / Change the Activity Preferred	Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number and capacity of enforcement officers, implementing a	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Increase the minimum height above high water mark required for coastal reclamations (currently 5ft) to a height determined sufficient to minimise loss given the projections of sea level rise of up to 1.9 feet and stronger storm surges.	Action (1)	ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Comprehensive Coastal Zone Development Plan as a part of a Comprehensive Land Use and Physical Development Plan; Assessment to determine safe minimum height for reclamation based on sea level rise mapping and improved storm surge maps.	
	Consider sea level rise and stronger storm surges in the distribution of crown lands in Anegada. (The distribution system being devised is already making effort to spread risk from storm surges etc. and is seeking to include buffer zones in the allocation of coastal parcels).	Spread Loss *Preferred Action (1)*	Storm surge mapping *(already done)*; Coastal inundation mapping of Anegada under various sea level rise scenarios; Community consultations to agree on a system of distributing risk among land owners, future compensation for lost land etc.; Public education and outreach about sea level rise threat.	Immediate *(Distribution of Anegada lands is ongoing).*
	Where appropriate, invest in "soft" measures (such as mangroves, coral reefs, and seagrass beds) to help protect existing vulnerable coastal settlements, especially where these protections naturally existed, but have been destroyed or degraded.	Prevent Loss *Preferred Action (1)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary; Monitoring of effectiveness;	Immediate *(to allow these natural protections time to mature)*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Institutional strengthening - build local capacity in coastal zone management and engineering; Public education and outreach; Formation of volunteer programme to plant mangroves.	
	Where feasible, establish "no build areas" for human settlements in areas highly vulnerable to sea level rise, stronger storm surges and flooding.	Change the Activity *Preferred Action (1)*	Flood hazard mapping; Storm surge and coastal inundation mapping; Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process; Public education and outreach to encourage support of no build areas; Compensation programme for land owners in no	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			build areas; Build political will.	
	If "no build area" is unfeasible, *mandate proper elevation of buildings' foundations* in flood prone areas and waterfront lots to deal with heavy rain events and stronger storm surges. *(Currently the Building Regulations require that all development sites be at least on average 4 feet above mean sea level).*	Prevent Loss Acceptable Alternative (2)	Flood hazard mapping; Storm surge / coastal inundation mapping; Amend building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Capacity building in construction for flood resistance through the established Virgin Islands Safer Building Course offered at HLSCC.	Near-term
	If necessary, *invest in 'hard" engineering structures* (such as sea walls and bulkheads) to help protect existing vulnerable coastal communities.	Prevent Loss *Last Resort Action (3)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary; Environmental impact assessments and coastal engineering studies;	Long - term *(as necessary)*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Institutional strengthening - build local capacity in coastal zone management and engineering; Significant capital investment.	
	Develop a monetary and or in-kind land compensation system for persons that lose land as a result of sea level rise.	Spread Loss *Last Resort Action (3)*	Develop a financing mechanism for monetary compensation; Preserve crown lands or acquire new lands for in-kind compensation.	Long-term *(as necessary)* *Preservation of lands for contingency purposes needs to occur in the near- term.*
	Relocation to "safe islands" and "safe areas." (E.g. Eventual relocation of Anegada population to less vulnerable main islands and encouragement of village development in gently to moderately sloping hillsides such as done in North Sound in Virgin Gorda).	Relocation *Last Resort Action (3)*	Comprehensive Land Use and Physical Development Plan with zoning; Integrate Hazard Vulnerability Assessments into the development planning process; Land compensation programme for displaced land owners; Incentives for new construction and relocation to "safe areas;" Relocation of lost economic activity; Public education and outreach.	Long-term *(as necessary)*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Increased damage to homes from more severe hurricane events.	*Improve and enforce planning and building laws/regulations,* especially in regards to elevation and coastal development setback requirements. (Currently development sites must have an average elevation of no less than 4 feet above mean sea level. The setback requirement is 50ft from the high water mark for main buildings. Ancillary buildings can be closer. The 50 ft requirement can be relaxed at the discretion of the Planning Authority. These provisions are weak. In the Caribbean, most islands have a setback requirement of 30m (98ft) from the high water mark with some islands having setbacks up to 81m (265 feet).	Prevent Loss *Preferred Action (1)*	Storm surge maps, coastal inundation maps, and beach assessments to determine appropriate building setbacks from the coast; Amend planning and building laws/regulations; Increase the number of enforcement officers, implement a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or provide resources to have assigned dedicated lawyers to handle violations of building laws/ regulations; Integrate Hazard Vulnerability Assessments into the development planning process; Public education and outreach; Build political will.	Near-term
	Ensure "climate-proof" structures by: - Overhauling the outdated Building Regulations, 1999 with future climate hazards a major consideration; - Ensuring that existing structures meet new regulations through systematic retrofitting; - Improving surveillance and enforcement of planning and building	Change the Activity / Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	laws/regulations and approval conditions.		development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.	
	Encourage adequate property insurance against hurricanes.	Spread Loss *Preferred Action (1)*	Valuations of homes; Measures to increase security and reduce the costs of insurance schemes; Public education and outreach.	Near-term
	Develop hurricane preparation, evacuation and recovery plans for communities; Enhance community hurricane preparedness.	Prevent Loss/Spread Loss *Preferred Action (1)*	Community buy-in and participation to develop plans; Public education and outreach to ensure awareness and compliance; Evacuation drills; Enhance management of and increase the *Disaster Relief Fund.*	Near-term
	Improve management of the Disaster Relief Fund.	Spread Loss *Preferred Action (1)*	Approve drafted guidelines to govern how monies can be spent.	Immediate

Insurance & Banking

General Guiding Adaptation Principles:

- ✓ Depend less on global insurance companies and look towards more regional risk pooling solutions.
- ✓ Minimise vulnerability of insured and mortgaged properties to climate change impacts.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Increase in insurance rates, resulting from a likely increase in damage claims as hurricanes become more severe, the likelihood of floods increases, and in the longer run the impacts of sea level rise are felt.	*Work towards the Caribbean being recognised as an insurance zone separate from areas of the United States* so that climatic events in the U.S. do not increase insurance rates in the Caribbean.	Spread Loss *Preferred Action (1)*	Coordinated efforts of regional Governments and insurance agencies.	Near-term
	Improve management of and increase the Disaster Relief Fund.	Spread Loss *Preferred Action (1)*	Approve drafted guidelines to govern how monies can be spent.	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Ensure "climate-proof" structures by: - Overhauling the outdated Building Regulations, 1999 with future climate hazards a major consideration; - Ensuring that existing structures meet new regulations through systematic retrofitting; - Improving surveillance and enforcement of planning and building laws/regulations and approval conditions.	Change the Activity / Prevent Loss *Preferred Action (1)*	Amend building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Increased interest rates on loans to cover increased risk to assets from climatic disasters; **Increased difficulty in obtaining construction loans due to increased risk.**	*Work with insurance companies, banks and property developers to encourage better building practices* to increase resilience to climatic disasters.	Change the Activity / Prevent Loss *Preferred Action (1)*	Formation of strategic policy partnerships between the banking sector and Government. For example, bank loan approvals could be conditional, based on meeting certain construction standards.	Near-term

Tourism

General Guiding Adaptation Principles:

- ✓ Take strong "no regrets" measures and precautions to preserve the quality of natural and historical attractions.
- ✓ Enhance the resilience of tourism infrastructure and facilities to climate impacts.
- ✓ Create a more environmentally responsible tourism industry.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
☆☆ **Loss of or more costly damage to tourism infrastructure and properties (ports of entry, hotels, marinas, ancillary services etc.) from floods, stronger hurricanes and storm surges, and sea level rise.**	*Improve drainage around critical tourism infrastructure and properties* through the following measures: - Improve road drainage design and construction; - Improving land use planning; - Site and building design (elevation etc.) that considers the contours of the surrounding landscape to minimise flooding; - Utilizing pervious concrete or porous pavement instead of the traditional imperious concrete and asphalt (these offer the inherent durability and low life cycle costs of typical concrete pavement while retaining stormwater runoff and replenishing local watershed systems);	Prevent Loss *Preferred Action (1)*	Include the Water and Sewerage Department or a hydrologist in drainage design; Flood hazard mapping; Rigorous analysis of the current drainage problem and possible solutions, including study of the impact of extreme rain events on the ghut drainage system; Comprehensive Land Use and Physical Development Plans with zoning; Amend planning laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	- Minimizing land clearing and creation of impervious surfaces during development to limit runoff and soil erosion; - Developing a maintenance and monitoring system for the natural drainage system (ghuts) instead of lining them with concrete. This would include, for example, regular (more than once per year and based on an assessment) clearing and pruning of vegetation and monitoring and removal of sediment build up; - Reducing littering and garbage disposal in the ghut drainage system to minimise blockage in flood events.		Institutional strengthening (more experienced engineers); Reforestation programme; Build political will; Public education and outreach.	
	Ensure "climate-proof" structures by improving construction standards: - Overhaul the outdated Building Regulations, 1999 with future climate hazards a major consideration; - Ensure that existing structures meet new regulations through systematic retrofitting; - Improve surveillance and enforcement of planning and building laws/regulations and approval	Change the Activity / Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations; Integrate Hazard Vulnerability Assessments into the development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	conditions.			
	Work towards enhanced insurance coverage of critical tourism infrastructure and properties against climate hazards.	Spread Loss *Preferred Action (1)*	Valuations of critical tourism infrastructure and properties; Measures to increase security and reduce the costs of insurance schemes; Measures to reduce the vulnerability of tourism infrastructure and properties to maximise insurability of properties and minimise associated costs; Targeted education and outreach.	Near-term
	Develop hurricane/flood preparation, evacuation and recovery plans for tourism properties. Enhance hurricane preparedness among tourism properties.	Prevent Loss/Spread Loss *Preferred Action (1)*	Business sector buy-in and participation to develop plans; Education and outreach to ensure awareness and compliance; Evacuation drills; Enhance management of and increase the Disaster Relief Fund; Build institutional capacity.	Immediate
	Increase setback and elevation requirements for coastal tourism infrastructure and properties. (Currently development sites must have an	Prevent Loss /Relocation *Preferred Action (1)*	Storm surge maps, coastal inundation maps, and beach assessments to determine appropriate building setbacks from the coast; Amendments to planning and building	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	average elevation of no less than 4 feet above mean sea level. The setback requirement is 50ft from the high water mark for main buildings. Ancillary buildings can be closer. The 50 ft requirement can be relaxed at the discretion of the Planning Authority. These provisions are weak. In the Caribbean, most islands have a setback requirement of 30m (98ft) from the high water mark with some islands having setbacks up to 81m (265 feet).		laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Build institutional capacity to improve monitoring and enforcement activities; Targeted education; Strategic re-branding to advertise a desirable product without the "hotel on a beach" expectation; Build political will.	
	Where feasible, establish "no build areas" for critical tourism infrastructure and properties in areas highly vulnerable to sea level rise, stronger storm surges, and flooding.	Change the Activity *Preferred Action (1)*	Flood hazard mapping; Storm surge and coastal inundation mapping; Amend planning and building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Comprehensive Land Use and Physical Development Plans with zoning; Integrate Hazard Vulnerability Assessments into the development planning process; Public education and outreach to encourage support of no build areas; Build political will.	
	Educate developers about the increasing risk of building in low-lying coastal areas and the impact to surrounding areas (e.g. climatic events considered as "100 yr" events are now happening within the space of a few years).	Change the Activity *Preferred Action (1)*	Storm surge maps and coastal inundation maps to provide visuals of impacts; Compile local and regional case studies; Climate change education strategy.	Immediate
	Develop best practice guidelines for developers to respond to climate change impacts and protect their properties.	Prevent Loss *Preferred Action (1)*	Ongoing research on best practices in use around the region and other small islands and coastal regions; Information seminars and workshops; Production of user-friendly reference manuals;	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Integration of best practice guidelines in the development approval process, for example, as a part of approval conditions.	
	Avoid move towards higher risk tourism development styles, e.g. building villas in the ocean (that is, in or over the seabed).	Prevent Loss *Preferred Action (1)*	Comprehensive tourism development policy to clearly define a direction and boundaries for tourism development; Amendments to planning and building laws/regulations; Integrate Hazard Vulnerability Assessments in the development planning process.	Immediate to Near-term
	Where appropriate, invest in "soft" measures (such as mangroves and near-shore reefs) to help protect existing vulnerable tourism infrastructure and properties.	Prevent Loss *Preferred Action (1)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary; Monitoring of effectiveness; Institutional strengthening - build local capacity in coastal zone management and engineering; Public education and outreach; Formation of volunteer programme to plant mangroves.	Immediate *(to allow these natural protections time to mature)*
	If necessary *invest in 'hard" engineering structures* (such as sea walls and bulkheads) to help protect existing vulnerable tourism infrastructure and properties.	Prevent Loss *Last Resort Action (3)*	Storm surge and coastal inundation mapping; Vulnerability analysis to determine priority areas and extent of fortification necessary;	Long-term *(as necessary)*

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Environmental impact assessments and coastal engineering studies; Significant capital investment; Institutional strengthening - build local capacity in coastal zone management and engineering; Significant capital investment.	
☆☆☆ **Diminished natural tourist attractions, such as coral reefs, beaches, and wildlife.**	*Enhance protection of natural tourist attractions* and supporting ecosystems through strengthening of environmental laws, more environmentally sensitive land-use planning and developments, expanded national parks system, long-term monitoring, implementation of management plans, and **adequate waste disposal systems**.	Prevent Loss *Preferred Action (1)*	Amend environmental and planning laws/ regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Pass the draft Environmental Management and Conservation of Biodiversity Bill; Assessment of carrying capacities at visitor attractions to maintain good environmental quality and visitor experiences. Public education and outreach; Institutional strengthening;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Building political will.	
	Diversify base of tourism industry by developing and promoting less vulnerable land-based attractions (such as national parks, historical sites) and activities (such as sightseeing, bird watching, hiking, and cultural events). Develop niche tourism markets such as health tourism. (Some of these strategies are already being explored and implemented by the Tourist Board).	Change the Activity *Preferred Action (1)*	Tourism rebranding and advertising; Enhanced protection of land-based natural resources; Historical and cultural preservation; Island beautification.	Immediate
☆ **Rising overheads in energy, water, and insurance.**	*Increase energy and water conservation and efficiency in tourism properties* by developing conservation tips and water and energy efficiency standards.	Change the Activity *Preferred Action (1)*	Amend building laws/regulations to mandate certain efficiency standards, i.e. integrate energy and water efficiency into the Building Regulations; Amendments to water laws/regulations to move away from bulk pricing of water to provide financial incentives for water conservation; Targeted education (e.g. distribution of a energy and water conservation guide to the tourism industry); Inform tourists about water and energy conservation and efficiency programmes to build support and maximise publicity value; Implement an optional bed tax at properties to pay for conversion to water and energy saving devices	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			(tourists must be provided proof of conversion); Recognition / certification programmes for properties taking initiatives to conserve e.g. Green Globe.	
	Encourage use of renewable energies in tourism properties. An easy starting point would be use of solar water heaters.	Change the Activity *Preferred Action (1)*	Formation of a Renewable Energy Committee; Territory level renewable energy policy; Amend energy laws/regulations; Targeted education to build interest among industry; Capacity building in solar and wind installation; Financial incentive/recognition programmes, including reversible metering; Study option of revising energy institutional structure to separate functions of electricity generation, distribution and sales to encourage smaller generators of renewable energy to feed into the grid; Build political will.	Near-term
	Incorporate "green" design into tourism properties– e.g. natural cooling systems and designs that maximise natural lighting.	Change the Activity *Preferred Action (1)*	Amendments to building laws/regulations to mandate certain "green" building standards; Incorporate green design into the HLSCC Safer Building Course or offer a separate course or other	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			opportunities for capacity building in green design; Public education and outreach.	
	Encourage use of more efficient cooling systems (and proper maintenance of systems).	Change the Activity *Preferred Action (1)*	Amend building laws/regulations to mandate certain efficiency standards, i.e. integrate energy and water efficiency into the Building Regulations; Targeted education and outreach.	Immediate
	Ensure "climate-proof" structures by: - Overhauling the outdated Building Regulations, 1999 with future climate hazards a major consideration; - Ensuring that existing structures meet new regulations through systematic retrofitting; - Improving surveillance and enforcement of planning and building laws/regulations and approval conditions.	Change the Activity / Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations; Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Integrate Hazard Vulnerability Assessments into the development planning process; Institutional strengthening to improve monitoring and enforcement; Public education and outreach; Continuation and expansion of The Virgin Islands Safer Building Course; Build political will.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Work towards the Caribbean being recognised as an insurance zone separate from areas of the United States so that climatic events in the U.S. do not increase insurance rates in the Caribbean.	Spread Loss *Preferred Action (1)*	Coordinated efforts of regional Governments and insurance agencies.	Near-term
Potential deterrents to travelers including, warmer winters, less comfortable and stable Virgin Islands' climate, higher airfares, and increased Dengue Fever outbreaks.	*Reframe/reposition The Virgin Islands as more than just a winter getaway* – e.g. historical/cultural experience, eco-tourism experience. Offer incentive packages and develop events to *attract vacationers during the summer*.	Change the Activity *Preferred Action (1)*	Tourism rebranding and advertising; Expand to new markets; Diversify the tourism product; Enhanced environmental protection and beautification; Cultural and historical preservation.	Near-term
	Reorient the industry towards high-end and adventure-driven tourists that are more likely to travel despite changes in climate and travel costs.	Change the Activity *Preferred Action (1)*	Enhanced environmental protection and beautification; Improvement of accommodation and service standards; Reduced crime; Cultural and historical preservation; Continued improvement and diversification of the yachting and water sport industries; Development of a network of hiking trails and bird watching lookouts;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Assessment of carrying capacities at visitor attractions to maintain good environmental quality and visitor experiences.	
	Enhance dengue fever prevention and control programmes to maintain high traveler confidence.	Prevent Loss *Preferred Action (1)*	Public education and outreach; Institutional strengthening.	Immediate
More tourists seeking carbon neutral, energy efficient or "green" vacations as climate change becomes an issue of public concern, especially in tourism source markets.	Develop easy or creative opportunities for tourists to "offset" their vacation carbon emissions (e.g. by donating money to fund local reforestation or renewable energy initiatives or by spending a few hours engaged in reforestation work locally).	Change the Activity *Preferred Action (1)*	Creation of legitimate and reputable carbon offsetting and reforestation programmes; Institutional capacity building; Public education and outreach; Marketing and rebranding as a low carbon destination; Introduction of green certification programmes for the tourism sector e.g. Green Globe.	Near-term
	Take actions to make the tourism industry more environmentally responsible to continue to attract the growing number of eco-conscious travelers.	Change the Activity *Preferred Action (1)*	Implement programmes to reduce energy and water use in tourism properties; Reduce toxic waste and non-biodegradable waste generated by tourism industry; Implement comprehensive system for treating sewage waste from yachts (holding tanks and pump out stations).	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Locate and build tourism properties and operations in a manner to avoid impacts to environmentally sensitive areas.	
	Encourage energy conservation programmes in the tourism sector; *Develop and enforce energy efficiency standards* for the tourism sector.	Change the Activity *Preferred Action (1)*	Creation of incentive schemes to encourage the industry to practice energy conservation e.g. highlights of the most conservative tourism properties on the Tourist Board website; Targeted education and outreach; Amend building laws/regulations to mandate certain efficiency standards, i.e. integrate energy efficiency into the Building Regulations; Introduction of "green" certification programmes for the tourism industry, such as Green Globe.	Immediate to Near-term
	Encourage use of alternative renewable energies at tourism properties.	Change the Activity *Preferred Action (1)*	Renewable Energy Committee; Territory level renewable energy policy; Amend energy laws/regulations; Targeted education to build interest among industry; Capacity building in solar and wind installation; Financial incentive/recognition programmes, including reversible metering; Study option of revising energy institutional	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			structure to separate functions of electricity generation, and distribution and sales to encourage smaller generators of renewable energy to feed into the grid.	
	Participate in green certification programmes for the tourism sector, such as Green Globe. *The Tourist Board in currently trying to introduce Green Globe to The Virgin Islands*	Change the Activity *Preferred Action (1)*	Assessment to determine most suitable and beneficial green certification programme; Establishment of independent bodies (NGOs etc.) to implement programmes as necessary; Awareness and buy-in from the tourism sector, including promotion of benefits; Build institutional capacity in green certification programmes; Assistance to the tourism sector to help property owners meet certification standards.	

Water Resources & Hydrological Characteristics

General Guiding Adaptation Principles:

- ✓ Increase resilience to heavy rain events and water shortages.
- ✓ Use water more conservatively and efficiently.
- ✓ Diversify freshwater sources.

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
Increased likelihood of flood events.	*Improve drainage* along roads, in human settlements and in commercial districts through the following measures: - Improving road drainage design and construction; - Improving land use planning. For example, implement various elevation and siting requirements for buildings in different zones based on land contours and potential drainage issues. Require new areas of development to include a drainage plan; - Improving road design to prevent settling of and to allow for rapid removal of water. Ensuring that all public roads are tied into an adequate drainage system;	Prevent Loss *Preferred Action (1)*	Include the Water and Sewerage Department or a hydrologist in drainage design; Flood hazard mapping; Rigorous analysis of the current drainage problem and possible solutions, including study of the impact of extreme rain events on the ghut drainage system; Comprehensive Land Use and Physical Development Plans with zoning; Amend planning and building laws/regulations; Improve enforcement of planning and building laws/ regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	- Utilizing pervious concrete or porous pavement instead of the traditional impervious concrete and asphalt (these offer the inherent durability and low life cycle costs of typical concrete pavement while retaining stormwater runoff and replenishing local watershed systems); - Minimizing land clearing and creation of impervious surfaces during development to limit runoff and soil erosion; - Developing a maintenance system (clearing and pruning more than once per year based on an assessment) and a monitoring system for sediment of the natural drainage system (ghuts) instead of lining them with concrete; - Reducing littering and garbage disposal in the ghut drainage system to minimise blockage in flood events.		violations; Implement a Land Change Permitting System; Institutional strengthening (more experienced engineers); Reforestation programme; Build political will; Public education and outreach.	
	Start concerted reforestation programme and minimise land clearing to reduce stormwater run-off and erosion.	Prevent Loss *Preferred Action (1)*	Amend planning and building laws/regulations (to minimise land clearing and require landscaping during development); Implement a Land Change Permitting System; Institutional strengthening;	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Organisation of community, school, and tourism based reforestation groups; Creation of legitimate and reputable carbon offsetting programmes for the tourism sector to help fund reforestation efforts; Public education and outreach.	
	Provide an early flood warning system through collaboration with agencies in the United States Virgin Islands and Puerto Rico to enhance local weather monitoring and modeling. System should have the following basic elements: • *Prediction* – Weather forecasts and news releases • *Detection* – Observation of rainfall and flood events • *Communication* – Relay of information to flood response teams and disaster agencies • *Decision making* – Decision to evacuate by flood response teams • *Mobilization* – Evacuation of community	Prevent Loss *Preferred Action (1)*	Create a fully functioning and funded local centre for the collection, storage, and analysis of weather data and events *(the Department of Disaster Management is increasingly trying to fill this role, but needs additional resources; the BVI Airport Authority has proposed to establish a Meteorological Office for aviation purposes)*; Expand network of commercial grade weather stations; Encourage community weather monitoring; Human capacity development / training in meteorology; Continued testing of and education about the siren emergency alert system; Public education and outreach about how to respond to flood warnings; Creation of evacuation plans and drills.	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Start flood prevention programmes in low-lying areas that not only plan for the impacts of excess water runoff, but also excess mass of flowing sediment and rock; *Develop flood preparation, evacuation and recovery plans* for communities.	Prevent Loss/Spread Loss *Preferred Action (1)*	Flood hazard mapping; Rigorous analysis of the current drainage problem and possible solutions; Community buy-in and participation to develop plans; Public education and outreach to ensure awareness and compliance; Evacuation drills; Enhance management of and increase the *Disaster Relief Fund.*	Near-term
	Encourage homeowners to *purchase adequate flood insurance.*	Spread Loss *Preferred Action (1)*	Valuations of homes; Measures to increase security and reduce the costs of insurance schemes; Public education and outreach.	Near-term
☆ ☆ ☆ **Decreased availability of rainwater leading to greater dependency on the desalinated public water supply system and an increased threat of water shortages in emergencies. `**	*Develop a sustainable freshwater, watershed, and coastal waters management and pollution prevention plan* to best manage use of and protect available sources of freshwater – rainfall, groundwater, and desalination. Plan would also help to ensure that population growth and development remains in the bounds of the Territory's carrying	Change the Activity *Preferred Action (1)*	Develop a comprehensive inventory of freshwater resources (including groundwater) and desalination production capacity in The Virgin Islands; Conduct a water carrying capacity study (i.e. determine what level of population can be sustained with our water resources and foreseeable production capacity in a cost effective manner);	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	capacity in regards to water resources.		Conduct a comprehensive analysis of current and projected water usage based on historic output of desalination plants and a household survey; Establish a Water Commission to address issues of water policy and quality (plan for such a Commission already exists); Amend existing laws or create new laws to address pollution of coastal waters and groundwater resources; Public education and outreach.	
	Repair and expand public infrastructure for water capture, storage and delivery (storage capacity should meet the three day supply international standard). This would include *continuing and expanding the leak detection programme* to eliminate leaks in the water distribution system.	Prevent Loss *Preferred Action (1)*	Assess best options for enhancing water capture on large and small scales; Build capacity in hydro-engineering; Targeted training in leak detection and hydrology; Prompt repair of leaks; Implement recommended maintenance of water distribution system; Use of more durable materials for pipes in the water distribution system; Large capital investment.	Near-term
	Work to eliminate water theft through illegal water connections.	Change the Activity	Amendments to laws and regulations to increase fines for water theft. Currently fines are so minimal	Immediate

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
		Preferred Action (1)	that it is only worth the cost and effort to prosecute major offenders; Amendments to laws and regulations to empower the Water and Sewerage Department staff to immediately enforce removal of illegal water connections and impose direct fines since the legal system is overwhelmed.	
	Improve methods of household capture, storage and use of rainwater through: - improving enforcement to ensure that buildings meet cistern area requirements in accordance with the Building Regulations, 1999; - encouraging regular cleaning and maintenance of cisterns and spouting to maximise usability of water.	Change the Activity *Preferred Action (1)*	Improve enforcement of planning and building laws/regulations by increasing the number of enforcement officers, implementing a ticketing system by which offenders are charged for each period that they fail to comply with a Stop Order or Compliance Notice, and or by providing resources to have assigned dedicated lawyers to handle such violations; Institutional strengthening; Public education and outreach.	Immediate
	Tap into groundwater resources for use in specific sectors/applications e.g. agriculture.	Change the Activity *Acceptable Alternative (2)*	Amendments to the Ground Water Ordinance, 1973 to better regulate groundwater use; Development of a sustainable groundwater plan based on a study to determine potential yield of groundwater aquifers and demand of selected sectors/applications e.g. agriculture; Study of the future impact of sea level rise on groundwater resources;	Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Dig, restore, and or upgrade wells in appropriate areas; Regulate and monitor extraction of water from wells; Public education and outreach.	
	Implement strict water conservation and efficiency programmes in Government facilities and offices, businesses, and households (these might vary) by: - encouraging / requiring use of water saving devices; - changing public perception about the value and true cost of water and providing water conservation tips; - improving water metering and billing system to ensure that customers pay the full price for water used, thus creating financial incentives for conserving water; - improving control, capture and reuse of stormwater and gray water.	Change the Activity *Preferred Action (1)*	Develop water conservation tips; Create financial incentive programmes to encourage water conservation and efficiency. E.g. inspect and assign a water efficiency rating to each residence; those identified as a "water conserving residence" would be rewarded by paying a cheaper rate for water and so forth; such an approach has been implemented in parts of the USA; Amend laws/regulations to mandate certain water efficiency standards, especially for apartment complexes where owners have no incentive to conserve water; Establish a Water Authority to inspect the plumbing systems of building as a part of the development review process; Amend laws/regulations to move away from bulk pricing/sale of water as that encourages water wastage by sending the wrong message– "use more and pay less per unit"; Public education and outreach.	Immediate to Near-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
	Invest in infrastructure to allow capture, basic treatment, and reuse of stormwater for specific uses e.g., toilet flushing in major commercial/business districts, and public landscaping in green spaces such as the Queen Elizabeth II Park, J.R. O'Neal Botanical Gardens, Noel Lloyd Positive Action Movement Park, recreational grounds, flower beds, etc. This might include, for example a) converting sections of some impervious parking lots and roads to pervious areas using interlocking permeable unit pavers, pervious concrete or porous pavement, and other technologies/techniques, and b) collection of stormwater in ghuts and engineered drainage systems using sump basins inclusive of a layered filtration bed and a pump to direct filtered water to an offsite storage area.	Prevent Loss *Preferred Action (1)*	Engineering and feasibility studies; Strengthen institutional capacity (experienced stormwater engineers); Amend Building Regulations to require separate plumbing for toilets in commercial buildings in select areas in order to accommodate reuse of stormwater; Stricter controls on upstream development in a certain proximity to ghuts in order to limit sediment flow and other debris in the ghut.	Near-term to Mid-term
	Plan for the future expansion of production capacity of desalinated water to meet projected water demand in the Territory. This would also include planning for increased capacity of water storage facilities to ensure a continuous delivery of water.	Prevent Loss *Preferred Action (1)*	Population projections and water demand study based on household surveys and historic output of desalination plants; Investment in additional desalination infrastructure; Protection of coastal water quality, especially around current and potential desalination intake areas;	Near-term to Mid-term

Potential Climate Change Impacts	Specific Adaptation Options	Adaptation Category & Rating	Supporting Activities	Time-frame
			Explore use of renewable energy in desalination plants to help mitigate increased energy demand for water production.	
Increased cost of desalinated water.	*Increase competition in the bidding process to produce desalinated water*.	Change the Activity *Preferred Action (1)*	Transparency in the bidding process; Study to determine feasible number of suppliers in the market.	Immediate
	Explore more long-term sustainable and potentially cost effective means of desalination such as solar-powered desalination technology.	Change the Activity *Preferred Action (1)*	Follow ongoing research into the use and further development of the technology in countries such as Mauritius, Saudi Arabia and Spain; Initial Government investment in and support of technology; Demonstration plant; Amend electricity laws/regulations to support use of solar energy.	Near-term to Mid-term *(as financially feasible)*
	Reduce per capita demand for desalinated water.	Change the Activity *Preferred Action (1)*	Fully implement water conservation and efficiency strategies outlined above.	Immediate to Near-term

Appendix B | Adaptation Opportunities & Constraints

Climate change not only presents a number of challenges for The Virgin Islands to grapple with, but in doing so, it also provides important opportunities to take “no regrets actions” that would contribute significantly to the long-term sustainable development of the Territory. Indeed a significant portion of the adaptation strategies outlined above in Appendix A are actions that have long been identified as important for implementation, with or without the climate change threat. Climate change, however, provides a universal banner for an integrated approach to addressing these outstanding and emerging issues and provides an extra impetus and the mobilization of external resources for action.

Currently available grants, ongoing legislative reforms, and public opinion provide favourable conditions to implement some of the key “no regrets” adaptation actions described.

While opportunities abound, naturally there are constraints that must be worked around through careful planning.

Beach & Shoreline Stability

Opportunities presented through climate change adaptation	Constraints
Increase the resilience of beaches and the shoreline to erosion and other forms of degradation; **Eliminate or significantly reduce future costs for beach re-nourishment projects through enhanced beach management.**	• Complex, multi-stakeholder process to amend planning laws/regulations; • Lack of rigorous local assessments to determine what the ideal coastal setbacks should be. Such assessments have been done in neighbouring islands such as Antigua and Barbuda, St. Lucia and Barbados; • Poor adherence to planning laws in many cases and stretched enforcement officers; • Potential pressures from large foreign direct investment development proposals that may run contrary to regulations and best management practices; • Traditional tendency to weigh present opportunity costs (lost financial revenues) more heavily than long-term financial gains from enhanced environmental protection/management; • Building stakeholder consensus on an overarching Beach Management Policy and specific beach management plans and finding the sustained resources for long-term implementation.
Protect natural beachscapes and seascapes from unsustainable, high density, or unsightly tourism and other developments to preserve the "Nature's Little Secrets" brand and services of these natural areas.	• Strong culture of tourism investment focused on the status quo "beach front" development model. • Limited coastal lands to meet the need for competing land uses.

Favourable Conditions for Action

- Ongoing revision of the Physical Planning Act, 2004 regulations and development of a Comprehensive Physical Development Plan. This provides a convenient opportunity to increase coastal development setbacks, and to establish zoning, including "no build areas" or "development density thresholds" where deemed appropriate.

- Reactivation of the Beach Commission.

- PhD thesis by Ms. Shannon Gore, CFD, on a framework for beach management in The Virgin Islands. Ongoing efforts with the Cane Garden Bay community to establish a Beach Management Plan for the area and ongoing multi-agency effort to develop a beach management plan for Smuggler's Cove which can be used as models for other beaches.

Coastal & Marine Ecosystems

Opportunities presented through climate change adaptation	Constraints
Enhancing the protection of coastal and marine resources in response to the increased threat level.	• Lack of a well-informed and broad based constituency that can create serious and lasting political will and accountability for enhanced protections; • Lack of lasting political will and accountability; • Week environmental laws and generally poor adherence to laws and stretched enforcement officers; • Limited financial resources to fund institutional restructuring and strengthening and other changes proposed under the Environmental Management and Conservation of Biodiversity Bill; • Limited human resources to take advantage of funding opportunities. • Lack of important infrastructure such as a national sewage treatment system, sewage pump out stations, and an adequate and properly maintained mooring system.
Developing an Earth Change Permit System to regulate the clearing of land to minimise erosion and flood potential and protect biodiversity. This System would include a schedule of the maximum percentage of land that can be cleared for various purposes. *(Currently, under the planning laws and regulations, the requirement already exists for persons to apply for permission to clear land. The regulations, however, do not limit the percentage of land that can be cleared. This provision is rarely followed. This may be due to lack of public awareness of this requirement and the perception that "land clearing" is not a form of development).*	• Complex process to amend planning laws/regulations and to develop new supporting institutional processes.
Reducing tourism pressures on coastal resources by developing a more diverse and "green" tourism industry that promotes land-based, cultural and historical attractions and low environmental impact development and operational models.	• Changing the culture of tourism investment towards more land-based and eco-tourism activities, more sustainable development accommodation models and supporting facilities, and "green" operations;

Opportunities presented through climate change adaptation	Constraints
	• Competition with the established "sand, sun, and sea" brand and well established eco-tourism and adventure tourism destinations such as Costa Rica; • Lag-time for quality of coastal and marine resources to reflect improved management.
Increasing revenues from better managed marine protected areas (MPAs).	• Limited human resources to manage MPAs, including limited capacity to enforce existing legislation; • Limited financial resources to enhance MPAs e.g. through clear demarcation of boundaries, snorkeling trails, etc.; • Limited public awareness and respect for MPA boundaries.

Favourable Conditions for Action

- Existing National Environmental Action Plan (NEAP) as well as the draft comprehensive Environmental Management and Conservation of Biodiversity Bill that when passed and implemented would facilitate several of the adaptation options proposed.
- Substantial JNCC funding currently available for invasive species research and management in the UK Overseas Territories (The Virgin Islands is applying).
- Neighbouring USVI has an Earth Change Permit System that can be used as a model for the development of a local system.
- Ongoing revision of the Physical Planning Act, 2004 regulations.
- Increasing environmental sensitivity and cultural awareness of travelers. Rapid growth of the North American eco-tourism and adventure tourism market.
- Passage of the National Parks Act, 2006, National Parks Regulations, 2008, and the Protected Areas System Plan 2007-2017, (2008).
- Building on the experiences and resources of the ongoing "Caribbean Challenge" - an unprecedented commitment by Caribbean Governments to support and manage new and existing national parks and protected areas.

Critical Infrastructure

Opportunities presented through climate change adaptation	Constraints
Reducing cost of coastal road repairs resulting from storm surges during hurricanes by enhancing coastal defences along existing vulnerable roads and constructing new roads in safe locations; **Creating an expanded and less vulnerable road network resulting in many benefits such as reduced traffic congestion, alternative emergency routes etc.**	• Lack of trained coastal engineers and limited capital to develop effective and environmentally sensitive coastal defence systems; • Significant lag-time between planting of mangroves and their ability to act as effective coastal defence systems; • Complex process to amend planning regulations; • Availability of lands in strategic areas for constructing new roads in safe locations; • Significant costs and risks involved in constructing well engineered, spacious and safe roads in the hilly interior.
Reducing cost of repairs to critical facilities (buildings) resulting from hurricanes, floods and storm surges by improving construction standards and avoiding siting buildings in vulnerable locations.	• High cost to retrofit existing facilities to withstand stronger hurricanes and floods; • Complex process to amend planning and building laws/regulations in order to enforce higher construction standards and restrict developments in vulnerable areas.
Mainstreaming natural hazard vulnerability and environmental sensitivity in the development planning process.	• Limited land resources (especially flat interior land) to accommodate competing needs.
Increasing critical facility and business recovery rates after climatic disasters due to more widespread adequate insurance coverage; development of early warning systems and preparation, evacuation and recovery plans; and an increased and better managed Disaster Relief Fund.	• Securing affordable and relatively stable insurance policies as the risk from climatic disasters increase; • Getting widespread community and stakeholder participation in the development of disaster preparation, evacuation and recovery plans.
Developing new building regulations reflective of climate change impacts and other natural hazards such as earthquakes.	• Limited technical capacity; • Poor adherence to building regulations in many cases and stretched enforcement officers.

Opportunities presented through climate change adaptation	Constraints
Proper management of sewage waste.	• Access to financial resources to build national sewage treatment system; • Selection and availability of suitable lands for placement of sewage treatment facilities.

Favourable Conditions for Action

- Ongoing revision of the Physical Planning Act, 2004 regulations in which climate change considerations can be integrated.
- Ongoing development of a Comprehensive Physical Development Plan in which climate change considerations can be integrated.
- Ongoing major development projects in which best management practices can be implemented e.g. wise positioning of the by-pass road for the East End/Long Look Waterfront Development Project taking into account climate change considerations such as sea level rise and stronger storm surges.
- Existence of The Virgin Islands Safer Building Course at the H. Lavity Stoutt Community College.
- Draft guidelines to govern how monies in the Disaster Relief Fund can be spent.
- Heightened focus and public support for improved natural disaster management in the wake of the January 2010 Haiti Earthquake.
- High community dissatisfaction with current management of sewage waste and support for a comprehensive sewage collection and treatment system.

Energy Security

Opportunities presented through climate change adaptation	Constraints
Becoming a low carbon emissions Territory by increasing energy efficiency and introducing renewable energies as a significant part of the Territory's energy portfolio. This would have several benefits including: - Creating a high degree of energy independence; - Reducing fossil fuel import bills and investing savings in climate change adaptation and other development needs; - Reducing the Territory's carbon emissions which can be used as a marketing point for tourism and would set a good moral example for the major polluting countries.	• Limited public knowledge about renewable energy and energy efficiency technologies, resulting in limited demand and lack of political pressure; • Legislation (BVI Electricity Corporation Ordinance) that severely limits the use of renewable energies (such as solar and wind) as a primary energy source; • Limited human capacity in renewable energy economics, planning and policy, installation and maintenance; • Lack of a policy environment and incentive programmes that encourage use of renewable energy; • Lack of lasting political will.
Construction of more energy efficient buildings that, for example, maximise natural lighting and cooling.	• Highly developed culture of air-conditioning and artificial lighting, especially in commercial settings; • Need for capacity building among the architectural and construction community in "green", especially energy efficient, design and construction; • Need for incentive programmes to encourage additional investment to build more energy efficient buildings.
Creating a voluntary tourism carbon offsetting programme, a carbon tax for tourists and or residents, or a combination of these to help establish financing mechanisms to support the integration of alternative energies and energy efficiency in households and the tourism sector.	• Tourist's and the public's willingness to pay; • Lack of political will.

Opportunities presented through climate change adaptation	Constraints
The Virgin Islands becoming and marketing itself as the first or one of few carbon neutral tourism destinations in the Caribbean. This would have several benefits including: - Reducing recurring energy costs for the tourism sector; - Improving the image and desirability of the Territory as a "green" tourist destination with high environmental quality.	• Securing a high level of support and buy-in from business owners in the tourism sector; • Legislation (BVI Electricity Corporation Ordinance) that severely limits the use of renewable energies (such as solar and wind) as a primary energy source; • Limited human capacity in renewable energy economics, planning and policy, installation and maintenance; • Lack of a policy environment and incentive programmes that encourage use of renewable energy.
Potential to become waste neutral and produce energy from waste given the close proximity between the waste incineration and electricity generation plants.	• Lack of human capacity in waste management and waste to energy generation; • Lack of strong waste management laws, including those that would minimise certain waste streams through control on imports. • Potentially unfavourable economics of scale.

Favourable Conditions for Action

- Current efforts to form a National Energy Committee through which important policy and legislative changes can be made.
- General consumer dissatisfaction with high electrical bills and frequent interruption of service.
- Increased construction in remote areas that are not connected to the existing electrical grid.
- High interest among key business stakeholder groups, including architects, builders and banks, in renewable energies (as expressed during the January and October 2009 Climate Change Public Consultations and otherwise).
- Ongoing renewable energy projects in the Caribbean in which the Territory could have the opportunity to be involved.
- Growing acceptance and popularity of voluntary carbon offsetting programmes and carbon taxes in the international tourism market.
- Growing global tourism market for "green" and "low carbon" tourist destinations.
- Installation of a new incinerator that has capability for waste to energy generation.

Food Security: *Agriculture*

Opportunities presented through climate change adaptation	Constraints
Restructuring and modernizing the agricultural sector to make significant steps towards greater food security. *(Greenhouses, for example, can reduce water demand (a limiting resource) by reducing water lost to the air through the leaves by evapotranspiration. Greenhouses can further decrease water demand if a recirculation system is used).* **Increasing local demand for agricultural produce among the tourism sector by improving guarantee of produce quality and quantity.**	• Limited capacity at the administrative and producer level in modern farming technologies and agronomics; • Building consensus between policy makers and producers about the introduction of modern farming technologies and their implementation and operation; • Making produce cost competitive or adding more value for money; • Lack of interest in and promotion of agriculture; • Building lasting political will and accountability.
Increasing producer recovery rates after climatic disasters due to more widespread adequate insurance.	• Increasing producers' access to affordable insurance.
Reducing damage to crops from pests, diseases and invasive species through, for example, use of green houses. *(Greenhouses can significantly reduce incidence of pests, especially those originating from the soil).*	• Limited human resources to take advantage of funding opportunities; • Limited capacity at the administrative and producer level in modern farming technologies and agronomics; • Building consensus between policy makers and producers about the introduction of modern farming technologies and their implementation and operation.
Decreasing desalinated water demand and associated expenditure per unit of produce due to improved water catchment techniques, utilization of groundwater, and enhanced water conservation and efficiency.	• Limited capacity in hydrology and hydro-engineering; • Willingness and finances to invest in systems to enhance water catchment and efficiency. • Lack of a sustainable groundwater plan. Need for modernization of wells to improve access to water.

Favourable Conditions for Action

- Ongoing project to construct large-scale greenhouses on Tortola and Virgin Gorda.
- Substantial JNCC funding currently available for invasive species research and management in the UK Overseas Territories (The Virgin Islands is applying).
- Existing use of drip irrigation technology which can be further expanded.

Food Security: *Fisheries*

Opportunities presented through climate change adaptation	Constraints
Developing a more sustainable fisheries, e.g. by alternating targeted species; **Increasing the diversity of commercially targeted species.**	• Poor adherence to existing Fisheries Act regulations in many cases and stretched enforcement officers; • Stakeholder resistance to new regulations; • Lack of sufficient and real time data to make informed management decisions; • Changing consumer preferences.
Increasing fisherman recovery rates after climatic disasters due to more widespread adequate insurance coverage and better preparedness.	• Securing affordable and relatively stable insurance policies as the risk from climatic disasters increase; • Ensuring compliance with hurricane preparedness recommendations.

Favourable Conditions for Action

- Ongoing efforts to revise the Fisheries Act regulations spearheaded by the Conservation and Fisheries Department.
- Existence of a few Fisheries Cooperatives that can potentially lobby for better insurance coverage for persons in the industry.

Forestry & Biodiversity

Opportunities presented through climate change adaptation	Constraints
Chance to further develop eco-tourism and adventure tourism through better protection of forests and wildlife.	Rapid population growth and development pressures; Changing the culture of tourism investment towards eco-tourism ventures; Competition with the established "sand, sun, and sea" brand and well established eco-tourism and adventure tourism destinations such as Costa Rica; Lag-time for quality of forest and wildlife resources to reflect improved management.
Creation of world-renowned outdoor environmental field stations and research laboratories that could serve as important capacity building facilities and revenue streams.	High initial capital requirement to set up and operate fields stations and research laboratories; Limited human capacity to manage set up and operation of field stations and laboratories; Rapid degradation of marine environments.
Review and improvement of the entire port inspection and processing system to reduce the influx of invasive species through the ports.	Complex process to amend laws and regulations and to develop new supporting institutional processes.

Favourable Conditions for Action

- Existing National Environmental Action Plan (NEAP) as well as the draft comprehensive Environmental Management and Conservation of Biodiversity Bill that when passed and implemented would facilitate several of the adaptation options proposed.
- Existence of ideal areas for the creation of outdoor environmental field stations and research laboratories that are already designated as marine protected areas, such as Hans Creek.
- Substantial JNCC funding currently available for invasive species research and management in the UK Overseas Territories (The Virgin Islands is applying).

Human Health

Opportunities presented through climate change adaptation	Constraints
Improving reporting, communication and information systems for health.	• Public reluctance or lack of concern about reporting of certain illnesses; • Poor culture of information flow and sharing among the various wings of the public health care sector and private health care sector; • Limited human capacity and financial resources to support a large scale health surveillance and analysis system.
Enhancing the Territory's emergency response services.	• Lack of strong early warning systems (for flood events) and evacuation and recovery plans; • Centralised nature of public health care services. Although there are several community clinics, these only offer very basic services; • Limited human capacity and financial resources.
Improving the primary health care system. *(Climate change adaptation creates another avenue through which to promote wellness, preventative care, early detection and public involvement in maintaining community health and sanitation. All of these lower expenditure for emergency care and treatment of chronic illnesses such as asthma, as well as reduce the risk for disease).*	• Building sustained political will; • High initial investment to expand and upgrade clinics and their staffing (long-term savings should be realised); • Changing public attitudes and behaviours in regards to basic principles of leading a healthy lifestyle including diet, exercise, stress management, maintaining healthy environmental surroundings, regular doctor visits etc.

Favourable Conditions for Action

- Recent signing of a contract to develop a National Health Insurance Scheme.
- New modern hospital soon to come on stream.
- New integrated patient data management system soon to come on stream.
- Existence of skeleton clinics in most communities.

Human Settlements

Opportunities presented through climate change adaptation	Constraints
Developing housing communities that are more resilient to natural disasters; **Mainstreaming natural hazard vulnerability and environmental sensitivity in the community development planning process.**	• Already high cost of construction and additional cost to build to a climate-proof standard and to build in less vulnerable areas (e.g. moderately sloping hillsides vs. flat low lands); • Limited land resources (especially flat/moderately sloping interior land) to accommodate competing needs; • Strong culture of family inheritance of lands versus purchasing of land. This normally confines persons to construct in pre-defined areas based on their inheritance.
Increasing community recovery rates after climatic disasters due to more widespread adequate insurance coverage; development of early warning systems and preparation, evacuation and recovery plans; and an increased and better managed Disaster Relief Fund.	• Securing affordable and relatively stable insurance policies as the risk from climatic disasters increase; • Getting widespread community and stakeholder participation in the development of disaster preparation, evacuation and recovery plans.
Reducing cost of repairs to homes resulting from hurricanes, floods and storm surges, due to higher building standards and wiser building practices.	• High cost to retrofit existing homes to withstand stronger hurricanes, storm surges and floods. • Complex process to amend planning and building laws/regulations in order to enforce higher construction standards and restrict developments in vulnerable areas.

Favourable Conditions for Action

- Ongoing revision of the Physical Planning Act, 2004 regulations in which climate change considerations can be integrated.
- Ongoing development of a Comprehensive Physical Development Plan in which climate change considerations can be integrated.
- Existence of The Virgin Islands Safer Building Course at the H. Lavity Stoutt Community College.
- Draft guidelines to govern how monies in the Disaster Relief Fund can be spent.
- Heightened focus and public support for improved natural disaster management in the wake of the January 2010 Haiti Earthquake.

Insurance & Banking

Opportunities presented through climate change adaptation	Constraints
Potential for insurance policies that are better suited for and reflect the circumstances in the Territory and wider Caribbean region.	Banks and insurance companies serving The Virgin Islands are typically subsidiaries of large international companies, thereby limiting the Territory's influence on decision making.
Developing partnerships with banks and insurance companies to use financial incentives to ensure higher construction standards and wiser building practices.	Securing support and buy-in from banks and insurance companies.

Favourable Conditions for Action

- Establishment of the Caribbean Catastrophe Risk Insurance Facility (CCRIF) that may be a useful body for pushing insurance reform regionally through various means outside of their regional disaster risk pooling model.

  (The Virgin Islands is not a member of CCRIF as it was not determined to be a cost effective insurance means for the Territory).

- The global insurance industry is becoming stricter about insuring properties with poor construction standards or located in vulnerable areas.

Tourism

Opportunities presented through climate change adaptation	Constraints
Reducing the cost of repairs to tourism facilities resulting from hurricanes, floods and storm surges, due to higher building standards and wiser building practices.	• High cost to retrofit existing facilities to withstand stronger hurricanes, floods and storm surges; • Higher initial costs to build to a climate-proof standard; • Complex process to amend planning and building laws/regulations in order to enforce higher construction standards and restrict developments in vulnerable areas.
Increasing the recovery rate of tourism facilities after climatic disasters, due to more widespread adequate insurance coverage; development of early warning systems and preparation, evacuation and recovery plans; and an increased and better managed Disaster Relief Fund.	• Securing affordable and relatively stable insurance policies as the risk from climatic disasters increase; • Getting widespread stakeholder participation in the development of disaster preparation, evacuation and recovery plans.
Diversifying the tourism sector to increase its resilience against climatic disasters and various external shocks.	• Changing the culture of tourism investment away from the established "sun, sand, and sea" business model. • Investment to develop high-class land-based tourism attractions e.g. restoration and interpretation of the Territory's several historical sites.
Moving towards eco-tourism which generates higher revenue and less environmental impact per visitor; **Developing "conservation tourism" in which tourists would take part in conservation projects while on vacation.**	• Changing the culture of tourism investment towards more land-based and eco-tourism activities, more sustainable development accommodation models and supporting facilities, and "green" operations; • Competition with the established "sand, sun, and sea" brand and well established eco-tourism and adventure tourism destinations such as Costa Rica; • Developing meaningful and high-quality conservation projects that tourists can be confident in. • Ensuring Government development policies are pro environmental protection and conservation.
Attaining environmental certification of the tourism industry through well recognised international programmes such as Blue Flag (for marinas) and Green Globe (for hotels etc.).	• Securing a high level of support and buy-in from business owners in the tourism sector; • High initial capital investment to meet certification standards;

Opportunities presented through climate change adaptation	Constraints
	• Lack of certain key public infrastructure that would make certification difficult or more expensive, such as proper sewage and toxic waste management systems.
The Virgin Islands becoming and marketing itself as the first or one of few carbon neutral tourism destinations in the Caribbean. To help facilitate this, a voluntary carbon offsetting programme or a carbon tax for tourists could be introduced to help finance the integration of alternative energies and energy efficiency in the tourism sector.	• Securing a high level of support and buy-in from business owners in the tourism sector; • Tourist's willingness to pay; • Potential political resistance to a tourist tax.
Minimising the long-term operating costs of the tourism sector through energy and water savings.	• Willingness of the industry to invest upfront in energy and water efficient devices and conservation practices.

Favourable Conditions for Action

- Ongoing review of the Physical Planning Act, 2004 regulations.
- Ongoing development of a Comprehensive Physical Development Plan.
- Increasing reluctance of the insurance industry to insure coastal tourism properties repeatedly severely damaged by hurricanes and storm surges.
- Increasing environmental sensitivity and cultural awareness of travelers. Growing global tourism market for "green" destinations. Rapid growth of the North American eco-tourism and adventure tourism market.
- The Caribbean Community Climate Change Centre's Carbon Neutral Tourism Project in which the Territory may have an opportunity to be involved. This would include an ISO certification component.
- Current efforts of the BVI Tourist Board to introduce the Blue Flag Programme, an environmental certification programme for marinas.
- Growing acceptance and popularity of voluntary carbon offsetting programmes and carbon taxes in the international tourism market.

Water Resources & Hydrological Characteristics

Opportunities	Constraints
Creating cost savings and improved reliability of the public water supply by reducing per capita water demand, through serious water conservation and efficiency programmes and reducing leakage in the water storage and distribution system.	• Higher initial cost of water efficient appliances; • Limited availability and variety of water saving appliances on island; • Lack of incentives for water conservation – imprecise metering and bulk water pricing; • Cost of detecting and eliminating leaks.
Exploring and utilizing the Territory's groundwater resources on a larger, but sustainable scale.	• Limited resources to invest in groundwater research, development and management; • No existing measures to protect groundwater from pollution.
Enhance public drainage system to reduce likelihood of flood events.	• Limited capacity in hydro-engineering; • Lack of comprehensive drainage plan; • Access to finances to upgrade or overhaul system.
Capturing and reusing stormwater for irrigation purposes etc.	• Significant capital investment to retrofit drainage system, plumbing systems etc. to facilitate capture and treatment of stormwater for re-use • Limited human capacity in hydro-engineering.
Reducing energy costs for desalination through eventual integration of renewable energy in desalination plants.	• Limited capacity in renewable energy technology; • Economic feasibility.

Favourable Conditions for Action

- General consumer dissatisfaction with frequent interruption of public water supply, including due to rapidly growing water demand and leaky infrastructure.
- Ongoing development of a Comprehensive Physical Development Plan in which drainage plans can be included.
- Continuous upgrade of public road system in which road drainage issues can be systematically addressed.
- Existing technologies and techniques, such as pervious concrete and porous pavement or interlocking permeable unit pavers that offer the inherent durability and low life cycle costs of typical concrete pavement while allowing for stormwater capture and reuse. These technologies can be systematically integrated in new parking lots, sidewalks, etc.

Appendix C | Geography & Topography of The Virgin Islands

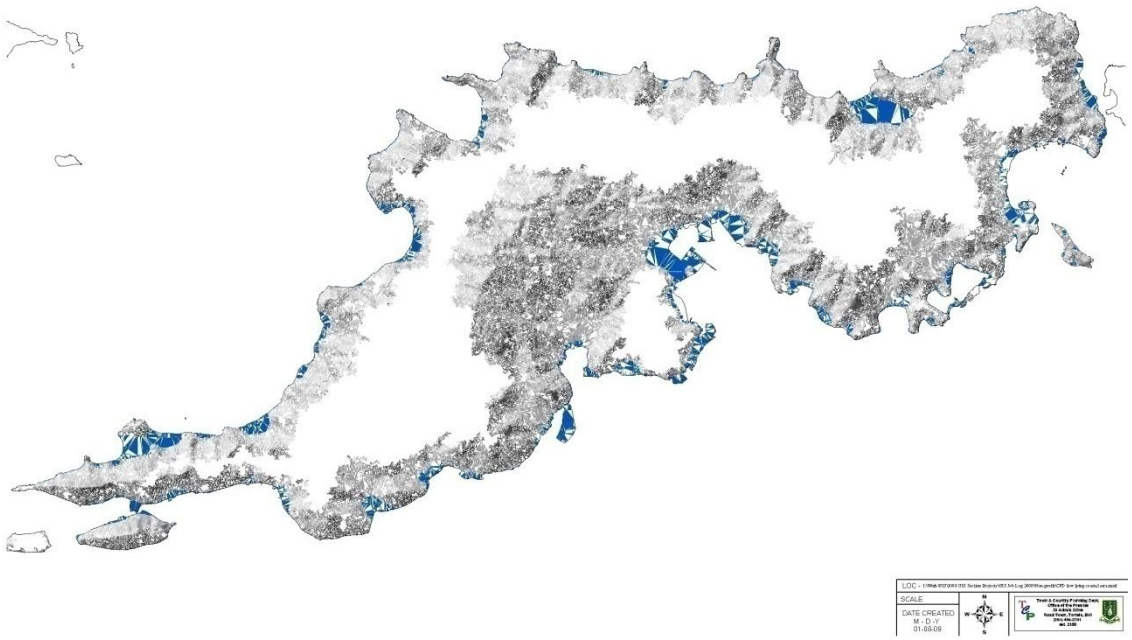


Figure C1. Tortola's topography. (Blue shaded areas represent land ≤ 2m above sea level) *(Source: Town and Country Planning Department)*

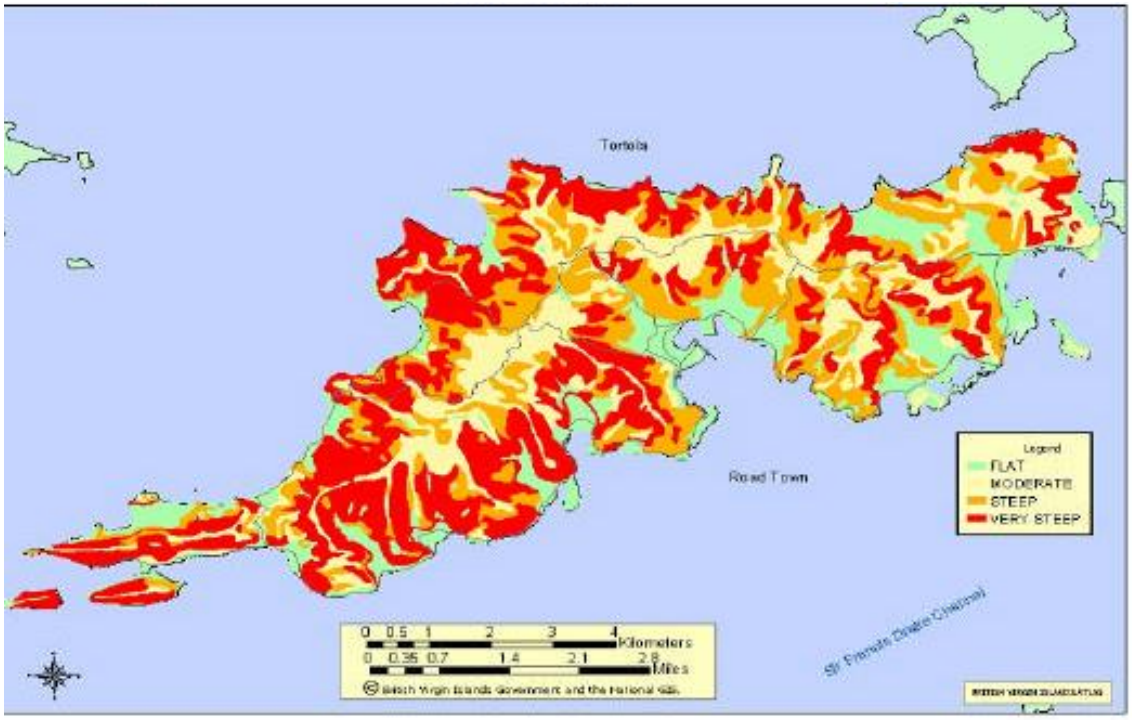


Figure C2. Slopes of Tortola. (Green = flat, yellow = moderate slope, organge = steep slope, red = very steep slope) *(Source: Orion Consultancy Services Ltd, 2004).*

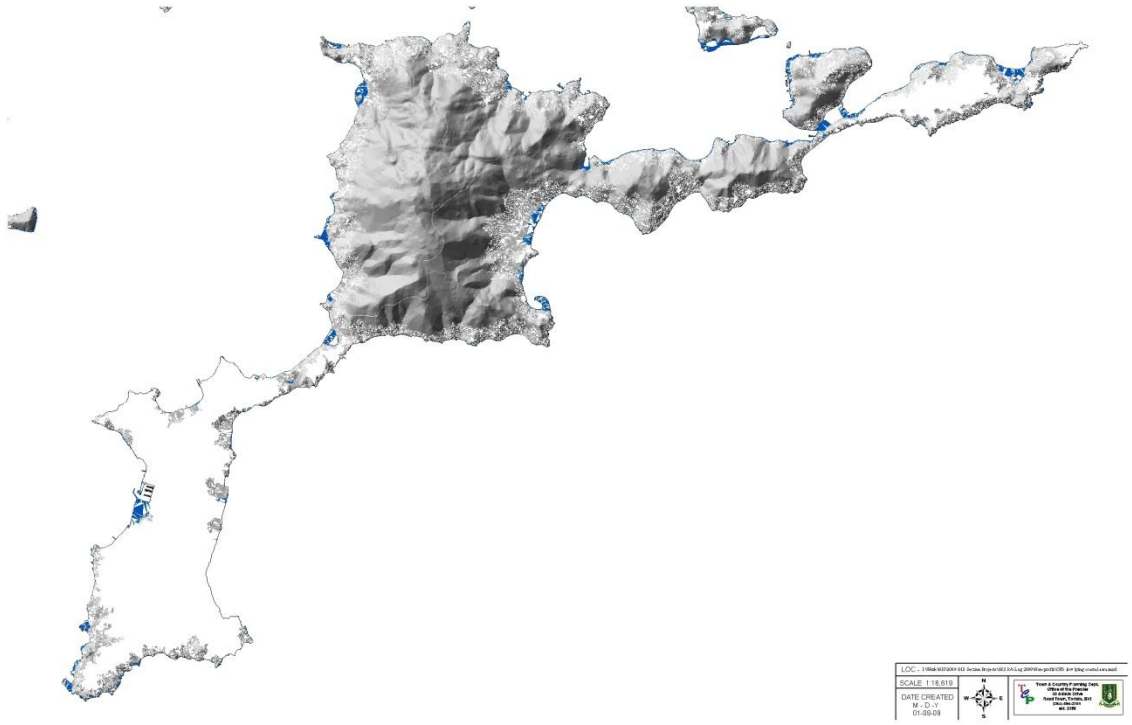


Figure C3. Virgin Gorda's topography. (Blue shaded areas represent land ≤ 2m above sea level) *(Source: Town and Country Planning Department).*

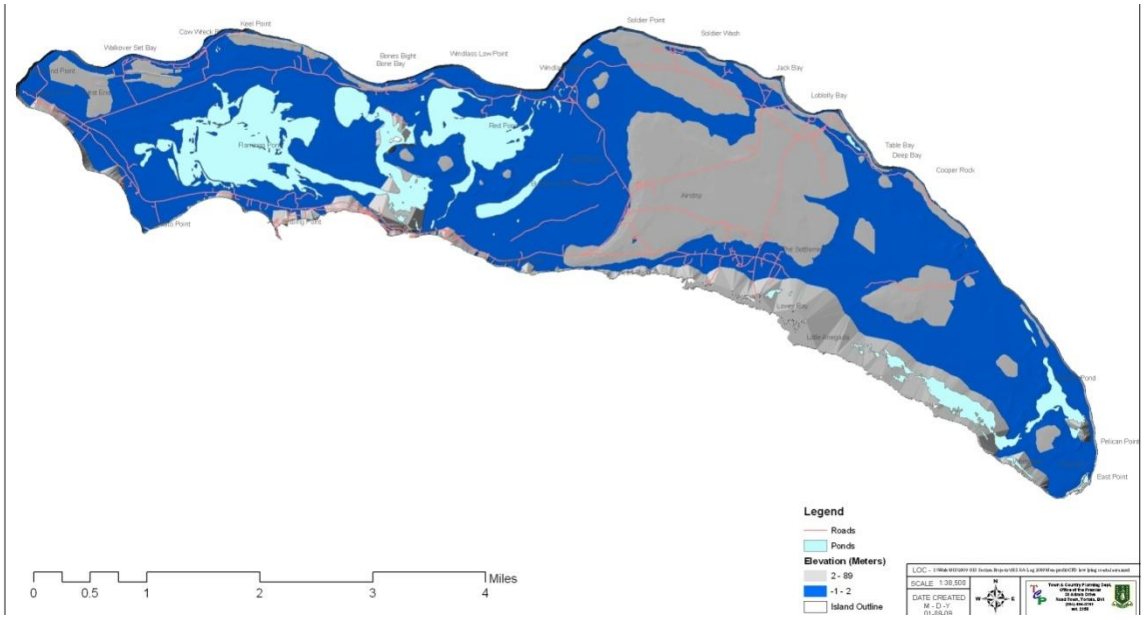


Figure C4. Anegada's topography. (Blue shaded areas represent land ≤ 2m above sea level) *(Source: Town and Country Planning Department).*

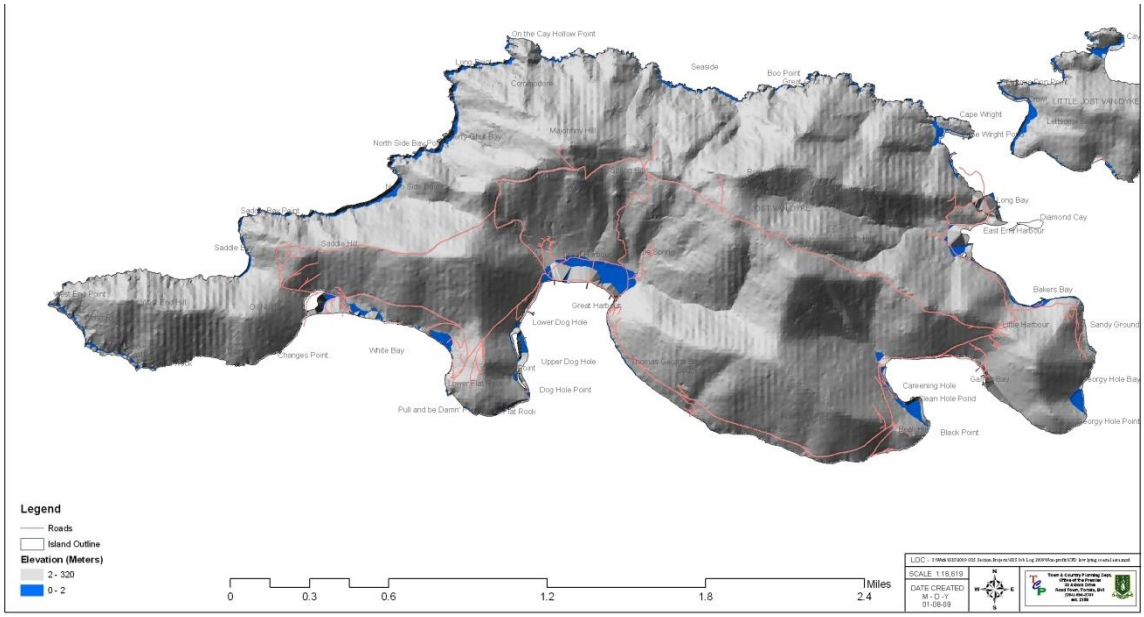


Figure C5. Jost Van Dyke's topography. (Blue shaded areas represent land ≤ 2m above sea level) *(Source: Town and Country Planning Department).*

Appendix D | Natural Hazards in The Virgin Islands

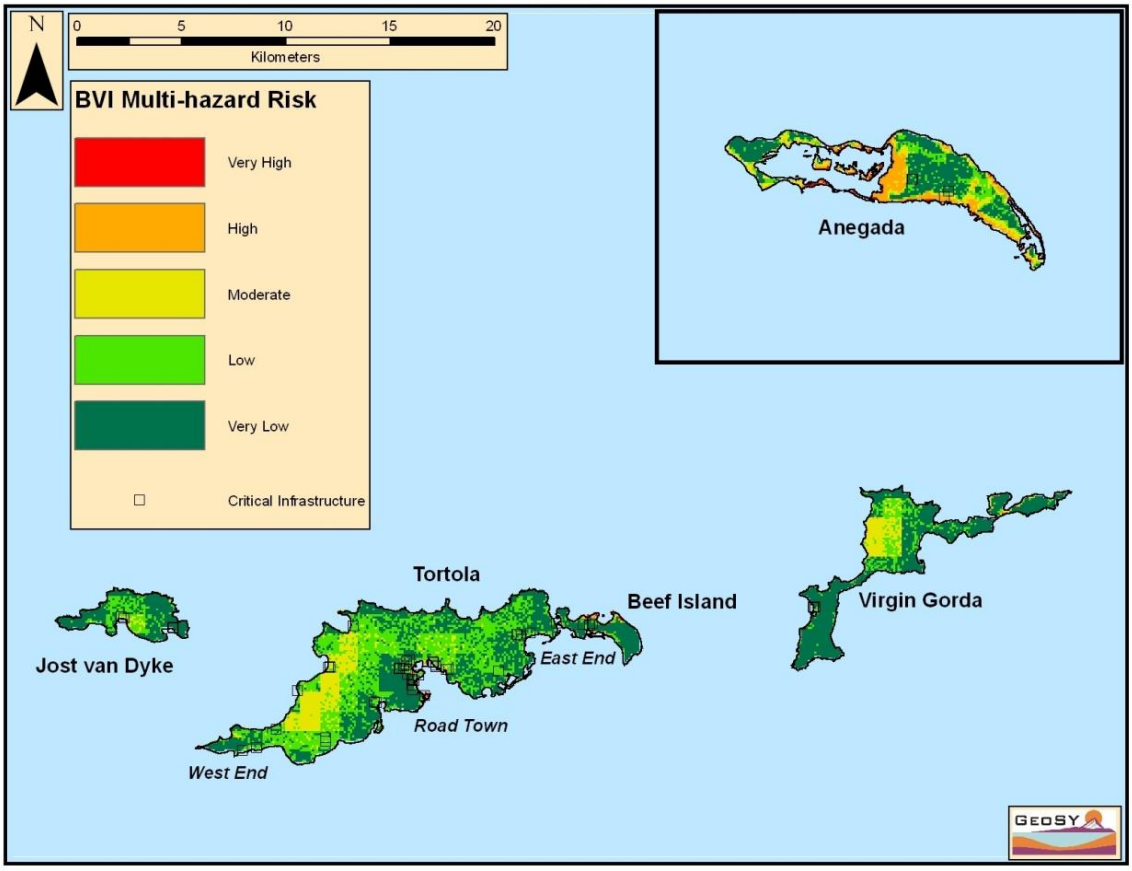


Figure D1. Multiple hazard risk distribution in The Virgin Islands. *(Source: Department of Disaster Management).*

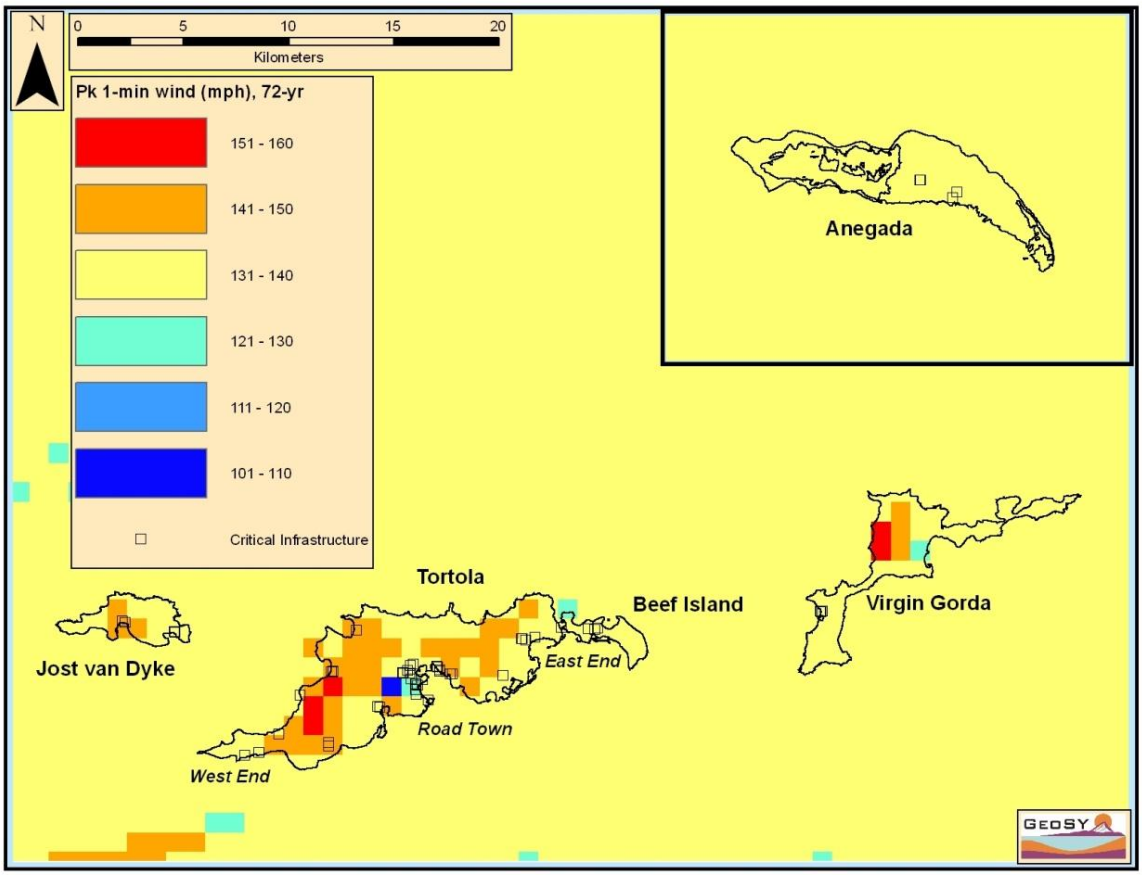


Figure D2. Wind hazard distribution across The Virgin Islands. (*Source: Department of Disaster Management).*

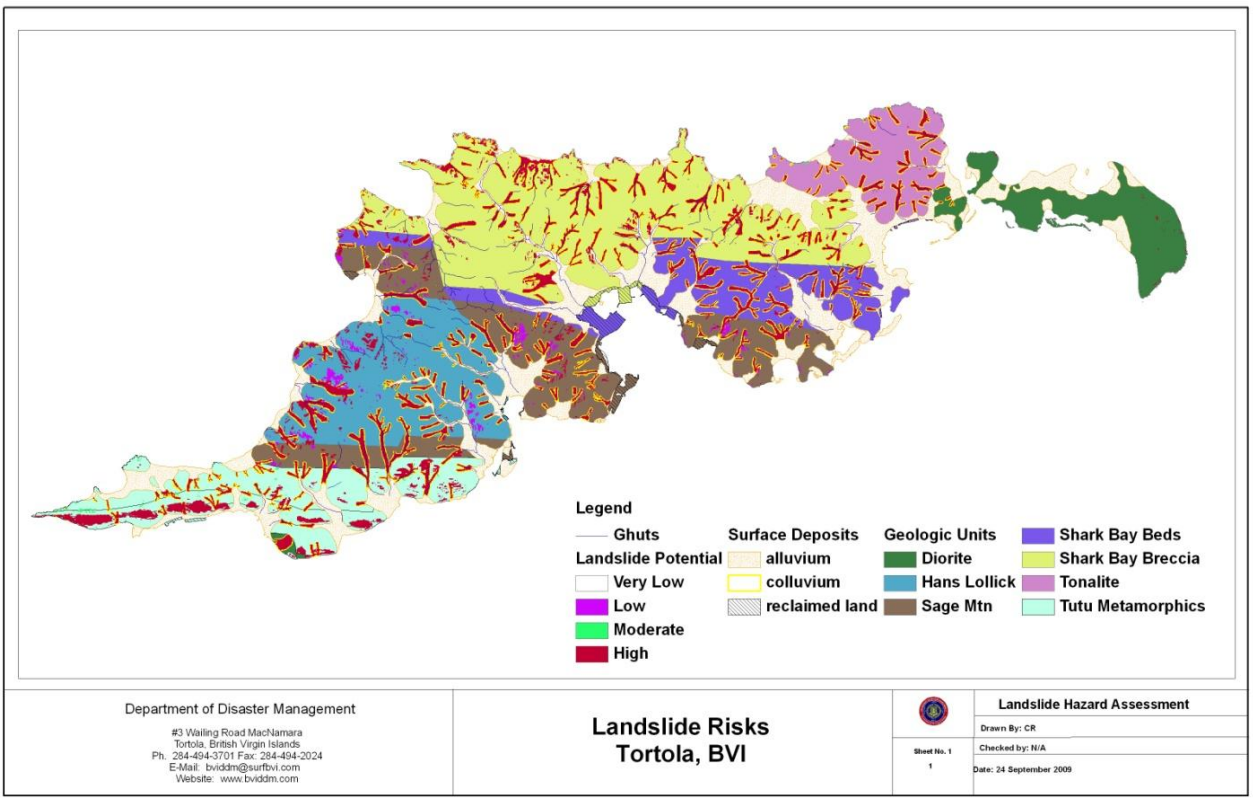


Figure D3. Landslide potential in Tortola. The areas where there is a "high" landslide potential (highlighted in red) tend to overlap with areas that have colluvium deposits (outlined in yellow). *(Source: Department of Disaster Management).*

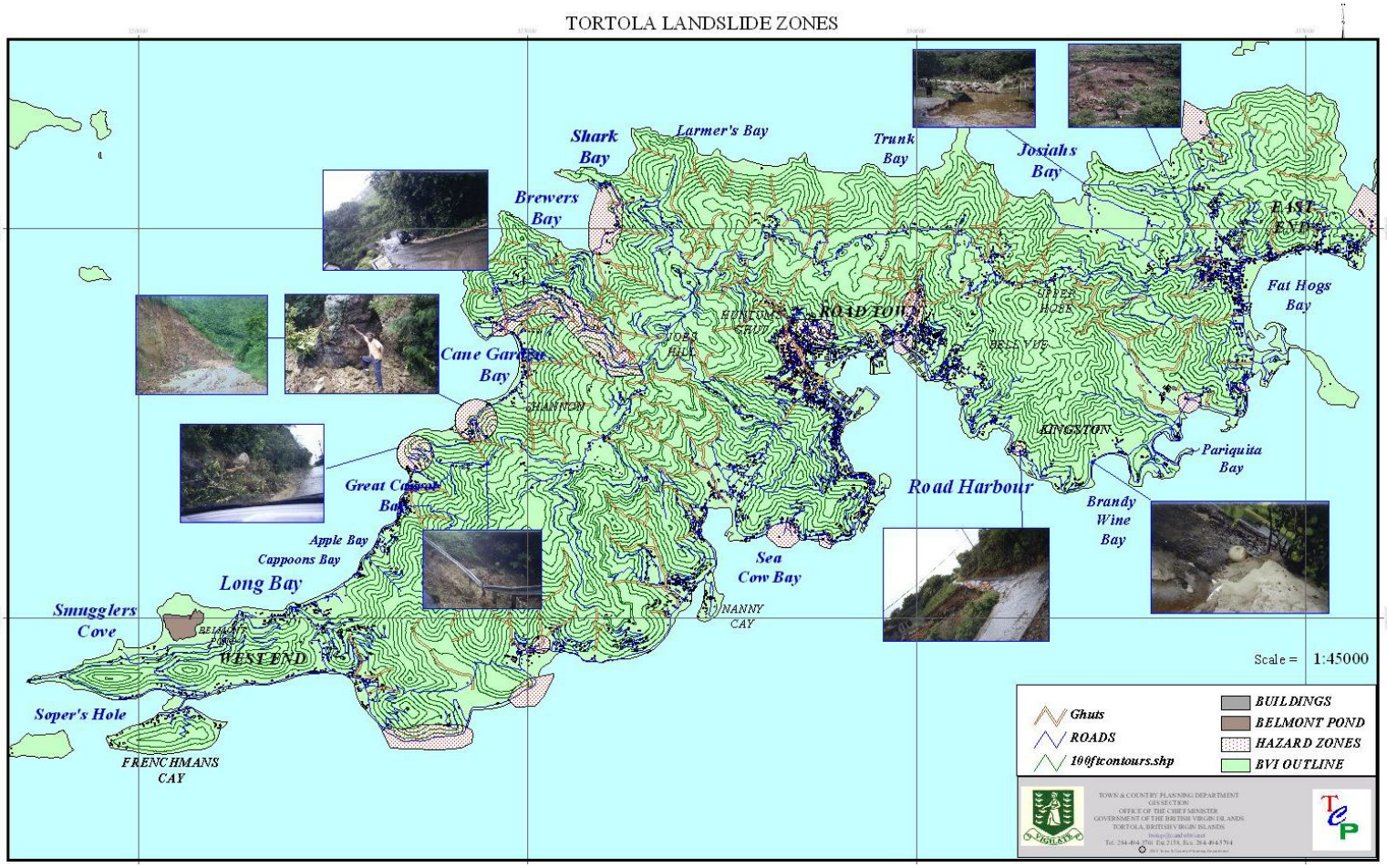


Figure D4. Tortola landslide zones. Hazardous areas are shaded in beige. *(Source: Town and Country Planning Department).*

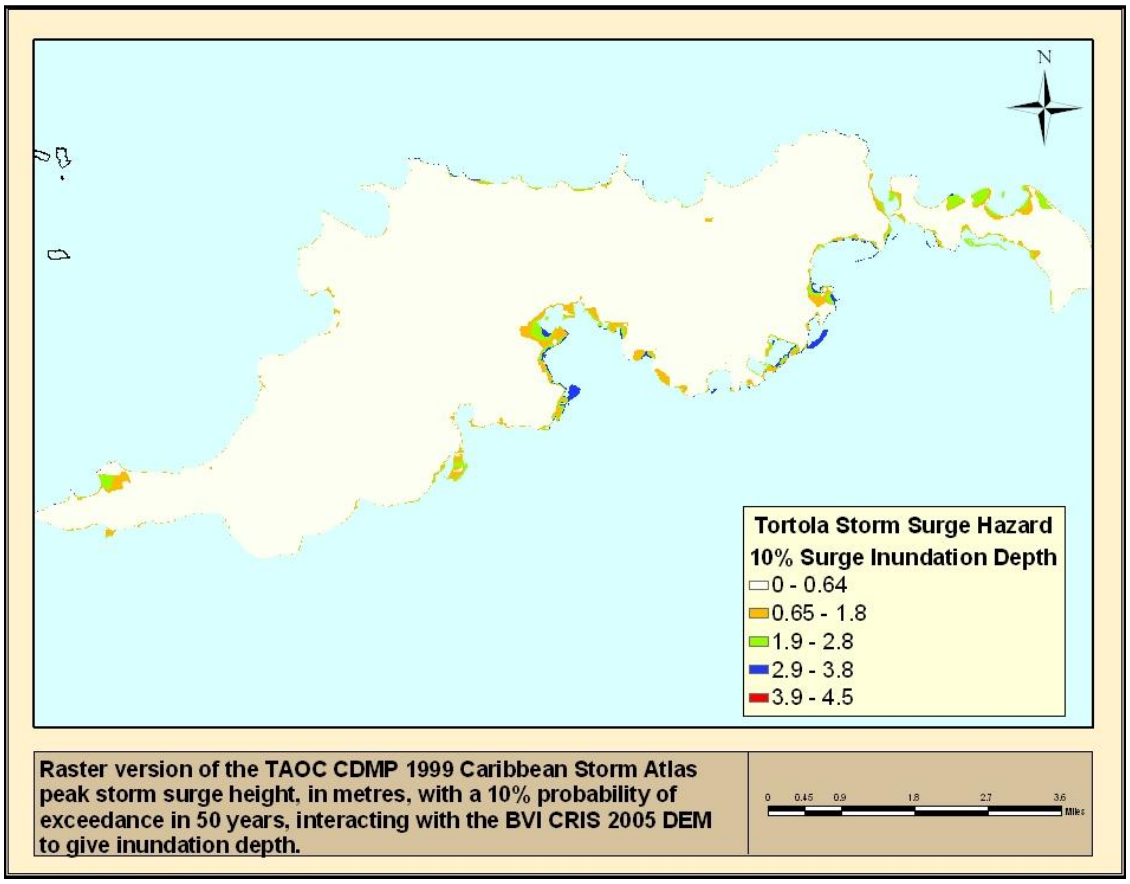


Figure D5. Tortola storm surge hazard. The depth of inundation for any given point of coastline is given in metres. Inundation depths are based on peak storm surge height. There is a 10% change that these maximums would be exceeded in any given 50 year period. *(Source: Department of Disaster Management).*

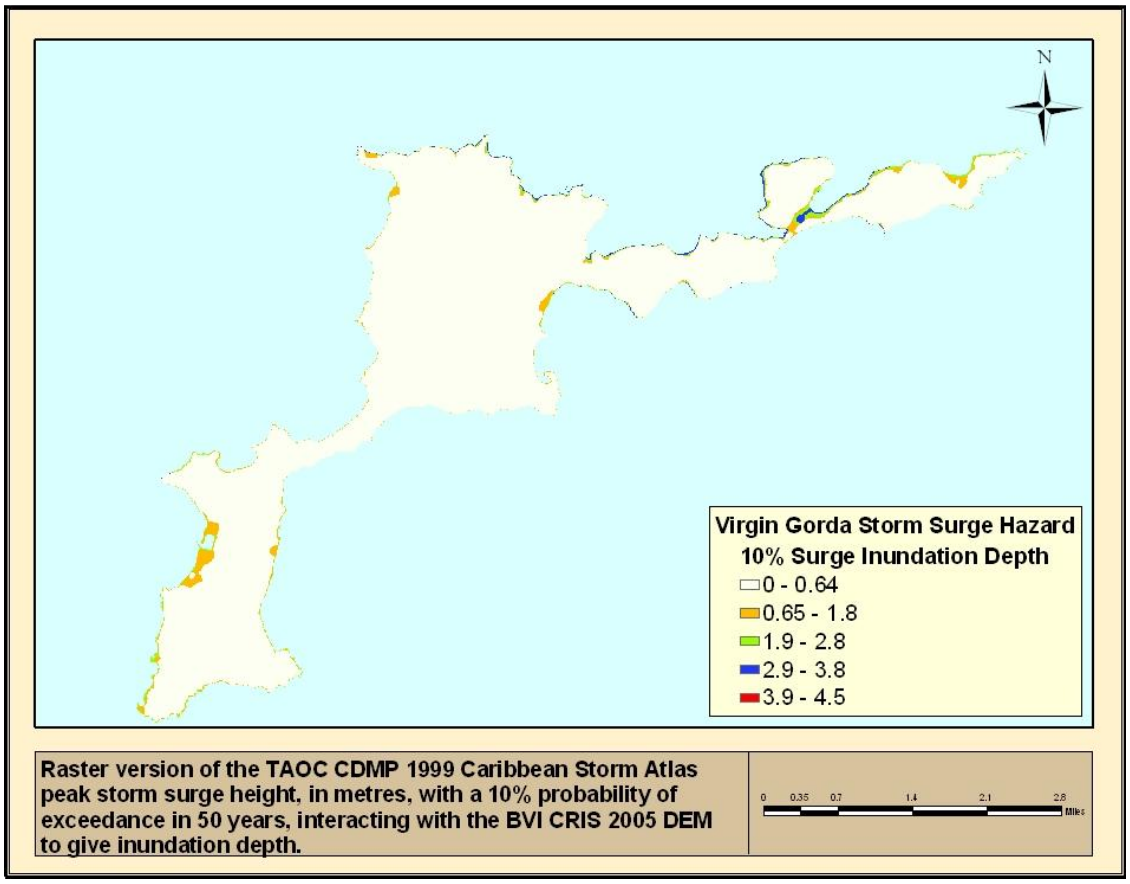


Figure D6. Virgin Gorda storm surge hazard. The depth of inundation for any given point of coastline is given in metres. Inundation depths are based on peak storm surge height. There is a 10% change that these maximums would be exceeded in any given 50 year period. *(Source: Department of Disaster Management).*

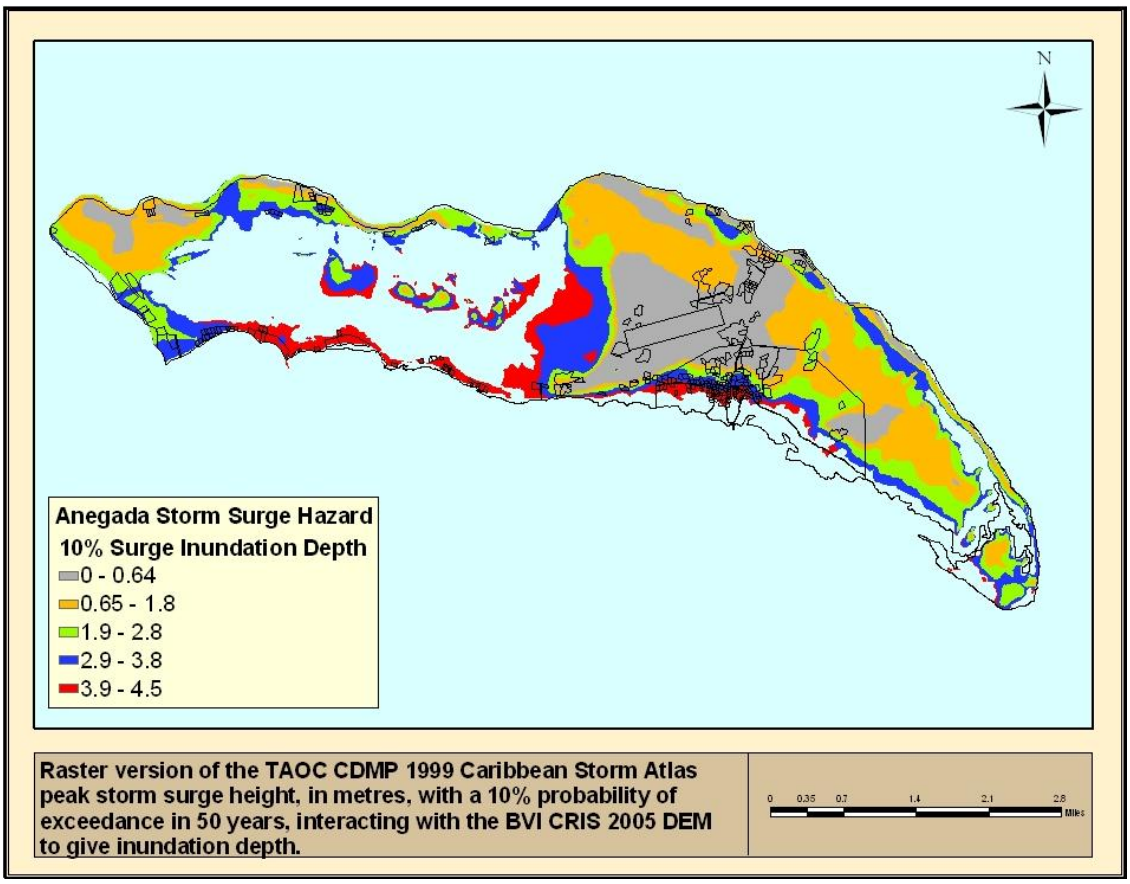


Figure D7. Anegada storm surge hazard. The depth of inundation for any given point of coastline is given in metres. Inundation depths are based on peak storm surge height. There is a 10% change that these maximums would be exceeded in any given 50 year period. *(Source: Department of Disaster Management).*

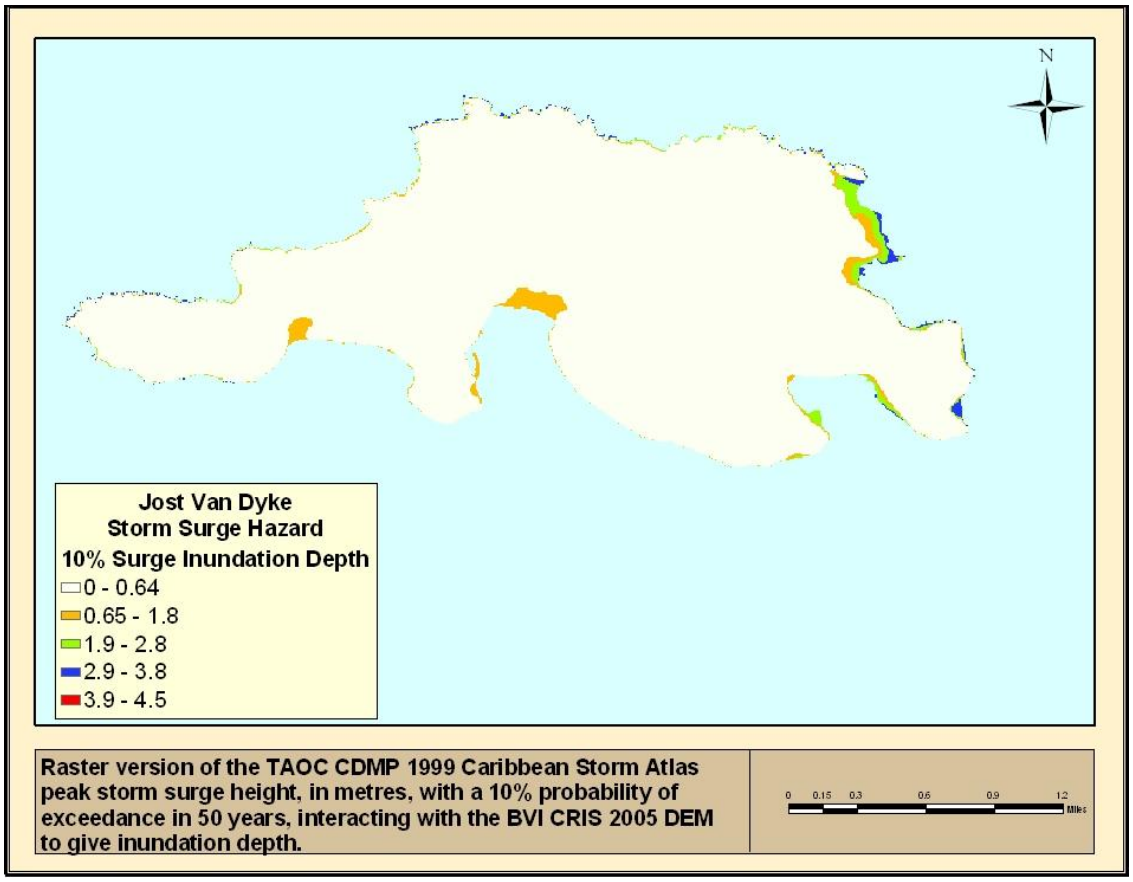


Figure D8. Jost Van Dyke storm surge hazard. The depth of inundation for any given point of coastline is given in metres. Inundation depths are based on peak storm surge height. There is a 10% change that these maximums would be exceeded in any given 50 year period. *(Source: Department of Disaster Management).*

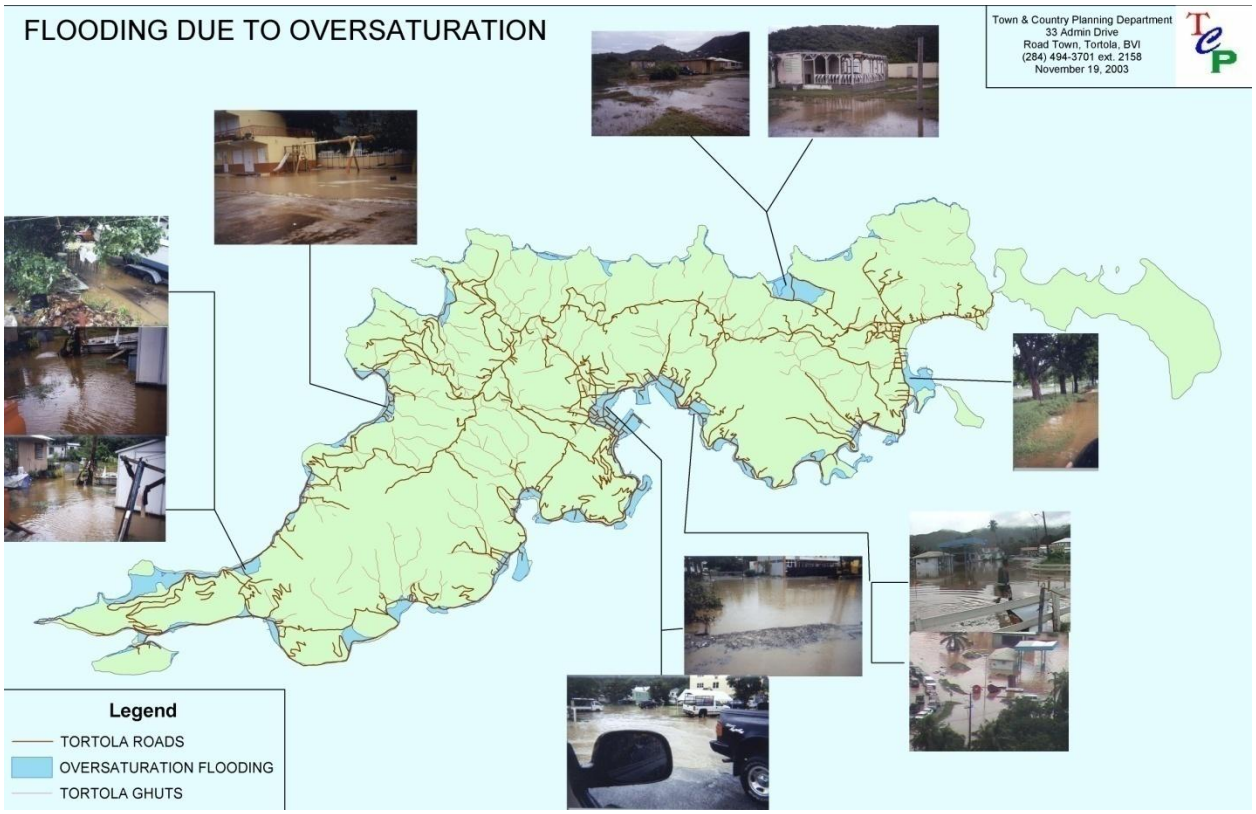


Figure D9. Flooding on Tortola due to oversaturation during the David Jones Tropical Wave November, 2003. *(Source: Town and Country Planning Department).*

Appendix E | Location of critical infrastructure in The Virgin Islands

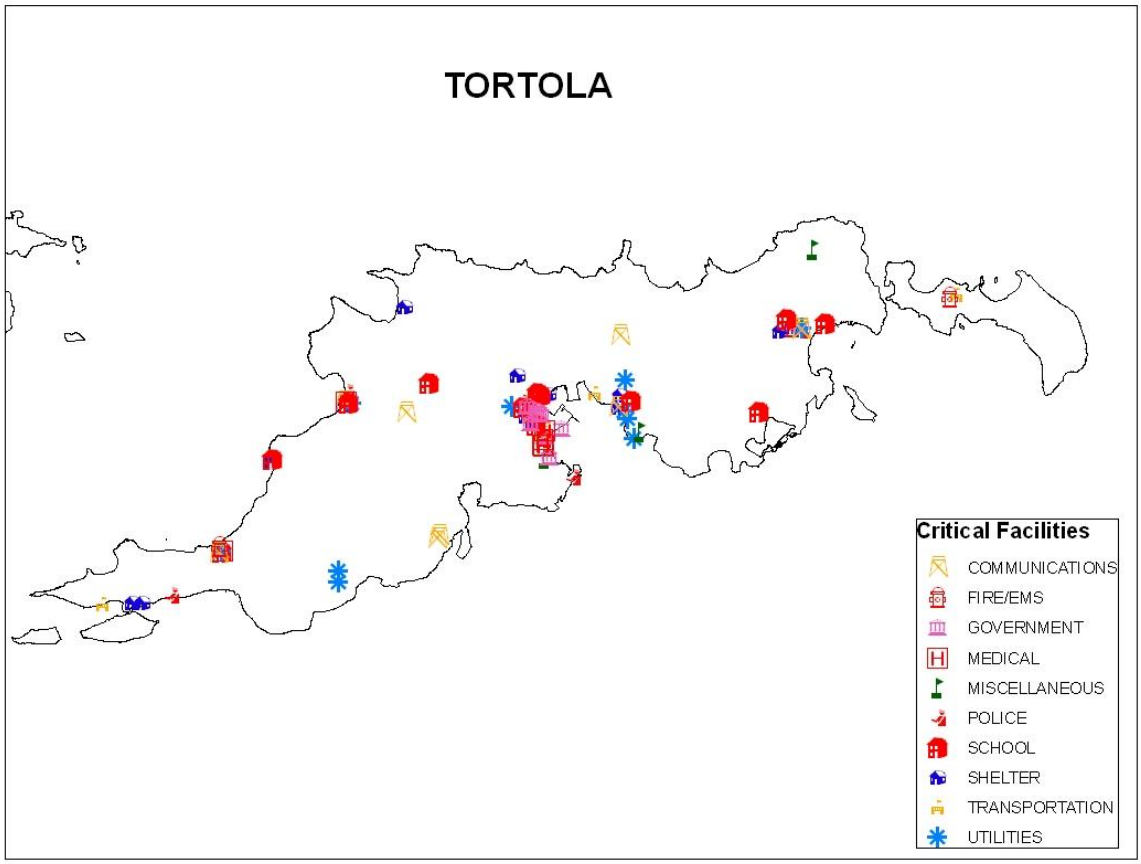


Figure E1. Location of critical infrastructure on Tortola. Most facilities are located in the coastal zone which is vulnerable to storm surge and sea level rise. *(Source Department of Disaster Management).*

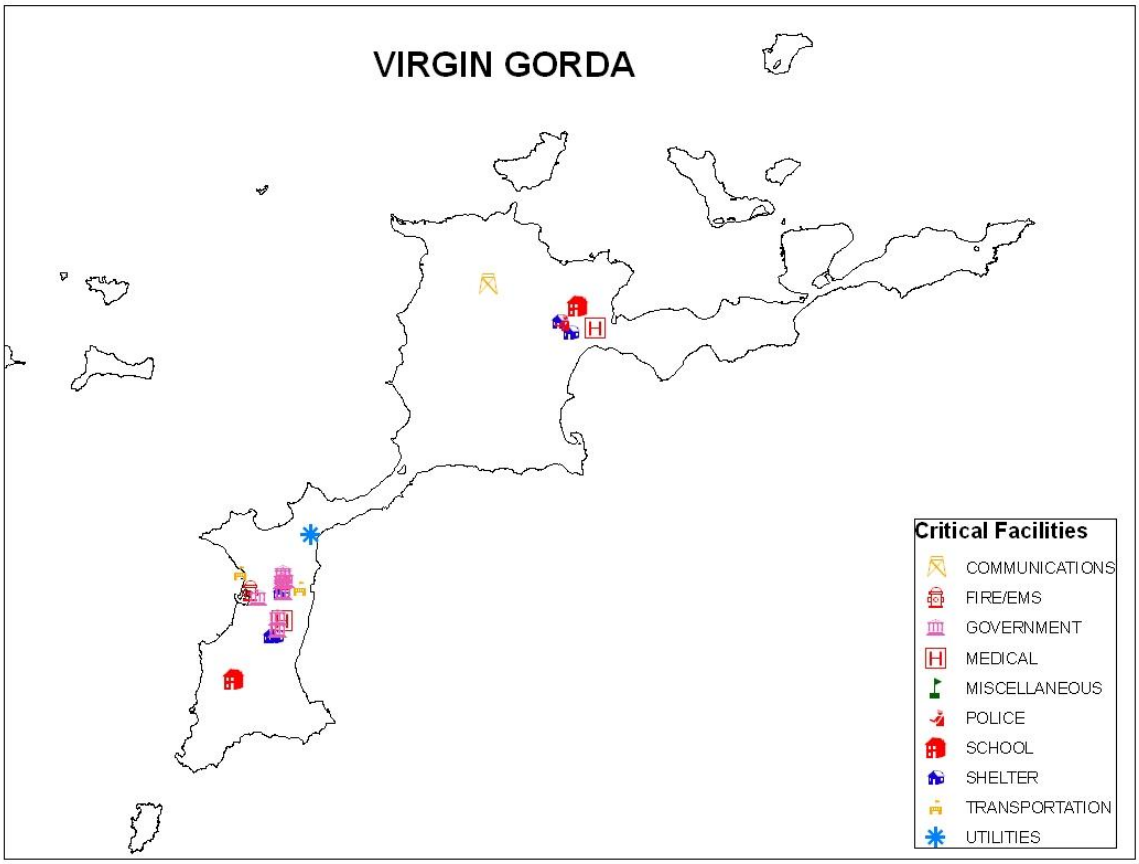


Figure E2. Location of critical infrastructure on Virgin Gorda. As compared to Tortola the critical facilities are located in slightly less vulnerable areas to storm surge and sea level rise. *(Source Department of Disaster Management).*

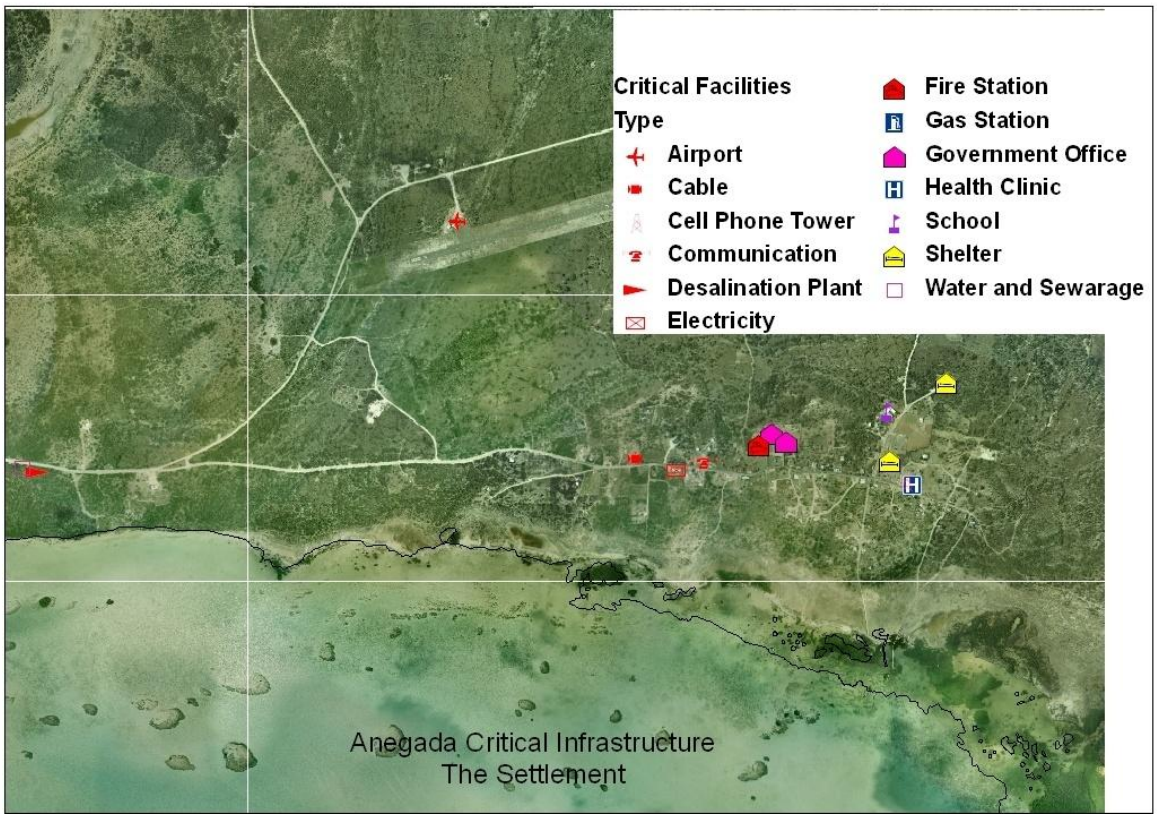


Figure E3. Location of critical infrastructure in the Settlement, Anegada. This infrastructure is highly vulnerable as it is not only very close to the coast, but practically at sea level. *(Source Department of Disaster Management).*

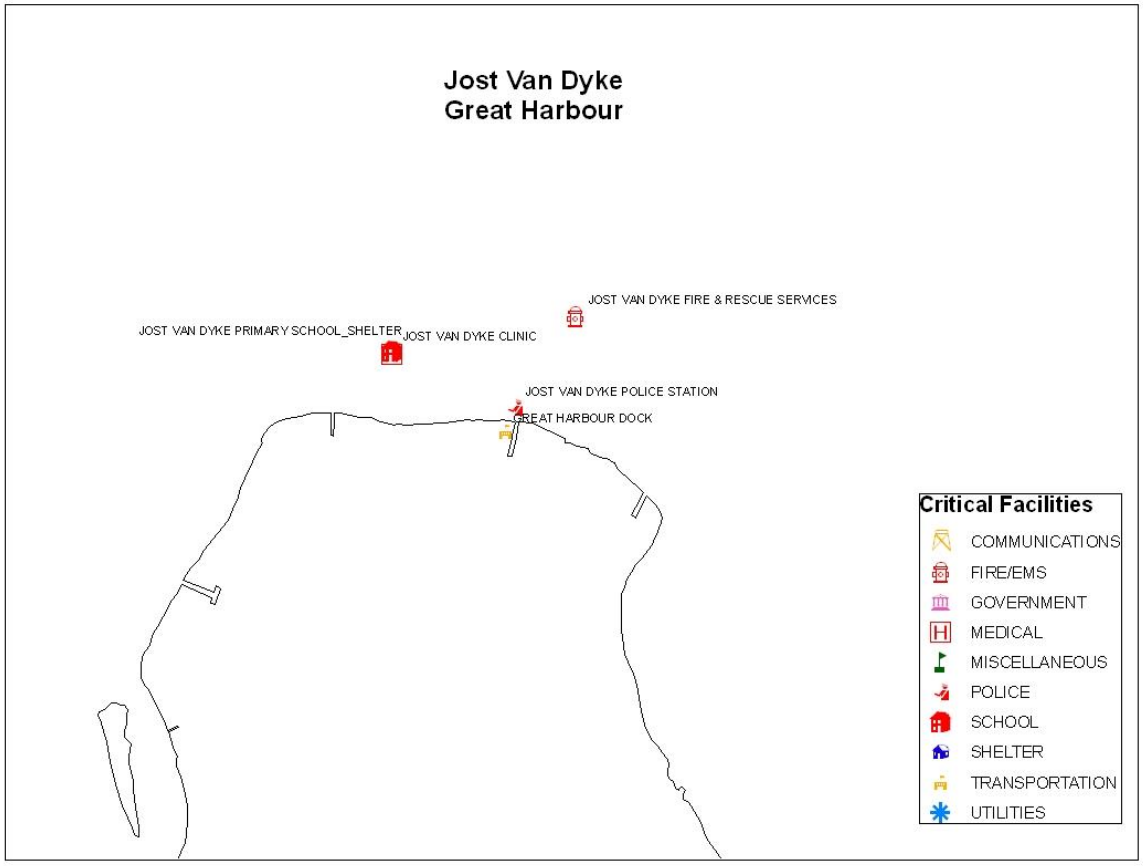


Figure E4. Location of critical infrastructure on Jost Van Dyke. The few critical facilities are located in the coastal zone vulnerable to storm surge and sea level rise. *(Source Department of Disaster Management).*

Appendix F | Summary of Environmental Laws Relevant to Climate Change Adaptation & Mitigation

Title of Statue	Objective	Limits (as information from prior reviews was available)	Responsible Agency
The Beach Protection Ordinance 1985	Prohibits the removal of natural sea barriers, beach sand or any other removal that is likely to result in shoreline erosion. This Act also applies to the fouling of the foreshore.	-Exceptions can be made at the Minister's discretion upon application in writing for a permit. -Fails to prohibit destructive activities that can adversely affect the coastal zone such as the removal of vegetation -Lacking management systems - Provides no authority to close the beach for the purposes of preserving any element of the environment.	Conservation and Fisheries Department
Wild Birds Protection Act 1959	This ordinance provides protection for approximately 31 species of rare or endangered wild birds, their eggs, nests, and young, except as authorised by the Governor for the purposes of bona fide research, at any time and under any conditions. Environmentally significant is the power to designate bird sanctuaries (S. 11) and the prohibition of certain activities within the sanctuary (20 sanctuaries already designated). Enforcement is by the Police Force and any others so designated by the Governor.	-Needs updating reflect current bird population	Conservation and Fisheries Department
The Turtles Ordinance, (1986) and the Turtles Act (1992) (CAP. 87)	In 1992, the Turtle Ordinance was replaced with the Turtles Act (1992). The Act protects Leatherback, Green and Hawksbill Turtles (those with a shell length greater than 24 inches) and their eggs at all time. The capture of turtles is		Conservation and Fisheries Department

Title of Statue	Objective	Limits (as information from prior reviews was available)	Responsible Agency
	prohibited on onshore areas and 100 yards thereof at all times.		
Virgin Islands National Parks Act 2006	This Act is the most recent and far-reaching of the legislative instruments dealing directly with protected areas, and repeals the National Parks Ordinance (Cap. 243) and the Marine Parks and Protected Areas Ordinance (Cap. 85). It introduces provisions for the management of historical sites by the National Parks Trust, provides guidance on management planning, and specifically requires the preparation of a protected areas system plan (Section 13(1).		National Parks Trust
Fisheries Act No. 4 of 1997	To protect and preserve the fishing industry and to monitor and control the use and harvesting of fish, the location where and the manner in which fish are caught as well as the vessels and equipment used in fishing. Provisions give authority for licensing and associated fees. The Minister is also given authority to declare any area a fishing priority area or a protected area and penalties attach for anyone not respecting these designations.		Conservation and Fisheries Department
Protection of Trees and Conservation of Soil and Water Act, (Cap 86) 1954	S. 3 provides for the declaration by Order of any tree to be a protected tree or any area to be a protected area, forestry area or water area. Areas can be protected for purposes of preservation and protection of trees, prevention of soil erosion and interference with agricultural land as well as the maintenance of water supply, prevention of silting and avoidance of water pollution. There is great opportunity to protect threatened or endangered trees in the Territory such as the century tree and mangroves.	Protection of a tree or area depends mainly on the results of public enquiry.	Agricultural Department
Endangered	Local enabling legislation for the	-Lists coral but needs to be	Conservation

Title of Statue	Objective	Limits (as information from prior reviews was available)	Responsible Agency
Animals and Plants Act 1987	Convention on International Trade of Endangered Species (CITES)— stipulates what animals and plants are classified as endangered and how these species are to be managed. The Act stipulates penalties with respect to removal or unauthorised treatment of endangered animals.	updated with a list of Caribbean species needing protection	and Fisheries Department
Plant Protection Act, (Cap 93) 1941	The Act gives general control over the importation and exportation of and general dealing with plants (defined) and by-products. In particular, it aims to prevent, eliminate or minimise the entry, existence or effect of pests or diseases into the environment and where needed, to stipulate quarantine areas.		Agricultural Department, Customs Department
Agricultural and Small Holdings Act (Cap. 83) 1939	This Act applies to contracts of tenancy for agricultural purposes in regards to properties ranging from ¼ acre to not more than 25 acres. It also aims to protect rules of good husbandry, conservation of soil, maintenance of fertility and preservation of the capital value of the holding.		Agricultural Department
British Virgin Islands Ports Authority Act 1990	The Act is generally directed to the safe use and management of waterways and harbours. It addresses the mooring, docking or moving of vessels and how to deal with wrecks.		Virgin Islands Ports Authority
Importation Prohibition (Epidemic Diseases) Act (Cap 179) 1903	The aim of this legislation is to prevent diseases from being brought into the country. By this Act, Health authorities may require visitors from certain countries to be screened before being allowed to enter into the Territory without infringing.	It may also be useful to include insects in the provisions.	Environmental Health, Public Health
Infections Diseases Notification Act (Cap 180) 1990	The legislation requires all persons suffering or suspected to be suffering from an infectious disease to be reported to the proper authorities.	The penalties for failing to so report are negligible. Additional provisions addressing quarantine and the establishment of an infectious	Environmental Health, Public Health

Title of Statue	Objective	Limits (as information from prior reviews was available)	Responsible Agency
		disease ward/clinic should be introduced. It would also be prudent to address the treatment of persons at ports of entry suspected to be suffering from or to have been exposed to infectious diseases.	
Public Health Act, (Cap 194) 1977	There are broad regulation making powers in relation to: the control and destruction of termites, mosquitoes and other insects, rodents or vermin; sewers;		Public Health Department
Water Supply Act 1956	The Governor is given authority to declare any area within the Territory a water supply area and to appoint superintendents of any such area.		Water and Sewerage Department
Buildings Ordinance (Cap 234) 1955	Control and monitors the erection and removal of buildings on land, including building standards. It also addresses sanitary arrangements and water storage facilities. The Act can be extended to the establishment of a zoning system.		Building Authority
Virgin Islands Physical Planning Act 2004 (note: Regulations from Land Development Control Act 1969 still in effect until new regulations developed)	Makes the provisions for the orderly and progressive development of land and to preserve and improve amenities. Requires environmental impact assessment (EIA) with application for major developments or developments in the coastal zone	-Requires the EIA unless Authority otherwise determines but does not state what conditions may apply -Building set backs from coastline not sufficient -Does not sufficiently address building in floodplains -more oriented towards regulating the use and development of land rather than for overall physical development	Town and Country Planning Department
Land Acquisition Act (Cap 222) 1957	This legislation authorises the Governor in Council to acquire land for public purpose. It provides for the procedure and compensation for so doing along with appeal provisions.		

Title of Statue	Objective	Limits (as information from prior reviews was available)	Responsible Agency
Wickhams Cay Development Authority Act 1975	This legislation establishes the Wickhams Cay Development Authority to promote and manage the Development of Wickham s Cay. The authority is given all necessary powers to effect the development and management of the Wickham s Cay area. (note: Wickham's Cay is the main financial and administrative district of the country)	The Wickhams Cay projects involved reclaiming and development of land. There does not appear to be any contemplation of the environmental impact of such a project.	Wickhams Cay Development Authority
Disaster Management Act 2003	An Act to provide for the more effective organisation of the mitigation of, preparedness for, response to and recovery from, emergencies and disasters in The Virgin Islands and other matters connected therewith.		Department of Disaster Management
Tourist Board Ordinance 1968	Provides the institutional framework for the development, promotion and management of tourism within The Virgin Islands. Implies obligations to protect and enhance the environment of The Virgin Islands as a tourist amenity	-Does not grant the Board authority to protect the coastal zone.	Office of the Premier, Tourist Board
British Virgin Islands Electricity Corporation Ordinance 1979	Establishes the BVI Electricity Corporation and rules for its governance and the production of power.	Does not allow businesses or individuals to use alternative energy as a primary energy source.	BVI Electricity Corporation

Source: (Orion Consultancy Services Ltd. & Samuels Richardson and Co. Ltd., 2004; Gore 2007)

Appendix G | Departments / Agencies Relevant to Climate Change Mitigation

DEPARTMENT/ AGENCY	Role and Functions Relevant to Climate Change
National Disaster Management Council	Ensure policy making for disaster management. The Chairperson of is the Governor and Deputy is the Premier.
Department of Disaster Management, Governor's Office	Seeks to reduce loss of life and property attributable to disasters by ensuring that adequate preparedness and mitigation measures, and response and recovery mechanisms are established to counteract the impact of natural and technological hazards. Functions: development application review; hazard, vulnerability, and capacity assessments; public education
Office of the Premier	for setting tourism development policies and management plans, encouraging and overseeing major tourism investment projects
Town and Country Planning Department, Office of the Premier	Ensuring proper land use and spatial development of the territory through integrated land use planning, development control, geographic information management, and public education. Functions: advice on development ideas and planning issues; processing development applications; monitoring and controlling development activities; preparing development studies; preparing and reviewing civic planning projects; compiling statistical data on development; and producing maps of data.
Planning Authority, (Associated Agency) Office of the Premier	Reviewing and deciding on physical development applications
Virgin Islands Tourist Board, (Statutory Body) Office of the Premier	Responsible for developing and maintaining a high standard of tourism product and marketing the tourism product.
Ministry of Natural Resources and Labour (MNRL)	National Climate Change Focal Point Responsible for effective promoting, managing, protecting, and sustaining the Natural Resources (environment, land, sea, and labour) of The Virgin Islands.

DEPARTMENT/ AGENCY	Role and Functions Relevant to Climate Change
	Functions: Process crown land requests, agricultural lands requests, fishing licenses, and reclamation requests. Declaration and acquisition of Marine and Terrestrial Parks, Enacting legislation, Implementing international environmental agreements
Conservation and Fisheries Department, MNRL	Responsible for all aspects of Natural Resources Management. Functions: environmental planning and monitoring, development application review, coastal resources management, oil spill response, fisheries management, environmental education, environmental surveillance and enforcement, environmental law and policy development
Virgin Islands Fishing Complex, MNRL	Responsible for encouraging the development of the fisheries industry in The Virgin Islands by acting as a centralised seafood hub designed to: operate shore facilities; handle and process a wide range of quality seafood; provide chilled and freezer storage; sell seafood products and related services; be a fishermen's supply outlet; provide ice-making capabilities; market its products via sub-depots for collection; distribution and transport on both land and sea.
National Parks Trust, (Statutory Body) MNRL	Responsible for preserving and managing designated natural and cultural areas in order to improve the quality of life in The Virgin Islands. Functions: environmental monitoring within National Parks, education, maintaining buoys etc.
Department of Agriculture, MNRL	Responsible for providing and managing cost effective information technology, resources and services to support the development of the agricultural sector. Functions: advising on wise farming practices; water and soil conservation; reforestation
Ministry of Health and Social Development	Serves as the focal point for leadership, legislation and policy direction in all operations relating to health and social welfare. The Ministry also promotes the physical, mental and social health of all persons in the Territory.
Environmental Health Division, Ministry of Health and Social Development	Responsible for ensuring that all aspects of the environment with the potential to negatively impact health are managed efficiently to enable persons in The Virgin Islands to attain and maintain optimal health and social well-being. Functions: vector control and monitoring, water quality surveillance
Building Authority (Associated Agency), Ministry of Communications and Works	Reviewing physical developments for structural integrity and compliance with the Building Regulations, 1999.
Public Works Department, Ministry of Communications and Works	Responsible for planning and maintaining critical public infrastructure, esp. the road and drainage infrastructure.

DEPARTMENT/ AGENCY	Role and Functions Relevant to Climate Change
Water and Sewerage Department, Ministry of Communication and Works	Responsible for ensuring the delivery of a continuous supply of safe potable water and an environmentally sound sewerage disposal service to all residents of The Virgin Islands, efficiently and at affordable rates.
Virgin Islands Ports Authority, (Statutory Board) Ministry of Communications and Works)	Maintenance and management of port facilities
Virgin Islands Airports Authority (Associated Agency), Ministry of Communications and Works	Maintenance and management of airport facilities
Ministry of Finance	Serves as the focal point for leadership and policy direction relating to fiscal and economic growth and development.
Financial Services Commission, Ministry of Finance	Responsible for the regulation of all financial services activities conducted in and from within the BVI, including banking and fiduciary business, investment business, insolvency services, insurance business, company management, company registration, and intellectual property.
Development Planning Unit, Ministry of Finance	Responsible providing a range of statistical information, economic analysis and recommendations to the Government to facilitate informed decision-making, planning and policy formulation for the overall strategic development of The Virgin Islands. Function: assist in the development of National Integrated Development Plans
Department of Education and Culture, Ministry of Education and Culture	Responsible for the provision of educational services and the promotion and preservation of cultural heritage.

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