



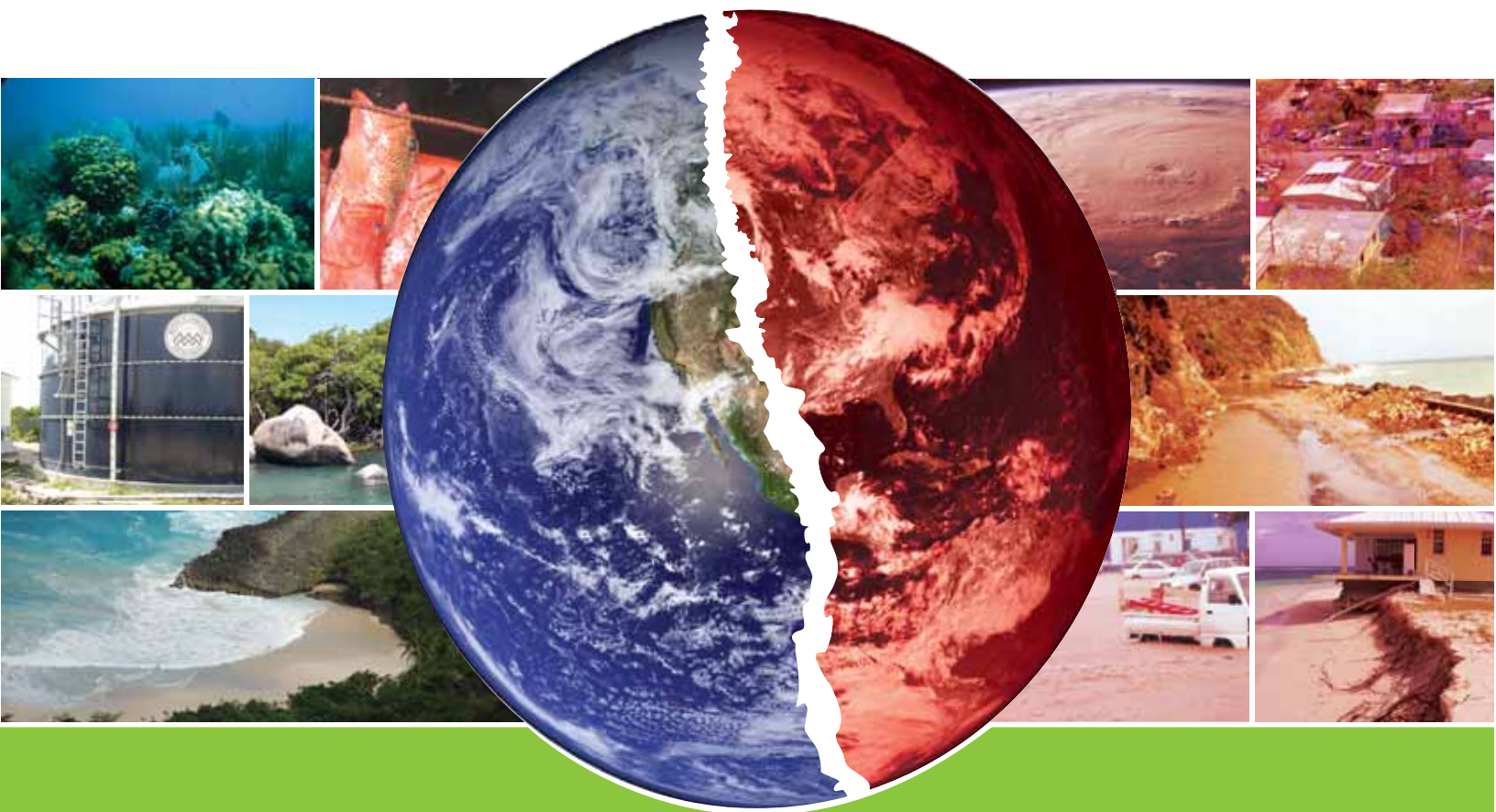
# THE VIRGIN ISLANDS Climate Change GREENPAPER

July 2010

## A SNAPSHOT

Conservation and Fisheries Department,  
Ministry of Natural Resources and Labour

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**Technical Report 5C/ECACC-10-7-1**

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Published by Caribbean Community Climate Change Centre, Belmopan, Belize

Digital Edition (September 2011)

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ISBN-13 978-976-8236-42-5 (pdf)

# Foreword



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, cannot 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 cannot 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.

A handwritten signature in black ink, appearing to read 'Omar W. Hodge'.

## Acknowledgements

The Conservation and Fisheries Department would like to thank all those Ministries, Departments and Statutory Bodies that reviewed and commented on various sections of the full 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, Town and Country Planning Department, and Water and Sewerage Department. The Department is also grateful to the Caribbean Community Climate Change Centre (CCCCC), Belize for the initial guidance provided in the preparation of this document.

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# The Green Paper – Purpose and Origins

Climate change affects us all and takes an informed citizenry to react. *The Virgin Islands Climate Change Green Paper* and this “Snapshot” version have been produced to help the general public, stakeholders in affected sectors and policy makers learn more about the emerging issue of climate change, its projected impacts locally, our vulnerabilities, adaptation options and our 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.



Participants at the first Public Climate Change Stakeholder Consultation, January 2009

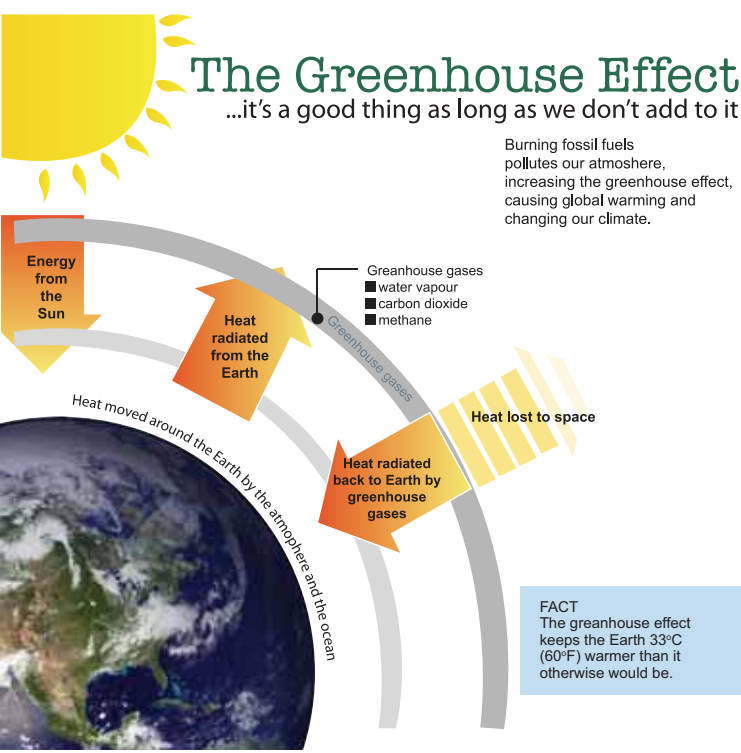


Get your copy of the full *Virgin Islands Climate Change Green Paper* at the Conservation and Fisheries Department located in the Quastisky Building, Road Town, Tortola (1-284-494-3429 / [cfd@gov.vg](mailto:cfd@gov.vg)).

## Climate Change – What Is It?

In basic terms, climate change is exactly what it sounds like - a significant change in the Earth's climate, the long term average weather conditions for given regions [1].

Climate change has been described by many as the defining challenge of our time. 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 changes in other fundamental aspects of our climate [2, 3, 4].

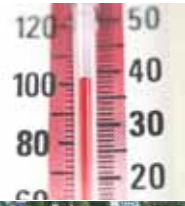


The science on climate change is clear. In their 2007 Synthesis Report, the Intergovernmental Panel on Climate Change states, “warming of the climate system is unequivocal” [1]. Human activities related to the use of fossil fuels and deforestation are causing a rapid and excess build-up of carbon dioxide and other “greenhouse gases” in our atmosphere. These “greenhouse 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* [4].



# Climate Change in the Caribbean

Imagine a Caribbean with:



## Rising temperatures

1°C - 5°C (1.8°F – 9°F) warmer by the 2080s relative to 1961-1990 average temperatures, under the Medium High Emissions Scenario [5];



## Changing rainfall patterns

**Up to 25% drier by the 2080s** under the Medium High Emissions scenario, accompanied by a change in rainfall patterns such that **more, heavier rain events and floods are likely** [5];



## Stronger, more persistent and devastating hurricanes

A greater likelihood of category 4 and 5 hurricanes [6].



## Rising sea level

Sea level 0.19 – 0.58 meters (0.6 – 1.9 feet) higher by 2100 as a result of warmer ocean temperatures and melting polar glaciers [6].

# Climate Changes Happening Now

- January 2000 to December 2009 was the warmest decade on record globally [7].

- The percentage of very warm days in the Caribbean has increased considerably since the 1950s, while the percentage cool days has decreased [5].

- Many Caribbean islands are experiencing generally drier conditions, but more episodes of heavier rain events resulting in flooding [5]. The frequency of droughts has “increased significantly” since 1960 and flood events have increased since the mid 1990s [5]. From October 2009 to at least May 2010, the majority of Caribbean islands experienced severe drought, the worst ever seen in many cases [8].



Photo credit: Growingourrown.wordpress.com

- In the Caribbean basin there has been an increase in hurricane activity since 1995 compared to the 1981-2000 baseline [5, 6].

- The average global sea level has been rising steadily at an average rate of 1.8mm/yr since 1961 and at an increased rate of 3.1mm/yr since 1993 [1].

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 recognised by the United Nations Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change [3, 6, 9].

A diagram illustrating the relationship between four key factors. At the center is a globe with a vertical crack down the middle. The left half of the globe is blue and represents Earth, while the right half is red and represents fire. Overlaid on the globe is the text "Climate Change". Surrounding the globe are three large, stylized arrows pointing outwards. The top-left arrow is blue and points towards the word "Society". The top-right arrow is green and points towards the word "Economy". The bottom arrow is black and points towards the word "Environment".

We depend on climate & climate impacts us.  
Change my climate, you change my life!

# Climate Change Impacts in The Virgin Islands

Climate change has impacts across virtually all aspects of the environment, economy and society. It is, therefore, everyone's business and a cause for concern and action at every level.

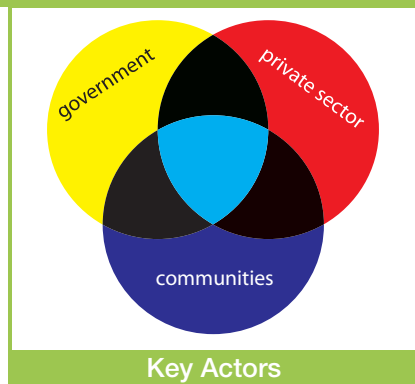
IMPACT AREAS	POTENTIAL AND EXISTING CLIMATE CHANGE IMPACTS
BEACH & SHORELINE STABILITY	<ul style="list-style-type: none"> <li>✓ Increase in beach erosion and shrinkage [3, 4, 5].</li> <li>✓ Shorelines retreating and more vulnerable to flooding [3, 4, 5, 6].</li> </ul>
COASTAL & MARINE ECOSYSTEMS	<ul style="list-style-type: none"> <li>✓ Coral reefs experiencing increased bleaching, structural damage, disease and death [3, 4, 7, 8].</li> <li>✓ Landward migration or inundation of mangroves and increased mortality [4, 6, 9].</li> <li>✓ Decreased growth of seagrass beds and increased stress and mortality [4, 8].</li> </ul>
CRITICAL INFRASTRUCTURE	<ul style="list-style-type: none"> <li>✓ Road network, critical facilities, utilities, developable lands and the sewerage system (especially coastal) at greater risk of damage [3, 6, 10, 11, 12].</li> </ul>
HUMAN SETTLEMENTS	<ul style="list-style-type: none"> <li>✓ Homes and developable lands (especially those in the coastal zone) at greater risk of damage [3, 6, 10].</li> </ul>
ENERGY SECURITY	<ul style="list-style-type: none"> <li>✓ Energy generation and distribution system at greater risk of damage [11].</li> <li>✓ Increase in energy costs. Increase in energy use for cooling [13, 14].</li> </ul>
FOOD SECURITY: AGRICULTURE	<ul style="list-style-type: none"> <li>✓ Decrease in agricultural yield (or increased costs of production) due to decrease in rainwater.</li> <li>✓ Increase in agricultural pests, weeds, diseases and invasive species [3, 16].</li> <li>✓ Decrease in agricultural produce (or increase in cost). Less rainwater for agriculture [2, 3, 17].</li> <li>✓ Soil degradation, resulting in reduced yield [3, 18, 19].</li> <li>✓ Increase in crop damage and disruption of production cycles [3, 18].</li> <li>✓ Increased stress to livestock, resulting in decreased productivity [18].</li> <li>✓ Changes in imported food availability, cost, and quality [6, 18, 20].</li> </ul>
FOOD SECURITY: FISHERIES	<ul style="list-style-type: none"> <li>✓ Loss of critical fish habitat and changes in plankton food resources [3, 6, 8, 21].</li> <li>✓ Migration of some fish species to cooler waters [3, 8, 14].</li> <li>✓ Potential changes in spawning opportunities and rates of mortality and disease [18].</li> <li>✓ Increase in opportunities for establishment of marine invasive species [22].</li> <li>✓ Increased damage to landing sites, on-shore facilities, boats and equipment [18].</li> </ul>
FORESTRY & BIODIVERSITY	<ul style="list-style-type: none"> <li>✓ Decline in health and abundance of marine resources [3, 4, 6, 8].</li> <li>✓ Decline in turtle nesting activity and creation of long-term reproduction issues [5, 23].</li> <li>✓ Shrinking upland forests and reduction of associated biodiversity [3, 6].</li> <li>✓ Disruption of bird migration and reproduction patterns. Increased mortality [6].</li> <li>✓ Increase in opportunities for establishment of invasive species [6].</li> </ul>



<b>HUMAN HEALTH</b>	<ul style="list-style-type: none"> <li>✓ Increase in dengue fever outbreaks (frequency and severity) [3, 24, 25].</li> <li>✓ Increase in prevalence of ciguatera (fish poisoning) [3, 6].</li> <li>✓ Increase in respiratory diseases, such as asthma [3, 26, 27].</li> <li>✓ Increase in risk of diarrhea and other environmentally transmitted illnesses [3].</li> <li>✓ Increased potential for heat stress [3].</li> <li>✓ Increase in risk of damage to health care facilities [11].</li> <li>✓ Greater threat of epidemics and pandemics [28].</li> </ul>
<b>INSURANCE &amp; BANKING</b>	<ul style="list-style-type: none"> <li>✓ Increased insurance rates, potentially leading to uninsurance/under-insurance [4, 26, 29, 30].</li> <li>✓ Increase in interest rates and difficulty in obtaining construction loans.</li> </ul>
<b>TOURISM</b>	<ul style="list-style-type: none"> <li>✓ Loss of, or more costly damage to, tourism infrastructure and properties [31].</li> <li>✓ Diminished natural attractions, e.g. coral reefs, beaches, and wildlife, resulting in reduced demand by tourists [6, 15, 31, 32].</li> <li>✓ Rising overheads in energy, water, and insurance [15].</li> <li>✓ Deterrents to travelers, e.g. warmer winters, less comfortable and stable VI climate, higher airfares, and increased dengue fever outbreaks [15, 32, 33].</li> <li>✓ More tourists seeking carbon neutral or energy efficient destinations [15, 34].</li> </ul>
<b>WATER RESOURCES &amp; HYDROLOGICAL CHARACTERISTICS</b>	<ul style="list-style-type: none"> <li>✓ Increase in likelihood of flood events [2, 3].</li> <li>✓ Decreased availability of rainwater leading to greater dependency on the public water supply system and an increased threat of water shortages in emergencies [2, 3, 18].</li> <li>✓ Increase in cost of desalinated water [35].</li> </ul>

## Our Capacity to Respond

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.



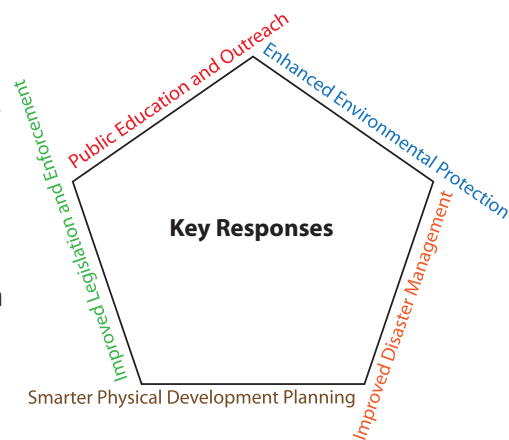
Climate change *adaptation* refers to any action to minimise or adjust to the local impacts (as described above) of climate change [42]. While there is some overlap, it is distinct from climate change *mitigation* which

refers to efforts to tackle the cause of climate change, that is, efforts to reduce the amount of “greenhouse gases” in our atmosphere [43].

Adapting to climate change will require all ministries of Government, statutory bodies, the private sector and communities to work together on an ongoing basis.

The Government’s ability to respond to climate change is restricted by a number of factors, including

limited finances and technical expertise. Effective climate change adaptation will call for significant improvements in environmental management, physical development planning and disaster management, including enhanced legislation and enforcement. The basis of these improvements must be a more informed citizenry; for this reason a public education and outreach strategy has been developed.



# Towards an Adaptation Strategy

Many institutions, a body of legislation, policies and programmes already exist that 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 [44].

The full cost of climate change adaptation is still being assessed for the Caribbean. What is known, however, is that climate change impacts will be extremely costly and that it is more cost-effective to adapt than to accept losses. Analysis from the Caribbean has shown that reconstruction costs can be as much as 40% of the original investment [44]. 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 [37]. It is also well established that adaptation measures should be taken as early as possible to minimise associated costs and maximise effectiveness [44].

## Key existing management plans, policies, and processes:

- 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 process)
- Disaster Mitigation and Development Planning Framework (2002)
- National Disaster Plan (2009)

## Key management gaps:

- A comprehensive Coastal Zone Management Plan
- Specific management plans for beaches
- 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)

# Climate Change Adaptation Options

This section 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, and 1 yellow stars have been identified by stakeholders as first, second, and third tier priorities for action, respectively. 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).



1st tier priority



2nd tier priority



3rd tier priority

Preferred action (PA)

Acceptable alternative (AA)

Last resort action (LRA)

# 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 result in too significant a loss.

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. (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 (through incentives, ideas) “soft” versus “hard” developments along beaches/vulnerable shorelines. (PA)
- Increase protection and restoration of shallow coastal reefs that act as coastal defences. (PA)
- Strongly protect all remaining significant mangrove forests. (PA)



Photo credit: Department of Disaster Management

- 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)

Photo credit: Wilbert Chambers, Conservation and Fisheries Department



Rogues Bay - Before “Big Swell Event” March 2008

Photo credit: Shannon Gore, Conservation and Fisheries Department



After



# 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 a permit system for the regrading of roads and land clearing, restrict vegetation clearing to the construction footprint and require timely landscaping, improve capture/reuse of stormwater. (PA)
- Decrease marine nutrient pollution - improve sewage management at land and sea through construction of tertiary treatment systems and pump-out stations.



Photo credit: Shannon Gore, Conservation and Fisheries Department

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. (AA)
- Use low-voltage electrical current to stimulate coral reef re-growth (AA).

Landward migration or inundation of mangroves. Increase in mortality from stronger hurricanes.

- Strongly protect all remaining significant mangrove forests. (PA)
- Expand and enhance mangrove reforestation programme. (PA)
- Land use planning to allow room for landward migration of significant mangrove forests. (PA)
- Shelter young mangroves from storm surges by protecting natural coral reefs and, where suitable, constructing artificial reefs in priority areas. (PA)



Photo credit: Shannon Gore, Conservation and Fisheries Department

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.



Photo credit: Department of Disaster Management

- 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 serious reforestation programme to reduce stormwater runoff and erosion. (PA)
- Reinforce undermined roads and improve road cutting techniques. (PA)
- Continue to build safe alternative road network through interior of the islands. (PA)
- Avoid building new roads in areas vulnerable to stronger storm surges and sea level rise. (PA)
- Invest in “soft” measures (e.g. mangroves) to protect existing vulnerable roads. (PA)
- If necessary invest in ‘hard’ engineering structures (e.g. sea walls) to help protect existing vulnerable critical roads. (LRA)
- 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 critical facilities at risk to

sea level rise and stronger storm surges. (PA)

- Invest in “soft” measures (e.g. mangroves) to protect existing vulnerable facilities. (PA)
- Where feasible, establish “no build areas” for critical facilities in highly vulnerable areas. (PA)
- If “no build area” is unfeasible, require 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)



Photo credit: Conservation and Fisheries Department

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)





# 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 in human settlements, 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 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 evacuation and recovery plans. (PA)
- Encourage homeowners to purchase adequate flood insurance. (PA)
- Improve management of and increase 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.



Photo credit: Department of Disaster Management

- 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 hurricanes. (PA)
- Enhance community hurricane preparedness, including evacuation and recovery plans. (PA)
- Improve management of and increase the Disaster Relief Fund. (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.

Photo credit: Department of Disaster Management



- Improve drainage around the main electricity generation plant at Pockwood Pond. (PA)
- Ensure existing and new energy facilities are “climate-proof.”(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 or flooded by 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)

Photo credit: Department of Disaster Management





# 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 concentration of carbon dioxide (CO<sub>2</sub>), 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. (PA)
- Depend more heavily on agriculture in controlled environments (e.g. greenhouses, poultry units, small stock units, feedlots and dairy units).



Photo credit: Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, United States

- Introduce more pest resistant crop varieties (while keeping traditionally resistant varieties). (AA)

Soil degradation from saltwater intrusion and soil erosion/leaching, resulting in decreased yields.



Photo credit: Government Information Services

- Encourage best management practices for erosion control. (PA)
- Start serious reforestation programme. (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.

Photo credit: Department of Disaster Management



- 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, 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)
- Enhance local weather monitoring and modeling to provide early flood warning systems. (PA)

## Changes in imported food availability, cost, and quality.

- Work towards greater agricultural self-sufficiency through investment, use of traditional best practices, new technologies, and capacity building. (PA)



Photo credit: Government Information Services



Photo credit: Government Information Services

# 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. (PA)
- 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. ★★☆☆



Photo credit: Shannon Gore, Conservation and Fisheries Department

- 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 key marine species in the Caribbean basin. (PA)

## Degradation of turtle nesting habitat (sandy beaches) and creation of unbalanced sex ratios.

- 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. (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 serious reforestation programme. (PA)
- Develop bird watching trails and lookouts as a key tourist attraction. (PA)



Photo credit: Andrew McGowan, Darwin Initiative - Anegada

## Bird migration and reproduction patterns disrupted. Increased mortality.

- Enhance protection of bird stopover habitats such as salt ponds and mangroves. (PA)
- Reduce populations of 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 conditions. (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)



Photo credit: [www.webonaute.net](http://www.webonaute.net)

## 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.



Photo credit: Getty Images

- 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 risk 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 coping strategies. (PA)
- Incorporate “green” design into buildings to maximise natural light and ventilation. (PA)
- Install backup air conditioning units in critical public buildings, especially those for children, the 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 health care 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 and planning. (PA)
- Enhance emergency response of health care system in natural disasters and epidemics. (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)
- Work towards enhanced insurance coverage of critical tourism infrastructure and properties. (PA)
- Enhance industry hurricane preparedness and resilience, including through evacuation and recovery plans. (PA)
- Increase setback and elevation requirements for coastal tourism infrastructure/facilities. (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 and over the ocean. (PA)
- Where feasible, in highly vulnerable areas, establish “no build areas” for critical tourism infrastructure and properties. (PA)
- Invest in “soft” measures (e.g. mangroves) to protect existing vulnerable tourism infrastructure and properties. (PA)
- If necessary, and where appropriate, invest in ‘hard’ engineering structures (e.g. sea walls) to help protect existing vulnerable tourism infrastructure and properties. (LRA)

Photo credit: Department of Disaster Management



Photo credit: Department of Disaster Management

Diminished natural tourist attractions, e.g. coral reefs, beaches and wildlife. ★★★

- Enhance protection of natural tourist attractions and supporting ecosystems as described above under relevant sections. (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-proof” structures. (PA)
- 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. (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 in tourism properties. (PA)
- Participate in green certification programmes for the tourism sector, such as Green Globe.





# INSURANCE & BANKING

- 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.

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 areas of the United States 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)



Photo credit: Legis



Photo credit: Wilbert Chambers, Conservation and Fisheries Department

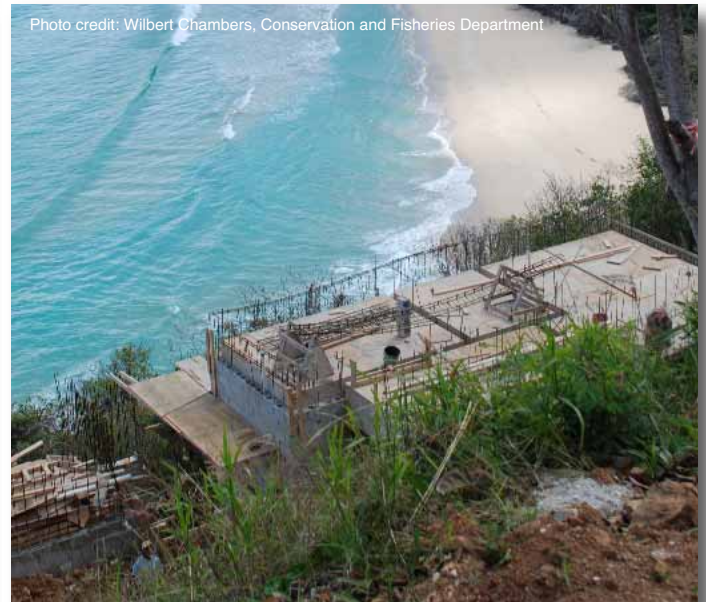


Photo credit: Wilbert Chambers, Conservation and Fisheries Department



Photo credit: British Virgin Islands Social Security Board



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# 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 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,



Photo credit: Department of Disaster Management

- including evacuation and recovery plans. (PA)
- Encourage homeowners and businesses to purchase adequate flood insurance. (PA)

## Decreased 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 the 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 strict water conservation and efficiency programmes. (PA)
- Invest in the capture, basic treatment and reuse of stormwater for specific purposes. (PA)
- Plan for the expansion of desalination production capacity to meet projected water demand. (PA)

## Increased cost of desalinated water.



Photo credit: Water and Sewerage Department

- Increase competition in the bidding process to produce desalinated water. (PA)
- Explore possibility of using solar-powered desalination technology. (PA)
- Reduce per capita demand for desalinated water. (PA)



# CONCLUSIONS

## The Problem

Climate change refers to the significant long-term change in our weather conditions. Climate change is often referred to as global warming because it is rooted in the steady increase in average air and ocean temperatures. As the climate system is extremely complex and interlinked, warmer temperatures are triggering other important changes, including stronger hurricanes, rainfall extremes – that is, a greater chance of drought and flood events, and sea level rise. These physical changes then create 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 our way of life. The Virgin Islands has a number of inherent characteristics that make it vulnerable to climate change impacts.

## The Response

While the impacts of climate change are diverse and costly they are also manageable, in most cases through the 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 is most cost-effective and, of course, minimises impacts [45].

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. In other cases, adaptation requires diversification to maximise traditionally under-tapped resources that may be impacted less by changes in climate.

## Opportunities

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 behaviors 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 [44]. 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.



# REFERENCES

- [1] Pachauri, R.K., Reisinger, A. & Core Writing Team (Eds.). (2007). Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland: IPCC.
- [2] Caribbean Natural Resources Institute (CANARI). (2008). Climate change: A brief overview of the science, policy, and you. United Kingdom: Joint Nature Conservation Committee (JNCC).
- [3] Caribbean Natural Resources Institute (CANARI). (2008). Climate change in the Caribbean: the case for greater investment in research and adaptive policies. CANARI Policy Brief No. 10: 4pp.
- [4] UNFCCC. Feeling the Heat: The greenhouse effect and the carbon cycle. Retrieved May 18, 2010 from [http://unfccc.int/essential\\_background/feeling\\_the\\_heat/items/2918.php](http://unfccc.int/essential_background/feeling_the_heat/items/2918.php)
- [5] Taylor, M. A., Centella, A., Charley, J., Borrajero, I., Bezanilla, A., Campbell, J., et al. (2007). Glimpses of the future: A briefing from the PRECIS Caribbean Climate Change Project. Belmopan, Belize: Caribbean Communication Climate Change Centre.
- [6] Mimura, N., Nurse, L., McLean, R., Agard, J., Briguglio, L., Lefale, P. et al. (2007). Small islands. In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden P.J., & Hanson, C.E. (Eds.), Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (pp 687-716). Cambridge, UK: Cambridge University Press.
- [7] NASA (2010, January 22). Last decade was warmest on record, 2009 one of warmest years, NASA research finds. ScienceDaily. Retrieved March 21, 2010, from <http://www.sciencedaily.com/~releases/2010/01/100121170717.htm>
- [8] BBC (2010, February, 18). Caribbean battles drought. BBC Caribbean. Retrieved March 17, 2010 from [http://www.bbc.co.uk/caribbean/news/story/2010/02/100218\\_drought.shtml](http://www.bbc.co.uk/caribbean/news/story/2010/02/100218_drought.shtml)
- [9] UNFCCC. (2007). Vulnerability and Adaptation to Climate Change in Small Island Developing States: Background paper for the expert meeting on adaptation for small island developing States. Retrieved May 18, 2010 from [http://unfccc.int/files/adaptation/adverse\\_effects\\_and\\_response\\_measures\\_art\\_48/application/pdf/200702\\_sids\\_adaptation\\_bg.pdf](http://unfccc.int/files/adaptation/adverse_effects_and_response_measures_art_48/application/pdf/200702_sids_adaptation_bg.pdf)
- [10] Nicholls, R.J., Wong, P.P., Burkett, V.R., Codignotto, J.O., Hay, J.E., McLean, R.F. et al. (2007). Coastal systems and low-lying areas. In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden P.J., & Hanson, C.E. (Eds.), Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. (pp 315-356). Cambridge, UK: Cambridge University Press.
- [11] Fish, M.R., Cote, I.M., Gill, J.A., Jones, A.P., Renshoff, S., & Watkinson, A.R. (2005, April). Predicting the impact of sea-level rise on Caribbean sea turtle nesting habitat. Conservation Biology, 19 (2): 482-491.
- [12] Petit J. & Prudent G. (2008, July). Climate change and biodiversity in the European Union Overseas Entities: Pre-conference version. Brussels: IUCN.
- [13] Wilkinson, C., & Souter, D. (Eds.). (2008). Status of Caribbean coral reefs after bleaching and hurricanes in 2005. Townsville, Australia: Global Coral Reef Monitoring Network & Reef and Rainforest Research Centre.
- [14] Johnson J.E., & Marshall P.A. (Eds.). (2007). Climate change and the Great Barrier Reef: A vulnerability assessment. Townsville Australia: Great Barrier Reef Marine Park Authority and the Australian Greenhouse Office, Department of the Environment and Water Resources.
- [15] Imbert D. (2002). Impact des ouragans sur la structure et la dynamique forestières dans les mangroves des Antilles. Bois et Forêts des Tropiques 273: 69-78.
- [16] Joyce, J. (2003). The David Jones Tropical Wave 2003, Impact Of The November 10-14, 2003 Rains On Hill Slopes, Embankments, Rock Cuts And Ghuts In The British Virgin Islands. The Virgin Islands: Department of Disaster Management.
- [17] Virella Crespo, J.C., & Young, S. (2005, December). Quantitative Risk Assessment Project (QRAP) Phase II for Public Buildings and Shelters of the British Virgin Islands. The Virgin Islands: Department of Disaster Management.
- [18] Boland, A. Former Deputy Sewerage Operations and Development Officer, Water and Sewerage Department, Government of the Virgin Islands. Personal communication, January 28, 2010.
- [19] Wilbanks, T.J., Bhatt, V., Bilello, D.E., Bull, S.E., Ekmann, J., Horak, W.C., et al (Eds). (2007). Effects of climate change on energy production and use in the United States. A report by the U.S. Climate Change Science Program and the subcommittee on Global Change Research. Washington, DC: Department of Energy, Office of Biological & Environmental Research.
- [20] Dr. Trotz, U. (2009, January 19). Climate change: A threat to future sustainable development in the Caribbean. PowerPoint presentation to The Virgin Islands Climate Change Public Consultation Workshop on behalf of the Caribbean Community Climate Change Centre.
- [21] University of the West Indies (UWI) Centre for Resource Management and Environmental Studies. (2008). Draft strategy – National tourism sector adaptation strategy to address climate change in Barbados. Barbados: Author.
- [22] Backlund, P., Janetos, A., Schimel, D., Hatfield, K. Boote, P., Fay, L., et al. (2008). The effects of climate change on agriculture, land resources, water resources, and biodiversity

in the United States: Final Report, Synthesis and Assessment Product 4.3. A Report by The U.S. Climate Change Science Program and the Subcommittee on Global Change Research. Washington, DC: U.S. Department of Agriculture.

[23] Rivero Vega, R.E. (2009, March). Food Security and Climate Change in the Caribbean. Presentation at the Review of the Economics of Climate Change in the Caribbean High Level Advisory Committee meeting, Bridgetown, Barbados.

[24] St. Lucia Ministry of Physical Development, Environment, and Housing. (2005). Report on national symposium on climate change and food production in St. Lucia. St. Lucia: Author.

[25] Easterling, W.E., P.K. Aggarwal, P. Batima, K.M. Brander, L. Erda, S.M. Howden, et al. (2007). Food, fibre and forest products. In Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden P.J., & Hanson, C.E. (Eds.), *Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 273-313). Cambridge, UK: Cambridge University Press.

[26] World Food Programme. (2008, June). Virtual Press Room: High food prices. Retrieved October 1, 2009 from <http://www.wfp.org/stories/virtual-press-room-high-food-prices>

[27] Hays, G.C., Richardson, A.J., & Robinson, C. (2005). Climate change and marine plankton. *TRENDS in Ecology and Evolution* 20 (6): 337-344.

[28] IUCN. (n.d). About marine invasive species. Retrieved September 29, 2009 from [http://www.iucn.org/about/work/programmes/marine/marine\\_our\\_work/marine\\_invasives/seychelles/about\\_marine\\_invasive\\_species/#](http://www.iucn.org/about/work/programmes/marine/marine_our_work/marine_invasives/seychelles/about_marine_invasive_species/#)

[29] Lovich, J.E. (n.d.). Turtles and global climate change. Retrieved October 1, 2009 from <http://geochange.er.usgs.gov/sw/impacts/biology/turtles/>

[30] PAHO. (2008). 2008: Number of reported cases of Dengue and Dengue Hemorrhagic Fever (DHF), region of the Americas (by country and subregion). Retrieved June 20, 2009, from <http://www.ops-oms.org/English/AD/DPC/CD/dengue-cases-2008.htm>

[31] PAHO. (2009). Number of Reported Cases of Dengue and Dengue Hemorrhagic Fever (DHF) in the Americas, by Country: Figures for 2009 (to week noted by each country). Retrieved March 27, 2010, from [http://new.paho.org/hq/index.php?option=com\\_content&task=view&id=719&Itemid=1119](http://new.paho.org/hq/index.php?option=com_content&task=view&id=719&Itemid=1119)

[32] Epstein, P.R. & Mills, E. (Eds.). (2005). *Climate change futures: Health, ecological, and economic dimensions*. Boston: The Center for Health and the Global Environmental, Harvard Medical School.

[33] Gyan, K., Henry, W., Lacaille, S., Laloo, A., Lamsee-Ebanks, C., McKay, S., et al. (2005). African dust clouds are associated with increased paediatric asthma accident and emergency admissions on the Caribbean island of Trinidad. *International Journal of Biometeorology* 49 (6): 371 -376.

[34] Wildlife Conservation Society (2008, October). 'Deadly Dozen' reports diseases worsened by climate change. *Science Daily*. Retrieved October 1, 2009, from <http://www.sciencedaily.com/releases/2008/10/081007073928.htm>

[35] Motavalli, J. (2004). *Feeling the heat: Dispatches from the front lines of climate change*. New York, NY: Routledge.

[36] d'Auvergne, C., James, A., & Barrow, D. (2001). St. Lucia country paper on national climate change issues. St. Lucia: Ministry of Planning Development Housing & Environment, Water Resources Management Unit, and St. Lucia National Communications Project.

[37] Margaree Consultants. (2002, July). Assessment of the economic impact of climate change on CARICOM countries. Toronto: The World Bank.

[38] Uyarra, M.C., Cote, I.M., Gill, J.A., Tinch, R.R.T., Viner, D., Watkinson, A.R. (2005). Island-specific preferences of tourists for environmental features: implications of climate change for tourism-dependent states. *Environmental Conservation* 32 (1): 11-19.

[39] Shriner, D.S. & Street, R.B. (Eds.). (2000). North America. In Watson, R.T., Zinyowera, M.C., Moss, R.H., & Dokken D.J.(Eds.), *IPCC special report on the regional impacts of climate change: An assessment of vulnerability*. Retrieved September 30, 2009, from [http://www.grida.no/publications/other/ipcc\\_sr/?src=/climate/ipcc/regional/index.htm](http://www.grida.no/publications/other/ipcc_sr/?src=/climate/ipcc/regional/index.htm)

[40] Chafe, Z. (2004). *Consumer demand and operator support for socially and environmentally responsible tourism*. Washington, DC: Center on Ecotourism and Sustainable Development (CESD) and the International Ecotourism Society (TIES).

[41] Campbell, C.J. (2001). The oil peak: A turning point. *Solar Today*, 15(4).

[42] UNFCCC. (2009, September). Fact sheet: The need for adaptation. Retrieved May 18, 2010 from [http://unfccc.int/press/fact\\_sheets/items/4985.php](http://unfccc.int/press/fact_sheets/items/4985.php)

[43] UNFCCC. (2009, September). Fact sheet: The need for mitigation. Retrieved May 18, 2010 from [http://unfccc.int/press/fact\\_sheets/items/4985.php](http://unfccc.int/press/fact_sheets/items/4985.php)

[44] Caribbean Natural Resources Institute (CANARI). (2008). *Climate change: An overview for politicians and senior decision makers*. United Kingdom: Joint Nature Conservation Committee (JNCC).

[45] Stern, N. (2007). *The Economics of Climate Change: The Stern Review*. United Kingdom: Cambridge University Press.



# Climate Change

The Virgin Islands in a nutshell



## Increasing average air and sea surface temperatures

by 1.8°F – 9°F by the 2080s relative to 1961-1990 average temperatures, under the Medium-High Emissions Scenario

Negative impacts to human health, agriculture, coral reefs, biodiversity, and tourism



## Sea level rise

of between 0.6 ft – 1.9 ft by 2100 relative to 1980 – 1999 levels

Negative impacts to low-lying coastal villages, agricultural lands, critical facilities and transport systems, as well as to beaches, sea turtles, and mangroves



## Decrease in total amount of rainfall

up to 25% drier by the 2080s

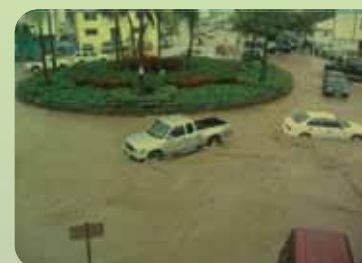
Negative impacts to freshwater supply and agriculture



## Increase in the frequency of heavy rain events and landslides

scientific community uncertain to what degree

Damage to critical facilities, transport and communication systems, and homes



## Stronger hurricanes

peak rainfall rates are likely to increase by 25% and maximum wind intensities by 5% - 10% by around 2050, resulting in higher storm surges

Damage to critical facilities, transport and communication systems, homes, agriculture, coral reefs, beaches, tourism, and the financial sector.

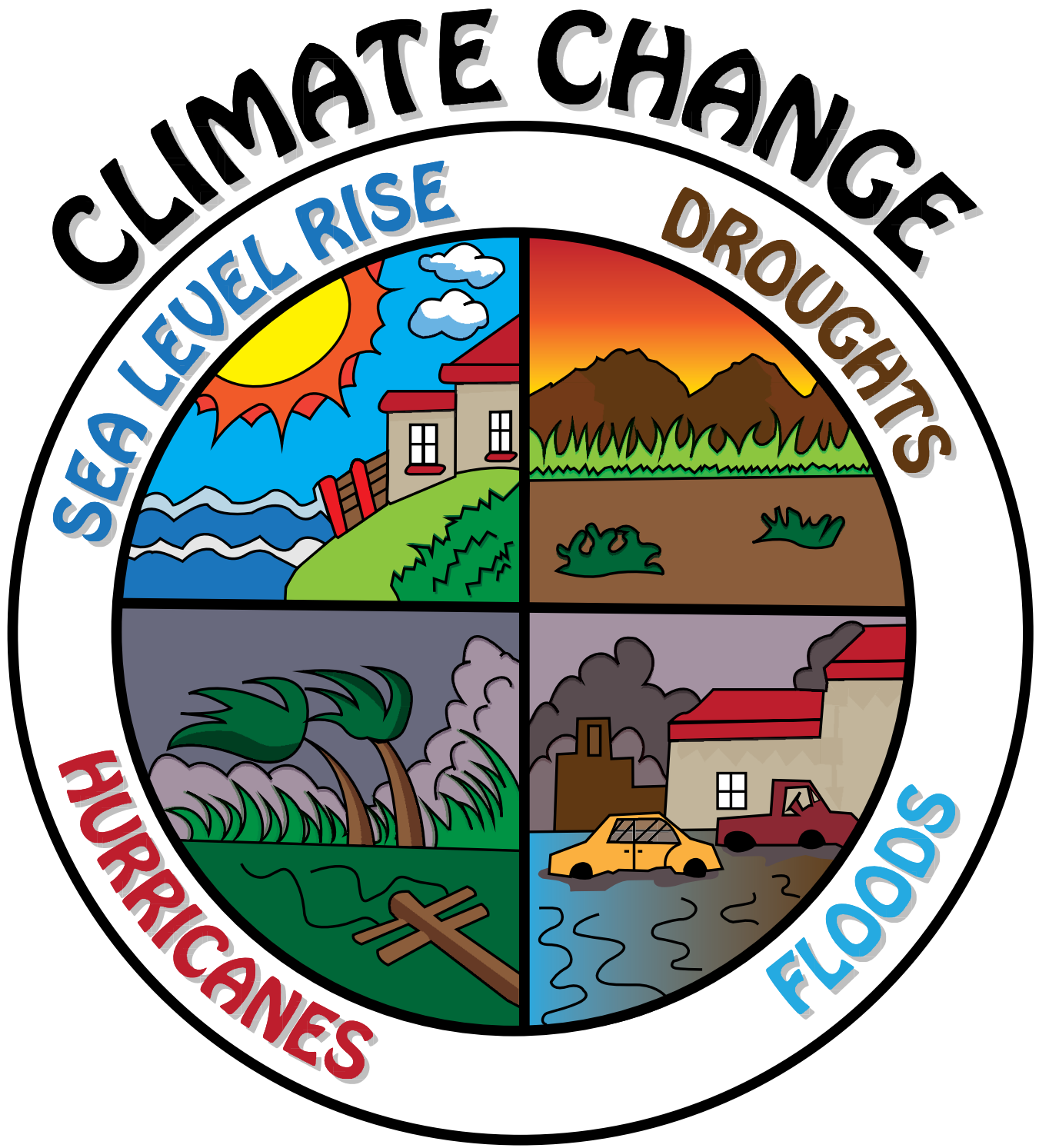


Information Sources: Intergovernmental Panel on Climate Change, Caribbean Community Climate Change Centre

## You are part of the solution!

Learn more at [www.bvidef.org](http://www.bvidef.org) and [www.bviddm.com](http://www.bviddm.com)





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**The Virgin Islands Climate Change Logo**



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