COMMONWEALTH OF DOMINICA

Category 5 Hurricane Maria strikes Dominica on 21st September 2017 resulting in 65 fatalities and US$1.37 billion in damage

Third National Communication to the United Nations Framework Convention on Climate Change






THIRD NATIONAL COMMUNICATION TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE OF THE COMMONWEALTH OF DOMINICA

20th March 2020

Environmental Coordinating Unit
Ministry of Environment, Rural Modernisation and Kalinago Upliftment
37 Great George Street
Roseau, Commonwealth of Dominica
Tel: (767) 266 5256
TelL/Fax: (767) 448 4577
Email: ecu@dominica.gov.dm

I. FOREWORD

On behalf of the Government of the Commonwealth of Dominica, I wish to present Dominica's Third National Communication (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC). As a Signatory of the UNFCCC, Dominica considers the publication of this report not only as a demonstration of ongoing efforts to meet our obligations under Article 12 of the Convention, but to also to showcase the domestic policies and actions that are being undertaken to tackle the causes and impacts of Climate Change.

This TNC report has come about after much hard work by Dominica experts who together have presented in the document the most comprehensive outlook of climate change for Dominica and our efforts to addressing its causes and impacts. It should be noted that during the preparation of the TNC, Dominica was most severely devastated by the impacts of Tropical Storm Erika in August 2015 and Category 5 Hurricane Maria which struck our country on 18th September, 2017. The successful preparation and conclusion of the report despite the enormous setbacks of Erika and Maria is yet another milestone in our effort to make Climate Change central to our socio-economic transformational agenda and to position Dominica as the First Climate Resilient Country in the World.

Accompanying this TNC is an annex entitled *Dominica's Climate Change Policy and Action Plan* which was developed by the National Climate Change Committee as a key output of the TNC process. This document, which is to shortly to be finalized through a public consultation process and thereafter to be presented to Cabinet for approval, represents a revision of Dominica's *Climate Change Adaptation Policy* of 2001 as well as an update to Dominica's *Low Carbon Climate Resilient Development Strategy* of 2012 to accommodate progress in climate change programming since these policies were approved by Cabinet and to define national priorities that recognize lessons learned as a result of Erika and Maria.

At the Policy Level, a *Climate Change, Environment and Natural Resource Management Bill* will soon be introduced in Parliament. The Bill has undergone several reviews and will provide a strategic framework for focusing the nation's effort and resources in meeting the challenges of Climate Change and sustainable development.

I conclude by underscoring Dominica's determination to building the First Climate Resilient Country in the World at the same time as pursuing an economic development agenda that is able to situate us as a Model for Sustainable Development for Small Island Developing States. Dominica is poised to pursue comprehensive domestic climate change risk management measures while continuing to partner with the International Community to implement the *Paris Agreement* and to mobilize strategic support for a multi-lateral approach aimed at addressing the causes and impacts of Climate Change.

It gives me pleasure to present Dominica's Third National Communication to Conference of the Parties (COP) of the UNFCCC.

Honourable Cozier Frederick
Minister for Environment,
Rural Modernisation and Kalinago Upliftment

II. ACKNOWLEDGEMENTS

The Ministry of Environment, Climate Resilience, Disaster Management and Urban Renewal wishes to acknowledge individuals, agencies and organizations for their efforts towards the completion of Dominica's Third National Communications (TNC).

Appreciation must go first and foremost to the leadership and staff of the Environmental Coordinating Unit, particularly to Ambassador Lloyd Pascal (Director) in his capacity as Project Manager. Appreciation is also extended to the project team, namely:

- Mr. George de Berdt Romilly, International Consultant and Technical Adviser (Vulnerability and Adaptation Assessment);
- Dr. Spencer Thomas, Regional Consultant, Economist;
- Mr. Craig Stedman, National Consultant(Greenhouse Gas Emissions and Inventory);
- Mr. Bernard Nation, National Consultant (GHG Inventory - Carbon Sequestration);
- Mr. Nigel Lawrence, National Consultant (National Circumstances and Mainstreaming);
- Mr. Adenauer Douglas, National Consultant (Mitigation Mainttreaming);
- Ms. Kimisha Thomas, Project Coordinator (2014-2016).

Sincere appreciation is also extended to the members of the National Climate Change Committee which served as the Project Steering Committee, the Permanent Secretary and Staff of the former Ministry of Health and Environment, other government agencies and institutions, other stakeholders and the media who participated in the consultations and made valuable contributions towards the development of the Third National Communications.

Sincere thanks are extended to Mr. Anthony Cyrille of the Livestock Department of the Ministry of Agriculture, Mr. Ronald Charles of the Forestry Department of the Ministry of Agriculture, Mr. Delroy Williams of the Extension Unit of Ministry of Agriculture, and the Lands and Survey Department for their corporation and willingness to gather and share required information.

Special thanks to the UNEP/GEF for providing the funding, guidelines and support for the project.

TABLE OF CONTENTS

ANNEXES

* * *

III. LIST OF TABLES

IV. LIST OF FIGURES

V. LIST OF ACRONYMS

ACCC	–	Adaptation to Climate Change in the Caribbean (project)
AF	-	Adaptation Fund
AFD	-	Agence Francaise de Developpement
ADP	-	Durban Platform for Enhanced Action
ALBA	-	Bolivarian Alliance for the Peoples of Our America (Trade Agreement) (Spanish: Alianza Bolivariana para los Pueblos de Nuestra América)
AMI	-	Advanced Metering Infrastructure
AOSIS	-	Alliance of Small Island States
BAU	-	Business as Usual
BBB	-	Build Back Better (principles)
BUR	-	Biennial Update Report
C	-	Celsius (degrees)
CARICOM	-	Caribbean Common Market
CCCCC	-	Caribbean Community Climate Change Center
CCM	-	Climate Change Mitigation
CCRIF	-	Caribbean Catastrophe Risk Insurance Facility
CCTF	-	Climate Change Trust Fund
CDB	-	Caribbean Development Bank
CDEMA	-	Caribbean Disaster Emergency Management Agency
CEC	-	Certificate of Environmental Clearance
CECCD	-	Council for Environment, Climate Change and Development
CERF	-	Central Emergency Response Fund
CFL	-	Compact Fluorescent Lightbulb
CH_4	-	Methane
CIF	-	Climate Investment Funds
CIMH	-	Caribbean Institute for Meteorology and Hydrology
CGIAR	-	Consortium for Spatial Information

CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
COP	-	Conference of Parties
CPACC	-	Caribbean Planning for Adaptation to Climate Change (project)
CREAD	-	Climate Resilience Executing Agency of Dominica
CSEP	-	Caribbean Sustainable Energy Project
CSO	-	Central Statistical Office
CUAHSI	-	Consortium of Universities for the Advancement of Hydrologic Science, Inc.
DASPA	-	Dominica Air and Sea Port Authority
DECCD	-	Department of Environment, Climate Change and Development
DG	-	Diesel Generation
DOAM	-	Dominica Organic Agriculture Movement
DOC	-	Degradable Organic Carbon
DOMEX	-	The DOMinica EXperiment
DOMLEC	-	Dominica Electricity Company Ltd.
DOWASCO	-	Dominica Water and Sewage Company
DMS	-	Dominica Meteorological Service.
DRM	-	Disaster Risk Management
DSWM	-	Dominica Solid Waste Management
DSWMC	-	Dominica Solid Waste Management Corporation
DVRP	-	Disaster Vulnerability Reduction Project
EC$	-	Eastern Caribbean Dollars
ECU	-	Environment Coordinating Unit
EDA	-	Enhanced Direct Access
EE	-	Energy Efficiency
EEO	-	Environmental Enforcement Officer
EIA	-	Environment Impact Assessment
ERDMP	-	Emergency Recovery and Disaster Management Program

ESA	-	Electricity Supply Act
F	-	Fahrenheit (degrees)
FAO	-	Food and Agricultural Organization
FAO STAT	-	Food and Agriculture Organization Statistical Database
FOD	-	First Order Decay
GCCA	-	Global Climate Change Alliance (project)
GCF	-	Green Climate Fund
GDP	-	Gross Domestic Product
GE	-	Geothermal Energy
GEF	-	Global Environment Facility
GHG	-	Greenhouse Gases
Ggs	-	Gigagrams
GoCD	-	Government of the Commonwealth of Dominica
GSPS	-	Growth and Social Protection Strategy
GTZ	-	Gesellschaft für Technische Zusammenarbeit (German federally owned international cooperation enterprise)
HIS	-	Hydrologic Information System
HIV	-	Human Immunodeficiency Virus
HFC	-	Hydrofluorocarbons
HPS	-	High Pressure Sodium (light bulbs)
HS Codes	-	Harmonized Item Description and Coding System
IBRD	-	International Bank for Reconstruction and Development (World Bank)
IDA	-	International Development Association
IDB	-	Inter-American Development Bank
IMF	-	International Monetary Fund
INC	-	Initial National Communications
INDC	-	Intended Nationally Determined Contribution
IPCC	-	Intergovernmental Panel on Climate Change

IPP	-	Independent Power Producer
IRC	-	Independent Regulatory Commission
IRE	-	Intermittent Renewable Energy
IRENA	-	International Renewable Energy Agency
IRP	-	Integrated Resource Plan
ISIC	-	International Standard Industrial Classification (of all economic activities)
IT	-	Information Technology
KAP	-	Knowledge Attitudes and Practices
Kg	-	Kilogram
Km	-	Kilometers
kWh	-	Kilowatt hours
LAC	-	Latin America and the Caribbean
LCCRDS	-	Low Carbon Climate Resilient Development Strategy (2012-2020)
LCDP	-	Low Carbon Development Path (project)
LED	-	Light-emitting Diode
LEED	-	Leadership in Energy and Environmental Design
LPG	-	Liquefied Petroleum Gas
LULUCF	-	Land Use, Land Use Change and Forestry
m	-	Meters
mm	-	Millimetres
MACC	-	Mainstreaming Adaptation to Climate Change in the Caribbean (project)
M&E	-	Monitoring and Evaluation
MDB	-	Multilateral Development Bank
MDNP	-	Morne Diablotin National Park
MEA	-	Multilateral Environmental Agreement
MoHE	-	Ministry of Health and Environment
MRV	-	Monitoring, Reporting and Verification
MW	-	Megawatts

NAP	-	National Adaptation Plan
NBSAP	-	National Biodiversity and Action Plan
NCSA	-	National Capacity Self Assessment
NDA	-	National Designated Authority
NDP	-	National Disaster Plan
NEP	-	National Energy Policy
NEPO	-	National Emergency Planning Organization
NGO	-	Non Governmental Organization
NH_3	-	Ammonia
NIE	-	National Implementing Entity
NMVOC	-	Non - Methane Volatile Organic Compounds
NOAA	-	National Oceanic and Atmospheric Administration of the United States Department of Commerce
NOx	-	Nitrogen Oxides
NRDS	-	National Resilient Development Strategy
NSEP	-	National Sustainable Energy Plan
N_20	-	Nitrous Oxide
ODA	-	Overseas Development Assistance
ODM	-	Office of Disaster Management
OECS	-	Organization of Eastern Caribbean States
OM	-	Operations Manual
PA	-	Protected Area
PCU	-	Project Coordination Unit
PDNA	-	Post Disaster Needs Assessment
PEO	-	Public Education and Outreach
P-E	-	Precipitation vs Elevation
PPCR	-	Pilot Program for Climate Resilience
PPP	-	Public Private Partnership

PSIP	-	Public Sector Investment Program
PV	-	Photovoltaic
REDD+	-	Reducing Emissions from Deforestation and Forest Degradation
RE	-	Renewable Energy
RETs	-	Renewable Energy Technologies
RMS	-	Risk Management Solutions, Inc.
SAP	-	Simplified Approved Process
SCF	-	Strategic Climate Fund
SDGs	-	Sustainable Development Goals
SEF	-	Sustainable Energy Facility
SIDS	-	Small Island Developing States
SLCPs	-	Short-Lived Climate Pollutants
SLM	-	Sustainable Land Management (programme)
SNC	-	Second National Communication
SOC	-	Soil Organic Carbon
SO_2	-	Sulphur Dioxide
SPACC	-	Special Program on Adaptation to Climate Change
SPCR	-	Strategic Program for Climate Resilience
SRTM	-	Shuttle Radar Topography Mission
SSE	-	Supporting Sustainable Ecosystem (project)
SSMR	-	Soufriere Scotts Head Marine Reserve
STEM	-	Science, Technology, Engineering and Mathematics (programs)
SUV	-	Sport Utility Vehicle
SWDS	-	Solid Waste Disposal Sites
TA	-	Technical Assistance
TAR	-	Third Assessment Report
T&D	-	Transmission and Distribution (system)
TCO_2e	-	Tonnes of Carbon Dioxide Equivalents

TDS	-	Total Dissolved Solids
TNC	-	Third National Communications
TWG	-	Technical Working Group
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environment Programme
UNESCO	-	United Nations Education, Scientific Cultural Organization
UNFCCC	-	United Nations Framework Convention on Climate Change
UNGA	-	United Nations General Assembly
USCRN	-	United States of America Climate Reference Network
US EPA	-	Environmental Protection Agency of the Unites States of America
US$	-	United States Dollars
VAT	-	Value Added Tax
WB	-	World Bank
WMO	-	World Meteorological Organization

* * *

EXECUTIVE SUMMARY

Introduction

1. The Commonwealth of Dominica ratified the *United Nations Framework Convention on Climate Change* (UNFCCC) in 1994, in recognition of the importance of climate change as a major environmental phenomenon with serious ramifications for all nations especially resource poor developing countries and small islands developing states (SIDS) of which Dominica is a member.

2. In fulfilment of one of the obligations under Article 12 of the UNFCCC, Dominica committed to the production of regular National Communications to the Conference of Parties (COP) through the UNFCCC Secretariat. The first such report, the *Initial National Communication* (INC) was submitted in 2001. The preparation of Dominica's *Second National Communication* (SNC) commenced in 2006 and was submitted in 2012. The SNC reported on the period from 2001 to 2005.

3. This *Third National Communication* reports on the period from 2005 until the end of 2017, and includes an assessment of greenhouse gas (GHG) emissions during this time, together with an update concerning activities that have been undertaken to reduce Dominica's carbon footprint while building climate resilience, in part though measures to implement *Dominica's Low Carbon Climate Resilient Development Strategy* including though building the legal and institutional capacity to manage impacts from climate change.

4. This *Third National Communication* report has been prepared with financial support from the Global Environment Facility (GEF) under the Umbrella Programme for National Communication to the UNFCCC that was approved in 2013.

5. During the preparation of this report, Dominica was struck by two extreme events which severely tested the countries adaptation preparedness and climate resilience readiness. Tropical Storm Erika struck Dominica on the 27th August 2015 resulting in heavy rainfall, flooding, and landslides. Hundreds of homes were left uninhabitable and thousands of people were displaced all told, 30 people died across the island in the nation's worst disaster since Hurricane David. Tropical Storm Erika resulted in total damage and loss of EC$1.3 billion (US$483 million), equivalent to approximately 90% of Dominica's Gross Domestic Product (GDP). Hurricane Maria made landfall in Dominica on the 18th September 2017 as a Category 5 hurricane with maximum sustained winds of 165 mph (265 km/h) - the most extreme to ever impact the island. The hurricane inflicted extensive damage to roads and public buildings, including schools, stores and churches, and affected all of Dominica's 71,000 residents in some form. Hurricane Maria resulted in 30 fatalities confirmed across the island with more than 50 reported missing. Hurricane Maria accounted for damage to the tune of 226% of GDP which amounted to a 14.7% decline in GDP.

6. The impact of these two events has been devastating to Dominica's economy, resulting in a 9.5 percent decline in GDP for 2017. In June 2016, total public debt stood at $1.1-billion, consisting of external debt of $776.4 million and domestic debt of $278.9 million, and national debt to GDP ratio stood at 72 percent, although this is a marked improvement from the situation in 2003 when national debts was 130% of GDP. Tropical Storm Erika and Hurricane Maria have compelled the Government to increase borrowing in order to finance recovery measures.

Country Background

7. Dominica is located at 15 degrees North and 61 degrees West, occupying a central position in the eastern Caribbean archipelago. The island is approximately 750.6 square kilometers (290 square miles) and is the largest in the Windward and Leeward groups of the Eastern Caribbean. Dominica is part of a group of 47 countries and territories that have been classified by the United Nations (UN) as Small Island Developing States (SIDS) that face a specific set of challenges and are especially highly vulnerable to the effects and impacts of climate change.

8. Dominica is volcanic in origin and is characterized by very rugged and steep terrain with approximately ninety miles of coastline. A chain of mountains extends from the islands center to the south and the topography is characterized by a number of ridges and steep river valleys with gently sloping lands being restricted to narrow coastal strips, particularly in the center and northeast of the island. Dominica has rich volcanic soil and is well served by over 365 streams and rivers. Dominica has a forest area of 45 000 hectares – constituting more than half of the island's 75 000 hectare over all land area. Dominica's rich biodiversity accounts for 48% of local food supply which comes in the form of wild meat, fish (from the rivers and sea), fruits, root crops and the wide range of domestic agriculture products.

9. Population estimates for 2011 indicate that Dominica had a population of approximately 71,293 persons (a decline from 74,750 in 1994), including two thousand Kalinago, the remaining survivors of the first inhabitants of the island. The total population comprises 36,411 males and 34,882 females The total population also represented a net decrease of 434 or a slight 0.6 percent decline over the 2001 head count and a fall below the 2010 mid -year population estimate of 72,72. After the devastation caused by Hurricane Maria in September 2017, an estimated 20,000 persons left Dominica to seek education and employment in neighbouring countries.

10. With gross domestic product (GDP) standing at US$517 million (2014 - IMF estimates), the Dominica economy reflects many of the traditional features of a small open economy. This includes a high level of dependence on external trade as a proportion of GDP, dependence on single sector export products (in this case agriculture) and tourism revenue, high levels of underemployment and unemployment, and dependence on foreign capital (both public and private sector) for investment into productive sectors and for infrastructural development. Over the past 10 years, economic growth in Dominica

averaged approximately 3.7% per annum, dropping to 1.5% by 2015 before suffering further decline after Tropical Storm Erika (2015) and Hurricane Maria (2017) resulting in a 9.5 percent decline in GDP for 2017.

11. Despite high human development – the 2014 United Nations Development Program Human Development Index ranked Dominica as 93 of 187 countries – poverty remains a pervasive development issue. According to the latest Country Poverty Assessment (2008-2009), 28.8 percent of the population lives below the locally defined poverty line (falling from 39 percent in 2003), 3.1 percent of the population was deemed to be indigent (declining from 10 percent in 2003) and 11.5 percent was deemed vulnerable.

12. Dominica has no petroleum resources, and energy required to sustain development in the country is imported. Annual import costs for energy continue to rise and are currently EC$116.65 million (US$43.39 million) representing 11.92% of GDP (2014 – World Bank estimates). Electricity constitutes the primary source of commercial energy for industrial and other uses in Dominica. The country presently (2017) has an installed capacity of 26.74 megawatts (MW) consisting of 6.64MW (28.5%) of hydropower and 20.1 MW of diesel powered units. High electricity costs (the highest in the Caribbean) constitute a real obstacle for numerous sectors, with the direct and indirect consequence of curtailing growth and parallel activities linked to the country's sustainable development

13. A limited amount of solar and wind energy is used in Dominica, mainly at the residential and commercial levels for both water heating and electricity production. Dominica's *Low Carbon Climate Resilient Development Strategy*, *National Energy Policy* (draft) (2014), *Sustainable Energy Plan* (draft) (2014), and *Intended Nationally Determined Contributions* (INDC) (September 2015) establish indicative targets for renewable energy in Dominica.

14. Dominica is vulnerable to numerous natural disasters arising from meteorological events (high wind, excess rainfall and hurricanes) and geophysical events (earthquake, volcano and tsunami). These recurrent events have significantly harmed both the population's socioeconomic well-being and the country's general economic and fiscal stability. Particularly damaging are events associated with excessive or prolonged rainfall, which provokes flooding and landslide activity.

15. Dominica has established a strong track record on climate change adaptation and mitigation, and many policy documents have been developed and/or approved by the Cabinet of Ministers that are specific to climate change or that incorporate or specifically mention climate change (see table below).

Year	Policy Document
2015	Dominica *Intended Nationally Determined Contribution* (INDC)
2014	Draft *Climate Change, Environment and Natural Resources Management Bill*
2012	Dominica ***Low Carbon Climate Resilient Development Strategy***
2012	Dominica ***Strategic Program for Climate Resilience*** (SPCR)
2012	Growth and Social Protection Strategy
2010	*Montreal Protocol (Substances that Deplete the Ozone Layer) Regulations*, 2010
2010	National Strategy for Health
2010	Sector Strategy, Natural Resources and Energy Sector Plan
2010	Tourism Policy 2010
2010	Draft Environmental & Planning Regulations for Renewable Energy
2010	Draft *Geothermal Development Bill*
2010	*National Energy Policy* (Draft)
2010	*National Integration Water Resources Management Policy* (Draft)
2009	*Dominica Forestry Policy*
2009	***Disaster Management Plan***
2009	*National Emergency Management Policy*
2009	*National Shelter Policy*
2007	National Policy for the Agriculture – Environment (Agri – Eco) System, 2007 – 2025,
2006	Growth and Social Protection Strategy
2005	National Biosafety Framework
2005	Draft National Implementation Plan on Persistent Organic Pollutants
2004	*National Environment Policy/National Environment Management Strategy*
2002	Dominica's ***Policy on Planning for Adaptation to Climate Change***
2002	*National Biodiversity Strategy and Action Plan*
1998	Plan to reduce the vulnerability of school buildings to Natural Disasters

16. In 2012, Cabinet approval was obtained to commence the consultation process to develop and draft comprehensive Climate Change, Environment and Natural Resource Management

Legislation for Dominica in collaboration with the Office of the Attorney General. This new legislation is expected to establish key legal and institutional frameworks needed to effectively implement Dominica's *Low-Carbon Climate Resilient Development Strategy*. Government expects to enact this new legislation by the end of 2019.

Greenhouse Gas (GHG) Inventory

17. A summary of GHG emissions and removal of GHGs by category for 2017 is provided in the table below.

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 eq removals	CH_4	N_2O	CO	NOx	NMVOCs	SOx
Total national emissions and removals	**444.158**	**-3,261.148 ****	**2.687**	**0.907**	**-491.704**	**0.019**	**0.86**	**X**
1. Energy	156.20	X	X	X	X	X	X	X
A. Fuel combustion (sectoral approach)	156.20	X	X	X	X	X	X	X
1. Energy industries	46.86	X	X	X	X	X	X	X
2. Manufacturing industries and construction	4.08	X	X	X	X	X	X	X
3. Transport	67.17	X	X	X	X	X	X	X
4. Other sectors	38.09	X	X	X	X	X	X	X
5. Other	X	X	X	X	X	X	X	X
B. Fugitive emissions from fuels	X	X	X	X	X	X	X	X
1. Solid fuels	X	X	X	X	X	X	X	X
2. Oil and natural gas	X	X	X	X	X	X	X	X
2. Industrial processes	X	X	X	X	X	X	**0.46**	X
A. Mineral products	X	X	X	X	X	X	X	X
B. Chemical industry	X	X	X	X	X	X	X	X
C. Metal production	X	X	X	X	X	X	X	X
D. Other production	X	X	X	X	X	X	X	X
E. Production of halocarbons and sulphur hexafluoride	X	X	X	X	X	X	X	X
F. Consumption of halocarbons and sulphur hexafluoride	X	X	X	X	X	X	X	X
G. Other	X	X	X	X	X	X	0.46	X

3. Solvent and other product use	**0.08**	X	X	X	X	X	**0.4**	X
A. Paints	0.08	X	X	X	X	X	0.4	X
4. Agriculture	**286.00**	**-497.504**	**0.962**	**0.002**	**X**	**X**	**X**	**X**
A. Enteric fermentation	X	X	0.936	X	X	X	X	X
B. Manure management	X	X	0.026	0.0023	X	X	X	X
C. Rice cultivation	X	X	X	X	X	X	X	X
D. Agricultural soils	286.00	-497.504	X	X	X	X	X	X
E. Prescribed burning of savannahs	X	X	X	X	X	X	X	X
F. Field burning of agricultural residues	X	X	X	X	X	X	X	X
5. Land-use change and forestry	**1.298**	**-2763.644**	**0.194**	**0.900**	**-491.704**	**0.019**	X	X
A. Changes in forest and other woody biomass stocks	0.649	-2760.45	X	0.630	2.60	0.019	X	X
B. Forest and grassland conversion	X	X	X	X	X	X	X	X
C. Abandonment of managed lands	X	X	X	X	X	X	X	X
D. CO_2 emissions and removals from soil	X		0.16	X	X	X	X	X
E. Other (Grasslands & Wetlands Remaining)	X	-3.194	0.034	X	-494.307	X	X	X
F. Other (emission from Forest fertilization.)				0.27				
G. Other burnt land	0.054				0.003			
Other (flooded land	0.595							
6. Waste	**0.58**	X	**1.531**	**0.0051**	X	X	X	X
A. Solid waste disposal on land	X	X	0.64	X	X	X	X	X
B. Waste-water handling	X	X	0.891	0.0048	X	X	X	X
C. Waste incineration	0.58	X	X	0.0003	X	X	X	X

Greenhouse Gas Mitigation Assessment

18. Despite several efforts in recent years to promote renewable energy technologies (RETs), Dominica is still largely dependent on fossil fuel as its main source of energy for power generation and other applications. Currently, the country imports in the range of 900 - 1,000 barrels of oil daily for energy generation and other applications. Power generation represents

the main use of imported fossil fuels (50%), followed by transport (33%). Dominica's current electricity power generation comes from diesel generators fuelled by imported oil (71%), and hydropower (27.4%) with marginal generation from wind power (0.95%) and solar (0.25%). Dominica does not have any domestic sources of fossil fuels, and therefore the fluctuations in the import price of oil have posed challenges for Dominica, notably when oil reached a high of US$145 per barrel in 2008. In 2011, Dominica spent US$ 41 million on oil imports, representing 20% of its GDP.

19. The price of electricity (tariff structure) in Dominica is approximately US$0.38 kWh for residential consumers and between US$0.38 and US$0.41 kWh for businesses, including fuel surcharge, VAT and a service charge per kilowatt of customer-installed capacity. The cost of electricity in Dominica has increased significantly in recent years as it is subject to world oil prices. The country has the highest electricity tariffs within the Organization of Eastern Caribbean States (OECS). In addition, the country experiences significant power losses of 8.2 per cent due to lack of maintenance and obsolescence of electricity distribution lines, which increases operational costs between 8 and 14 per cent that are passed on to consumers.

20. The following table summarises barriers to low carbon development in Dominica.

Barrier type	Barrier Descriptions
Regulatory Policy / Legal	No detailed action plans for the development of RE sources and EE appliances, lack of standards for the importation of RE and EE equipment and its installation using best practices; a utility-driven cap on RE development (2.5 MW) that does not address potential for higher intermittent renewable energy (IRE) penetration to the national grid; and no policy on feed-in tariff to safeguard cost recovery of IPPs feeding into the national grid.
Institutional / Technical	No "energy champions" solely dedicated to the promotion of low carbon development in Dominica. Key institutions include the Ministry of Trade, Energy and Employment (MoTEE) whose energy-related personnel are being driven primarily by geothermal development, and Ministry of Health and Environment (MoHE) under which it's Environmental Coordination Unit is driving a broad but important climate resilience agenda that includes energy-related climate change actions, which is not considered a core discipline within this ministry. This lack of government capacity to provide focused development of low carbon for relief from high energy costs for commercial and residential sectors, are being led by the privately-owned DOMLEC.
Awareness/ Knowledge	This ranges from politicians and policymakers with insufficient exposure to these issues, to the financial sector, energy designers and architects in Dominica, technicians with the vocational skills to install RE and retrofitting equipment for EE benefits, and general public who are aware of the high cost of electricity but not aware of the means of reducing these costs.
Market / Financial	Barriers that restrain the public sector from making investments in RE and EE include investments in RE or EE not being factored into public sector capital expenditure or operating budgets; high upfront cost of RE and EE investments that do not have immediate or highly visible benefits; RE and EE being outside of the core expertise area of most public sector entities; and the lack of testing of alternate public sector financing vehicles for RE and EE, such as Energy Performance Contracting and Third Party Ownership models.

21. Dominica, being a volcanic island has tremendous potential for geothermal energy, with estimates ranging from 300 MW to 1,390 MW. Site assessments, and feasibility studies have been carried out that indicate that the energy capacity in the Roseau Valley Geothermal Resource area is at least 300 MW, The current production capacity based on wells already drilled is approximately 11 MW.

22. Over recent years, the Government has formulated several policies aimed at reducing energy prices, increasing environmental sustainability, and reducing fossil fuel use. Most notably, the *Low Carbon Climate Resilient Development Strategy*, adopted by Cabinet in 2012, sets out many of the Government's objectives for the energy sector, envisioning a "low-carbon, climate-resilient" development path for the country. Specifically, it identifies the objectives of developing renewable energy projects and promoting energy efficiency and energy conservation programs.

23. The *Low Carbon Climate Resilient Development Strategy* 2012-2020 considers climate change mitigation measures as a priority. The Strategy provides the rationale and outlines strategies towards the development of a low carbon development path including the promotion of energy conservation and RE development to address rising energy costs that affect the cost of living and quality of life, the high costs of manufacturing and services, and the challenges of remaining competitive. Climate change mitigation is a priority with the understanding that interventions will generate energy savings and funds that can be availed through a sustainable financing mechanism for Dominica to invest into urgent climate change adaptation measures.

24. In 2014 the Government of Dominica developed the *National Energy Policy* (NEP) for Dominica, 2014 and the supporting *National Sustainable Energy Plan* (NSEP). The Policy objective is to promote the utilization of indigenous sources of energy to produce and supply electricity at the lowest possible cost. The Policy provides, amongst other issues, conditions to facilitate the exploitation and development of cheaper energy through using renewable energy technologies, encouragement on the installation of solar photo-voltaic technology (where economically viable) on all new public sector buildings, commercial buildings, and residences, particularly for buildings that could benefit from those systems in the event of service outages, and measures to promote energy efficiency in all electricity consuming sectors, as well as in production of electricity.

25. Dominica`s *Intended Nationally Determined Contributions* (INDC) (September 2015) defines priority mitigation measures that are to be established to achieve specified GHG emissions reduction targets. As stated earlier, under the INDC, Dominica commits to progressively reduce total gross greenhouse gas (GHG) emissions below 2014 levels (164.5 Ggs est.) at the following reduction rates:

    17.9% by 2020; 39.2% by 2025; and 44.7% by 2030.

    By 2030, total emission reductions per sector will be as follows:
    - Energy industries – 98.6% (principally from harnessing of geothermal resources);
    - Transport – 16.9%;
    - Manufacturing and construction – 8.8%;
    - Commercial/institutional, residential, agriculture, forestry, fishing – 8.1%;
    - Solid waste – 78.6%.

    Benefiting from sound management practices, it was foreseen that Dominica forests would continue to sequester 100 Ggs of national GHG emissions on an annual basis during the period 2020 to 2030. However, with the devastation caused by Hurricane Maria, the achievement of this target will depend upon how quickly Dominica`s forests recover.

26. Hurricane Maria caused devastation to the DOMLEC transmission and distribution (T&D) system. The DOMLEC Post Maria Recovery Plan (December 2017) indicated that 100% of the T&D system was affected by the hurricane, with initial assessments revealing that a significant amount of equipment on the distribution system was recoverable and not requiring complete replacement. The total transmission and distribution (T&D) system comprises 17,000 poles, 1,400 km of wires and more than 1,500 pole-mounted transformers. DOMLEC estimated that 35% of the system remained standing and requires repairs, 40% was down but recoverable, and 25% required replacement. DOMLEC also estimated that at least 50% of the pole-mounted transformers in rural communities were damaged and not recoverable. None of the T&D system was insured. DOMLEC's Recovery Plan is to build back a national electricity system that is more reliable, more efficient, contains more renewable sources, and above all, is more resilient in the face of climate change. A key component of the Recovery Plan involves micro-grid and off-grid renewable energy initiatives.

27. It is DOMLEC's intention to adopt the micro-grid approach in the restoration of the transmission and distribution system, to create communities where "Planned Islanding" can be achieved in the event of major operational issues, or a natural disaster such as Hurricane Maria. Through planned islanding, the grid is designed and constructed in such a way that there are smaller distributed generation grids in selected areas which are normally connected and fed from the main grid, but will have their own energy sources and therefore capable of operating for long periods independent of the main grid.

Vulnerability, Risk and Adaptation Assessment

28. Dominica, by its very nature is vulnerable, given its susceptibility to natural disasters and its ecological and economic fragility. Vulnerability to climate change in Dominica, like many developing countries, is aggravated by external pressures affecting its resilience and adaptive capacity such as terms of trade, impacts of globalisation (both positive and negative), financial crises, international conflicts, external debt, and internal local conditions such as minimal population growth, incidence of poverty, political instability, unemployment, reduced social cohesion, and a widening gap between poor and rich, together with the interactions between them. It is widely acknowledged that climate change can exacerbate natural disasters with enormous human and economic costs.

29. Recognising the threats posed by climate change, Dominica has, over the last two decades, undertaken a number of initiatives to respond to this threat. Dominica developed a *National Climate Change Adaptation Policy*, formulated with support under the Caribbean Planning for Adaptation to Climate Change (CPACC) Project, which was adopted by the Cabinet in 2002. In January 2005, the Phase II Enabling Activity, under the UNFCCC was completed, which involved capacity building for climate change. The country has undertaken an number of adaptation projects, including:

- the Special Program on Adaptation to Climate Change (SPACC);
- the Sustainable Land Management (SLM);
- the Mainstreaming Adaptation to Climate Change (MACC);
- Strategic Program for Climate Resilience (SPCR) under which Dominica's *Low-Carbon Climate Resilient Development Strategy* was developed in 2011-2012 through an extensive consultative process that was supported under the Pilot Program for Climate Resilience (PPCR) funded under the Climate Investment Funds (CIF).

30. Through the climate change risk assessment undertaken by national stakeholders under the Pilot Program for Climate Resilience (PPCR), the following risks from climate change have been identified as priority:

Event Risks and *Outcome Risks*	Ranking of Risks
Increase in extreme events and climate variability (Cumulative Risks) - *Physical damage to crops and agricultural access roads, impact on agricultural and fisheries productivity, increase of pests/disease, impact on livelihoods and food security*	10
Increase in extreme events -*More frequent economic setbacks, prolonged recovery periods, stress on economy (including increase in loss of life, impact on tourism arrivals, impact on agricultural production, food security, forest cover, human health and social capital), and less attractive environment for foreign investment due to cumulative destruction of critical infrastructure for tourism, manufacturing, agriculture, trade*	10
Increase in extreme events (increased intensity of hurricanes, flooding, landslides) – *Increased damage to houses, human settlements, critical infrastructure, forest resources, business and other properties*	10
Sea level rise – combined with increased incidents of storm surges - *Damage to coastal infrastructure (roads, ports, jetties, storage, processing, packing, landing sites) used for agricultural trade and access to markets*	9
Increased frequency of extreme events -*Water shortages due to increased drought and storms* **(Note: includes loss to crops)**	9
Sea level rise – combined with increased incidents of storm surges - *Damage to coastal tourism facilities (beaches, hotels, airports, sea ports and cruise ship/ferry terminals)* **(NOTE: Includes impacts on Kalinago people and lost income to farmers)**	8
Sea level rise and storm surge - *Loss of coral reefs – loss of protection to coastal areas and impact of marine ecosystem and associated effect on livelihoods and food security*	8
Climate variability -*Loss and impact on marine and terrestrial biodiversity which is key pillar for tourism*	8
Changes in rainfall intensity -*Increased coastal marine habitat degradation (including corals) and damage to fisheries infrastructure*	8
Increased climate variability -*Changes in fish and marine mammal migration patterns affecting food security and tourism*	8
Changes in rainfall patterns - *Increased incidents of landslides affecting houses, human settlements and infrastructure, and forest resources, in addition to costs for insurance and building loans*	8
Increase in extreme events –*Damage to coastal property and infrastructure due to storms surges*	7

31. Dominica's SPCR is being implemented under the US$35 million Disaster Vulnerability Reduction Project (DVRP) which was officially launched in September 2014. The DVRP is funded by the World Bank, International Development Association (IDA), Pilot Program for Climate Resilience (PPCR), Strategic Climate Fund (SCF) and the Government of the Commonwealth of Dominica. The total approved financing is US$39.5 million.

32. While there are several sectors and issues identified by national stakeholders during the SPCR and INDC planning processes as being important to address climate change risks in Dominica, there are a few that require priority attention if building of climate resilience is to be achieved. These priorities have bee identified by national stakeholders during the SPCR planning process and INDC development process to be a priority for Dominica, have not yet been funded or implemented under the DVRP, and which possess the greatest potential to contribute to the successful transformation of the country to a climate resilient low carbon development path. These include :

(a) Addressing climate change ***mitigation measures*** on the basis that savings in energy costs will allow Dominica to invest more in priority and much needed ***adaptation measures***;

(b) Establishing ***community off-grid mini-grid or micro-grid renewable energy electrical supply systems*** (backed up by emergency alternative energy systems such bio-diesel generators should local conditions allow for the operation to be efficiently established) in vulnerable communities on the east and south east coasts that are periodically without electricity as a consequence of storm and hurricane events;

(c) Establishing ***early warning systems, multi-use disaster shelters (powered by renewable energy and back up bio-diesel generators) and emergency preparedness training programs*** in vulnerable communities;

(d) Facilitating ***capacity building*** through education, awareness and training programs on climate change risk management and resiliency measures in order to strengthen capacity at the community and sectoral level, within municipalities and local authorities, and the private sector;

(e) ***Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development*** to build climate resilient communities by strengthening capacity to address climate change risks to food security associated with changing precipitation patterns;

(f) Establishing the ***enabling legal/institutional framework to facilitate coordination/implementation*** of priority climate change measures and the mainstreaming of climate change activities into national, sectoral and community planning/development;

(g) ***Creating the supportive enabling framework whereby communities and vulnerable segments of society (women, youth, elderly, people with disabilities) can manage their own climate change risks,*** thereby addressing climate change impacts on vulnerable sectors (particularly agriculture, fisheries and water resources) and threats to food security, human health, poverty alleviation, sustainable livelihoods and economic growth;

(h) Establishing a ***sustainable financing mechanism*** to ensure timely and direct access to international climate change financing to implement priority climate change risks management measures by the private sector and vulnerable communities;

(i) ***Legal establishment of the Department of Climate Change, Environment and Development and the financing of key technical personnel*** needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`*s Low Carbon Climate Resilient Development Strategy*, and to serve as National Implementing Entity (NIE) to facilitate direct access to and management of international climate change financing under the Green Climate Fund;

(j) Design and implementation of ***climate change adaptation and disaster risk management education and awareness program*** at all levels to be coordinated by the Department of Climate Change, Environment and Development;

(k) ***Legal establishment of Climate Change Trust Fund*** in addition to US$5 million seed funding to the *Climate Change Trust Fund* to provide support to priority community climate change risks management measures identified through community vulnerability mapping and adaptation planning and the establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisher-folk, women and vulnerable communities in particular the Kalinago people).

Dominica`s INDC indicates that costs for the abovementioned priority adaptation measures that are to be undertaken over the next 5 years are US$25 million. Some of these measures are being supported under projects to be implemented under projects funded by the Green Climate Fund (GCF), including the Enhanced Direct Access (EDA) Project and the National Adaptation Plan (NAP) project.

Research and Systematic Observation

33. Support was provided under the DVRP project for a comprehensive assessment of the country's hydrometeorological data collection network. Chapter 7 of this report is largely drawn from the report "Improving Hydrometeorological Data Collection Network, Data Management, and Relevant Institutional Frameworks in the Commonwealth of Dominica" (April 2015) which was undertaken under the Disaster Vulnerability Reduction Programme (DVRP). No corresponding assessments have been undertaken during the reporting period in regards to systematic observation systems pertaining to other climate parameters (temperature, evaporation, extreme events) in order to update information provided in the INC and SNC.

Mainstreaming Climate Change in Development Planning

34. Chapter 8 provides an overview of ongoing efforts to mainstream climate change considerations into national development planning, and builds upon information on climate change mitigation and adaptation initiatives that have been described in earlier chapters of the TNC.

35. In the aftermath of Hurricane Maria in September 2017, the Government of Dominica embarked upon a process to develop a *National Resilient Development Strategy* (NRDS) which will build upon the existing *Growth and Social Protection Strategy* (GSPS). The

NRDS is meant to have broader scope than the GSPS being a derivative of a postulated *Climate Resilient Recovery Plan* which will go on through to 2030. The NRDS builds upon the framework outlined in the Dominica's *Low Carbon Climate Resilient Development Strategy* (2012 – 2020).

36. At the end of 2017, another agency, the Climate Resilience Execution Agency of Dominica (CREAD) was launched "to coordinate all reconstruction work to avoid duplication, maximize economies of scale, spot and fill critical gaps, avoid bureaucratic infighting and ensure all reconstruction activities are focused on a single Climate Resilient Recovery Plan". This agency like the NRDS, is in its formative stage and information of their activities are not well articulated at the time of the preparation of this report. It is too early to determine whether their work will actively support mainstreaming of climate change measures, or merely serve to implement a narrow range of disaster recovery measures rather than building adaptive capacity at the national, sector and community level and within civil society.

Recommendations

37. Comments have been made in Chapter 3, 4, 5, 6, 7 and 8 concerning the poor quality of data, and information required for domestic reporting and verification – for both mitigation and adaptation. Addressing this deficiency and constraint to national reporting is a priority to be addressed under future projects, including the Biennual Update Report (BUR) project.

38. Chapters 3 and 4 include comments concerning the collection and storage of data for the GHG inventory and the need to ensure that more formal arrangements are established to ensure that the collect and archiving of data for the preparation of national GHG inventories, is undertaken on a regular and real-time basis. Addressing this deficiency and constraint to national reporting is a priority to be addressed under future projects, including the Biennual Update Report (BUR) project.

Chapter 1: Introduction

The Commonwealth of Dominica ratified the *United Nations Framework Convention on Climate Change* (UNFCCC) in 1994, in recognition of the importance of climate change as a major environmental phenomenon with serious ramifications for all nations especially resource poor developing countries and small islands developing states (SIDS) of which Dominica is a member.

In fulfilment of one of the obligations under Article 12 of the UNFCCC, Dominica committed to the production of regular National Communications to the Conference of Parties (COP) through the UNFCCC Secretariat. The first such report, the *Initial National Communication* (INC) was submitted in 2001. The INC consists of a description of Dominica's national circumstances, a national Greenhouse Gas Inventory for 1994, an assessment of Dominica's vulnerability to the potential adverse impacts of climate change, an outline of the existing institutional framework for climate change adaptation and mitigation, a description of the national response measures that will be pursued by the Government and a listing of the priority actions that the Government of Dominica intends to undertake in the short term to implement commitments under the UNFCCC.

The INC process enhanced the general awareness and knowledge of climate change-related issues in Dominica and strengthened the dialogue, information exchange and cooperation among all relevant stakeholders including Government, non-government, academic and private sector agencies, and civil society. The preparation of the INC was coordinated by the Environmental Coordinating Unit (ECU) which is the unit established by Cabinet Decision in 1999 with the mandate to coordinate all environmental activities in Dominica. The overall function of the ECU is to bring about more focused environmental management approaches to the solving of Dominica's environment problems, advise government of the development of more coherent environmental policies, and enhance Dominica's compliance with international treaties and conventions to which it is signatory. It also serves as the focal point for Multilateral Environmental Agreements (MEA) to which Dominica is a party.

During the preparation and following the publication of its *Initial National Communication*, Dominica carried out a number of important climate change related activities, as summarised below.

- Participation in the Caribbean Planning for Adaptation to Climate Change (CPACC) program that commenced in 1997 that built capacity in the Caribbean region for adapting to climate change impacts, particularly sea level rise. This was accomplished through the completion of vulnerability assessments, adaptation planning, and capacity building activities. Participating countries in CPACC included the majority of CARICOM members, namely: Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, and Trinidad and Tobago. CPACC consisted of four regional projects and five pilot projects. The regional projects were:
  a. Design and establishment of a sea level/climate monitoring network;

b. Establishment of databases and information systems;
c. Inventory of coastal resources; and
d. Use and formulation of initial adaptation policies.

With technical support provided under the CPACC project, the Government of Dominica developed and obtained Cabinet approval for its *Climate Change Adaptation Policy and Action Plan* (2002).

- Participation in the Adaptation to Climate Change in the Caribbean Project (ACCC) that succeeded the Caribbean Planning for Adaptation to Climate Change (CPACC) project, and lasted from 2001 to 2004. This project was designed to sustain activities initiated under CPACC and to address issues of adaptation and capacity building not undertaken by CPACC, thus further built capacity for climate change adaptation in the Caribbean region. ACCC also facilitated the transformation of the Regional Project Implementation Unit (RPIU) originally established through CPACC into a legal regional entity for climate change (the Caribbean community Climate Change Centre). It did so by providing the resources to develop a comprehensive business plan for the Centre and a strategy to ensure its financial sustainability. ACCC had nine components, namely:

a. Project design and business plan development for a regional climate change centre;
b. Public education and outreach;
c. Integration of climate change into a physical planning process using a risk management approach to adaptation to climate change;
d. Strengthening of regional technical capacity, in partnership with the Caribbean Institute for Meteorology and Hydrology (CIMH), the University of the West Indies (Scenario Projection and Establishment of Climate Change Master's Programme), and the Caribbean Environmental Health Institute, in order to enhance association between Caribbean and South Pacific small island States;
e. Integration of adaptation planning in environmental assessments for national and regional development projects;
f. Implementation strategies for adaptation in the water sector;
g. Formulation of adaptation strategies to protect human health;
h. Adaptation strategies for agriculture and food; and
i. Fostering of collaboration/cooperation with non-CARICOM countries.

The outcomes of ACCC included:

- Development and distribution of risk management guidelines for climate change adaptation decision making;
- Political endorsement (by CARICOM) of the business plan and establishment of the basis of financial self-sustainability for the Caribbean Community Climate Change Centre (CCCCC);
- Development of a guide to assist environmental impact assessment (EIA) practitioners in CARICOM countries to integrate climate change in the EIA process;
- A draft regional public education and outreach (PEO) strategy;
- Development and handover to MACC (see below) of the organization's website;
- Successful launch of a Master's Programme in climate change at the University of the

West Indies (the first set of graduates, in 2003, included eight students);

- Statistically downscaled climate scenarios development for several participating countries;
- Staff training and development at the Caribbean Institute for Meteorology and Hydrology (CIMH) in climate trend analysis in order to strengthen climate change capacity;
- Dialogue established with the South Pacific Regional Environment Programme (SPREP) and the Pacific Islands Climate Change Assistance Programme (PICCAP) for collaboration on issues related to climate change; and
- Implementation of pilot projects on adaptation studies in the water health and agricultural sectors.

During ACCC's tenure, negotiations took place for a third project, the Mainstreaming Adaptation to Climate Change (MACC) project (see below). With technical support provided under the ACCC project, the Government of Dominica developed a comprehensive public awareness program on climate change which included the oorganisation of several workshops for information sharing and awareness raising on climate change.

- Initial National Communication Phase II - Building Capacity to Respond to Climate Change Project, a capacity building project intended to build upon the activities completed in the context of Dominica's Initial National Communications (INC) - the overall goal was to allow Dominica to extend current knowledge to facilitate the emergence of national networks and promote the integration of climate change concerns in the developing national dialogue.

- The Mainstreaming Adaptation to Climate Change in the Caribbean (MACC) Programme which sought to reduce vulnerability (physical, social, economic and environmental) of Caribbean countries to the impacts of climate change - climate vulnerability risk assessment undertaken under the MACC program were in the areas of Water Resources, Tourism, Agriculture and Coastal Zone. MACC also focused on *Public Education and Outreach* (PEO) strategies as a major component of the program in Dominica.

- The National Capacity Self Assessment (NCSA) process commenced in Dominica in January 2004 and focused on three thematic areas, Land Degradation, Biodiversity and Climate Change. The objective of the NCSA process was to allow for a thorough assessment of the capacity needs and constraints facing national efforts to improve environmental conservation and sustainable development programmes, and to meet global environmental management obligations. The NCSA process supported the analysis of the institutional capacity framework that was initiated under the UNFCCC and the formulation of the *National Biodiversity Strategy and Action Plan* (NBSAP), and facilitated the identification of management strategies relevant to sustainable environmental development.

- Accession to the Kyoto Protocol in January 2005.

- In 2008, the Commonwealth of Dominica together with St. Lucia and St. Vincent and the Grenadines began implementation of the Special Programme for Adaptation to Climate Change in the Caribbean (SPACC) project entitled "Piloting an Integrated Operational

Approach to Climate Change Adaptation, Biodiversity and Desertification Planning and Management”. The SPACC project sought to make adaptation to climate change an integral part of a broader agenda to address major MEA within national planning processes in the participating countries.

- The National self-assessment exercise was carried out in 2010 in accordance with Global Environment Facility (GEF) Operational Procedures for the Expedited Financing of National Communications from Non-Annex I Parties (GEF/C.22/Inf.16) - the main objective was to conduct highly consultative and participatory needs assessment of activities completed or under preparation that are relevant to the Second National Communication, while identifying priorities for implementation during the SNC process.

- Community climate change vulnerability, risk and capacity assessment were undertaken in 2011 as a collaborative initiative between the SPACC program and the GEF-funded *Sustainable Land Management* (SLM) project – under this initiative Dominica pioneered: (a) the vulnerability mapping and “climate proofing” of National Parks Management Plans; and (b) community-based vulnerability mapping and the development, through community engagement, of community adaptation plans.

The preparation of Dominica’s *Second National Communication* (SNC) commenced in 2006 and was submitted in 2012. The SNC reported on the period from 2001 to 2005. Chapter 1 of the *Second National Communications* updated the national circumstances since the INC, and in particular the aspects of development policies related to the major components of the climate change process. Although the baseline year for the report is 2000, Chapter 2 was devoted to Greenhouse Gases Inventories, carried out for the period 2000-2005 in accordance with the methodology recommended by the Convention Secretariat and the IPCC. This inventory was complemented by tables providing details on calculations carried out, data gaps, uncertainties, etc. Chapter 3 dealt with vulnerability to climate change and variability. The capacity for mitigating the effects of greenhouse gas (GHG) emissions related to social and economic development policies of the country was presented in Chapter 4. It was followed in Chapter 5 with information related to the achievement of the convention objectives, and provides a detailed assessment of Dominica’s ongoing efforts and requirements to efficiently implement the Convention.

During the period of the preparation of the *Second National Communication*, Dominica was selected to participate in the Pilot Program for Climate Resilience (PPCR). Based on recommendations of an independent Expert Group, Dominica was selected in 2009 as one of the countries to participate in the Pilot Program for Climate Resilience (PPCR) which is part of the Strategic Climate Fund (SCF), a multi-donor Trust Fund within the Climate Investment Funds (CIF). The Caribbean PPCR has seven components: country activities in six countries (Dominica, Grenada, Haiti, Jamaica, Saint Lucia, St. Vincent and the Grenadines) and a region-wide component. The PPCR sought to provide financing through the multilateral development banks (MDBs) to support programs in the selected pilot countries. Proposals for PPCR funding were prepared jointly by the recipient country and the relevant MDBs. The goal of the Pilot Program for Climate Resilience (PPCR) is to help countries transform to a climate resilient development path, consistent with national poverty reduction and sustainable development goals. In its nature as a pilot program and supporting learning-by-doing, PPCR implementation ultimately aims to result in an increased application of knowledge on integration of climate resilience into development. The PPCR complements, yet goes beyond, then available adaptation financing in providing finance for programmatic approaches to upstream climate resilience in development planning, core development policies, and strategies.

During 2011-2012 Dominica was provided Technical Assistance (TA) to undertake the design and development of the country's *Strategic Program for Climate Resilience* (SPCR). In light of the need to develop a strategic approach to climate change management as identified by stakeholders during the comprehensive and country-driven SPCR planning process, the TA also supported the development of Dominica's ***Low Carbon Climate Resilient Development Strategy*** that constitutes a compendium first part to the SPCR. Dominica's ***Low Carbon Climate Resilient Development Strategy***, which has been adpted by Cabinet, describes Dominica's development context and the constraints/challenges to sustainable development from climate change. It provides a review of climate change adaptation activities and how lessons learned from previous experiences are being used to foster an integrated strategic approach to address these vulnerabilities. Most importantly, Dominica's ***Low Carbon Climate Resilient Development Strategy*** articulates, for the first time in the country, a strategic vision with clearly defined goals/activities to support the country's transformation to a low-carbon climate resilient development path within the government's national development planning process.

Dominica's ***Low Carbon Climate Resilient Development Strategy*** provides an overview of the country circumstances, the development context and identifies climate change vulnerabilities and risks in key sectors, for specifically vulnerable groups, for the private sector, important eco-systems and natural resources. It also provides an overview of linkages to existing development plans and programs, most importantly Dominica's *Growth and Social Protection Strategy* (GSPS) and Dominica's *National Climate Change Adaptation Policy*. Section 5 of Dominica's ***Low Carbon Climate Resilient Development Strategy*** contains a policy, legal and institutional analysis that list key agencies involved in managing climate change risks, together with the associated legal/policy framework.

The evaluations undertaken during the SPCR preparation process has demonstrated that since signing the UNFCCC, Dominica has established a strong track record on climate change adaptation, and has made considerable progress in implementing Stage 1 adaptation measures. However, the implementation of Stage 2 and Stage 3 measures have not been possible due to serious resource (human, technical, financial) constraints. The PPCR National Adaptive Capacity Assessment identified considerable limitations in climate change risk management capacity at the systematic, institutional and individual levels, at the national, sectoral, district and local level, and within the public sector and civil society, highlighting the need for considerable capacity building. The National Adaptive Capacity Assessment confirmed the need for improved levels of earmarked financial resources for climate change risk management and resiliency building as articulated in the NCSA, and the need for improved coordination amongst key state and non state actors involved in climate change risk management. Other identified key challenges include:

- Critical infrastructure in the country is vulnerable to significant loss and damage from extreme weather events, sea level rise and storm surges;
- Lack of systems, expertise and facilities to collect, store and analyze relevant information and

data on topics related to climate change;
- Inadequate knowledge and awareness of potential impact of climate change and lack of technical skills to address them;
- Policies, laws, rules and regulations related to climate change and disaster risk reduction need strengthening and the capacity to enforce these revised regulations need enhancement; and
- Planning for coordinated response to climate change and disaster risk reduction activities need improvement.

By addressing the deficiencies identified during the SPCR priority planning process, SPCR interventions sought to support the establishment of an appropriate enabling framework to guide and facilitate Dominica's transformation to a low-carbon climate resilience development pathway that can serve as a model for other small island developing States in the region. By positioning climate change as a development issue rather than an environmental issue, Dominica's SPCR has the opportunity to demonstrate viable interventions to address climate change risks within the context of a national development framework that establishes the country firmly on the path to a Green Economy.

SPCR interventions were to be sustained in the long-term by ensuring that climate change planning/management becomes an integral part of the national development planning process under Dominica's *Growth and Social Protection Strategy* (GSPS) and ***Low Carbon Climate Resilient Development Strategy*** – the latter Strategy have been formulated under the SPCR planning process. In supporting the transition from government being solely responsible for climate change risk management to a country where this is a shared responsibility, SPCR interventions have the opportunity to demonstrate a model for transformation changes that could benefit other developing countries. Sustainability will be achieved by establishing effective partnerships with all stakeholders (public sector and civil society, technical and financial partners, local governments, vulnerable communities, grass-roots organizations) to transform Dominica to a low-carbon climate resilient country that will make a significant contribution to sustainable development in the country, and add value by ensuring that the SPCR is not a stand alone activity, but becomes a responsibility assumed by all stakeholders.

The following priority investments for support under Dominica's SPCR were identified:

<u>Component 1 - Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development</u>
The objective of this component was to build climate resilient communities by strengthening capacity to address climate change risks to food security associated with changing precipitation patterns. Component 1 will support the following activities:

(i) Formulation of Water Resource Inventory (surface and ground water resources), water balance assessment, continued monitoring of water resources, installation of hydro-met and coastal monitoring stations (including for automatic hydro-met and coastal monitoring equipment) to support establishment of community early-warning systems development (see *Component 3 (ii) below*) and formulation of Integrated Natural Resource Management Plan (*see sub-Component ii*) that will, inter alia, guide water conservation, extraction and use;

(ii) Development of Land Use Capability, and Integrated Natural Resources Management Plan and supporting legislation (as part of supporting mechanism for the National Physical Development Plan being developed with support from the Caribbean Development Bank {CDB}) to regulate development in coastal and watershed areas, prevent pollution, regulate the extraction, conservation of water, and determine sustainable irrigation levels;

(iii) Establishment of food security program (to be scaled up and replicated with proposed support under the Adaptation Fund) involving:

1. design and construction of a pilot rain-fed organic greenhouse, drip irrigation, and organic food processing/storage facility utilizing renewable energy sources to demonstrate technical/financial viability to support scaling up and replication;
2. community-based pilot transplanting and restocking of climate resilient corals to demonstrate technical and financial viability in Dominica with a view to replication in other vulnerable coral reef areas.

<u>Component 2 - Comprehensive Risk Management Framework and Sustainable Climate Change Financing.</u>

Component 2 will support the following capacity building activities:

(i) Financing of key technical personnel needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`s ***Low Carbon Climate Resilient Development Strategy***;

(ii) design and implementation of climate change adaptation and disaster risk management education and awareness program at all levels to be coordinated by the Department of Environment, Climate Change and Development (DECCD);

(iii) community vulnerability mapping and adaptation planning undertaken for all Dominica (based on process piloted under SLM and SPACC projects) and integrated into National Physical Development Plan being developed with support from CDB – *see Component 1 (ii)*;

(iv) legal establishment of Climate Change Trust Fund in addition to US$1 million seed funding to the Climate Change Trust Fund to provide support to priority community climate change risks management measures identified through community vulnerability mapping and adaptation planning;

(iv) establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisherfolk, women and vulnerable communities in particular the Kalinago people);

(vi) establishment of climate change adaptation standards for the private sector.

<u>Component 3 - Enhancing Infrastructure Resilience and Promotion of Sustainable Human Settlements</u>

The objectives of this component are to establish the enabling environment whereby government, households and individuals assume the lead role in building resilient communities by addressing climate change risks to critical infrastructure. Component 3 will build climate change resilience in vulnerable communities, including through:

(i) establishment of community early warning systems based on real-time hydro-met data – *see Component 1 (i)*;

(ii) design, retrofitting/construction of at least three pilot multi-use climate resilient and energy efficient emergency shelters (one in Kalinago Territory) using appropriate traditional building methods and renewable energy sources;

(iii) design and implementation of a climate change risk management training program for Ministry of Public Works staff to climate proof the design, construction and maintenance of critical infrastructure including roads – with infrastructure climate proofing to be funded under IDA, Regional IDA and possibly IBRD loans.

Expected Outcomes from the implementation of the SPCR were to include: i) the establishment of an enabling environment to mainstream climate change risk management into national planning processes at the national, sectoral and community level and within the private sector; ii) increased resilience in economic, social, infrastructural and eco-systems to climate variability and climate change through transformed social and economic development; iii) climate change risks formally integrated into national physical (core) planning processes; and iv) replication and knowledge sharing of Dominica SPCR lessons learned in non-PPCR CARICOM countries and SIDS.

Dominica's SPCR is being implemented under the US$35 million Disaster Vulnerability Reduction Project (DVRP) which was officially launched in September 2014. The DVRP is funded by the World Bank, International Development Association (IDA), Pilot Program for Climate Resilience (PPCR), Strategic Climate Fund (SCF) and the Government of the Commonwealth of Dominica. The total approved financing is US$39.5 million. However, due to considerable changes in the scope of DVRP activities, expected outcomes for SPCR implementation are no longer possible, which has resulted in the Government of Dominica actively seeking direct access to the Green Climate Fund (GCF) in order to ensure greater country ownership and control over future climate change projects to implement commitments under the UNFCCC.

In the three years following the launch of the DVRP, Dominica was struck by two extreme events which severely tested the countries adaptation preparedness and climate resilience readiness.

Tropical Storm Erika

Tropical Storm Erika formed in the mid-Atlantic at about 47^{o} West longitude 15^{o} North latitude on the 24th August 2015. It was immediately classified as a tropical storm and continued west-northwest at a speed of approximately 20 mph. On the morning of the 27th August 2015, the system (storm center) arrived at the Leeward Islands with the majority of rainfall associated with the eastern side of the system. Rainfall arrived in Dominica in the morning of the 27th August 2015 producing heavy rains for approximately 9 hours. Rain Gauge readings taken at Canefield Airport (on the coast near Roseau) indicated the rain event started at approximately 7:00 a.m. local time and continued through 6:00 p.m. As recorded at Canefield, the heaviest accumulation occurred between 7:00 a.m. and 12 noon with an accumulation of approximately 200 mm (nearly 8 inches over the 5 hour period).

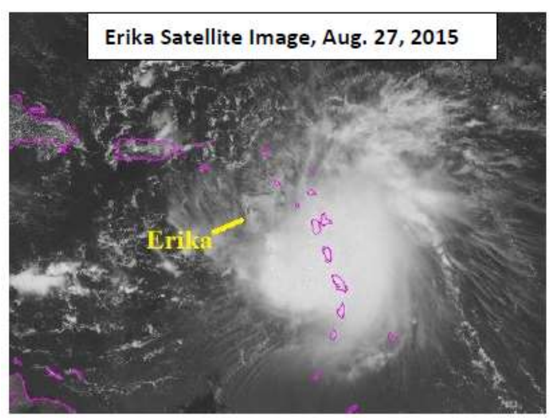


Figure 1 – Special Disaster Areas

Additional rainfall data were available from the climate station Gleau Gommier located in the mountains near the center of the island at a higher elevation. Data recorded from this station indicated that rainfall accumulation on the 27th August between 1:00 a.m. and 5:00 p.m. was 17.08 inches or 434 mm, of which 14.1 inches (359.7mm) accumulated from 4:00 a.m. to 9:00 a.m. which was higher than the Canefield data. As a result of the intense rainfall in combination with steep topography and relative short distance from the center mountain ridge to the coastal areas (6 miles or so), flash flooding rapidly ensued with little warning to the population. Tropical Storm Erika was, at the time, the deadliest and most destructive natural disaster in Dominica since Hurricane David in 1979.

The storm's asymmetric structure, coupled with the mountainous terrain of the island and ample moisture aloft, led to rainfall accumulations up to 33 in (850 mm). With grounds already saturated from antecedent rainfall, tremendous runoff quickly overwhelmed river basins and triggered catastrophic floods. Accompanying mudslides worsened the situation, temporarily damming the rivers before collapsing. On the 29th August, the Prime Minister declared 9 "special disaster areas", namely: Petite Savanne, Pichelin, Good Hope, Bath Estate (Paradise Valley), Dubique, Campbell, Coulibistrie, San Sauveur, Petite Soufriere (see Figure 1). Hundreds of homes were left uninhabitable and thousands of people were displaced; the entire town of Petite Savanne was evacuated and subsequently abandoned as a result of the storm. All told, 30 people died across the island in the nation's worst disaster since Hurricane David. The storm's devastating effects in Dominica prompted an influx of international assistance. Aid from multiple nations and intergovernmental organizations poured in to assist victims of the storm. Thousands of homes needed to be built or repaired, including 500–1,000 houses for the relocation of all of Petite Savanne's residents.

Flooding and landslides severely damaged transport infrastructure and substantially diminished the productive capacity of agriculture and tourism. The main airport was badly damaged. Based upon an initial assessment of impacts to each affected sector, Tropical Storm Erika resulted in total damage and loss of EC$1.3 billion (US$483 million), equivalent to approximately 90% of Dominica's Gross Domestic Product (GDP). The majority of damage was sustained in the transport sector (60 percent), followed by the housing sector (11 percent) and agriculture sector

(10 percent). Out of a total population of 71,000 persons, 574 were homeless and 713 evacuated with approximately 7,229 impacted by the event in disaster declared areas.

The recovery and rehabilitation costs will be substantial, putting tremendous pressure on already challenging fiscal and balance of payments positions. Recovery in Dominica was halted in September 2017 by Hurricane Maria, a Category 5 hurricane that wrought far greater devastation on the island.

Hurricane Maria

Rainfall ahead of the hurricane caused several landslides in Dominica as water levels across the island began to rise by the afternoon of the 18th September 2017. Hurricane Maria made landfall in Dominica at 21:15 AST as a Category 5 hurricane with maximum sustained winds of 165 mph (265 km/h). These winds, the most extreme to ever impact the island, battered the roof of practically every home—including the official residence of Prime Minister Roosevelt Skerrit, who required rescue when his home began to flood. Downing all cellular, radio and internet services, Maria effectively cut Dominica off from the outside world; the situation there remained unclear for a couple of days after the hurricane's passage. Prime Minister Skerrit called the devastation "mind boggling" before going offline, and indicated immediate priority was to rescue survivors rather than assess damage. Initial ham radio reports from the capital of Roseau on the 19th September indicated "total devastation," with half the city flooded, cars stranded, and stretches of residential areas "flattened".

The next morning, the first aerial footage of Dominica highlighted the scope of the destruction. Maria left the mountainous country blanketed in a field of debris: rows of houses along the entirety of the coastline were rendered uninhabitable, as widespread floods and landslides littered neighborhoods with the structural remnants. The hurricane also inflicted extensive damage to roads and public buildings, including schools, stores and churches, and affected all of Dominica's 71,000 residents in some form or way. The air control towers and terminal buildings of the Canefield and Douglas Charles airports were severely damaged, although the runways remained relatively intact and open to emergency landings. The disaster affected all of the island's 53 health facilities, including the badly damaged primary hospital, compromising the safety of many patients.

***Roads in the Roseau area littered with structural debris, damaged vegetation and downed power poles and lines*.**

The infrastructure of Roseau was left in ruins; practically every power pole and line was downed, and the main road was reduced to fragments of flooded asphalt. The winds stripped the public library of its roof panels and demolished all but one wall of the Baptist church. To the south of Roseau, riverside flooding and numerous landslides impacted the town of Pointe Michel, destroying about 80% of its structures and causing most of the deaths in the country. Outside the capital area, the worst of the destruction was concentrated around the east coast and rural areas, where collapsed roads and bridges isolated many villages. The port and fishing town of Marigot, Saint Andrew Parish, was 80% damaged. Settlements in Saint David Parish, such as Castle Bruce, Good Hope and Grand Fond, had been practically eradicated; many homes hung off cliffs or decoupled from their foundations. In Rosalie, rushing waters gushed over the village's bridge and damaged facilities in its bay area. Throughout Saint Patrick Parish, the extreme winds ripped through roofs and scorched the vegetation. Buildings in Grand Bay, the parish's main settlement, experienced total roof failure or were otherwise structurally compromised. Many houses in La Plaine caved in or slid into rivers, and its single bridge was broken.

For Dominica earliest ***estimates indicate that the total damage from Hurricane Maria could reach 200 percent of GDP***. Source – World Bank (Dominica 2017 GDP = US$1 billion – IMF. Dominica is among the lowest ranking in the Caribbean region with a GDP per capita of US $6,460 – World Bank)

The most catastrophic impacts may have been in countries with very low insurance coverage, which is why Maria's **insured losses across the Caribbean will be significantly lower than overall economic damage of between $30 and $60 billion**. Source RMS.

Overall, the hurricane damaged the roofs of as much as 98% of the island's buildings, including those serving as shelters; half of the houses had their frames destroyed. Its ferocious winds defoliated nearly all vegetation, splintering or uprooting thousands of trees and decimating the island's lush rainforests. The agricultural sector, a vital source of income for the country, was completely wiped out: with 100% of banana and tuber plantations was lost, as well as vast amounts of livestock and farm equipment. In Maria's wake, Dominica's population suffered from an island-wide water shortage due to uprooted pipes. The Caribbean Disaster Emergency Management Agency (CDEMA) estimated that the hurricane has caused "billions of dollars" worth of damage. As of October 1, there were 30 fatalities confirmed across the island with more than 50 reported missing.

Extracts from the address to the United Nations General Assembly on the 23rd September 2017 by the Dominica Prime Minister Roosevelt Skerrit in the aftermath of the devastation caused by Tropical Storm Erika and Hurricane Maria.

I come to you straight from the front line of the war on climate change. With physical and emotional difficulty I have left my bleeding nation to be with you here today because these are the moments for which the United Nations exists!

In the case of Dominica, it has been only 2 years since we lost lives and endured substantial physical and infrastructural damage from the ravages of the floods and mud slides of Tropical Storm Erika.

Mr. President to deny climate change is to procrastinate while the earth sinks; it is to deny a truth we have just lived! It is to mock thousands of my compatriots who in a few hours without a roof over their heads will watch the night descend on Dominica in fear of sudden mud slides…and what the next hurricane may bring.

We as a country and as a region did not start this war against nature! We did not provoke it! The war has come to us!! Mr. President my fellow leaders there is no more time for conversation! There is little time left for action. While the big countries talk, the small island nations suffer. We need action….and we need it NOW!!

We in the Caribbean do not produce greenhouse gases or sulphate aerosols. We do not pollute or overfish our oceans. We have made no contribution to global warming that can move the needle. But yet, we are among the main victims…on the frontline!

In the Commonwealth of Dominica, we have long pursued and respected an existence that preserves our Little Eden. The Morne Trois Pitons has been a national park for 40 years and a UNESCO World Heritage Site for 20. Our livelihoods are part of our ecosystem. This is how my people and my country earn and survive! But what is our reality at this moment? Pure Devastation!!…as Dominicans bear the brunt of climate change. I repeat - we are shouldering the consequences of the actions of others! Actions that endanger our very existence…and all for the enrichment of a few elsewhere.

The time has come for the international community to make a stand and to decide; whether it will be shoulder to shoulder with those suffering the ravages of climate change worldwide; Whether we can mitigate the consequences of unprecedented increases in sea temperatures and levels; whether to help us rebuild sustainable livelihoods; or whether the international community will merely show some pity now, and then flee….; relieved to know that this time it was not you.

The success of the COP21 in Paris is a demonstration of the collective political will of Member States to take action to combat climate change. One year on, the call for urgent action is even greater if we are to curtail the impact of climate change on us and future generations. We need all of humanity all countries - big and small; developed and developing to come together to save our planet! We must all live up to our obligations and commitments to do more! Let us take serious action against the realities of climate change. As a result of Tropical Storm Erika in 2015, we committed to creating a National Vulnerability Risk and Resilience Fund to improve the ability of our Government to respond to the impact of natural disasters.

Through the Caribbean Catastrophe Risk Insurance Facility, Dominica received approximately US$19.2 million in emergency funds. On 29 September 2017, the United Nations and partners launched a Flash Appeal for $31.1 million to support relief and early recovery efforts in Dominica till the end of 2017. The UN has allocated US$3 million from the Central Emergency Response Fund (CERF) to address the urgent needs of Dominica's people. The World Bank is working towards providing a financial package of about $100 million for Dominica, including accessing the IDA crisis response window.

Extracts from address by Dr. Hon. Roosevelt Skerrit Prime Minister of the Commonwealth of Dominica on the occasion of High-Level Conference for the Reconstruction and Resilience of CARICOM Countries Affected by Hurricanes Irma and Maria on the 21st November 2017.

Hurricane Maria's 226% of GDP damage and loss come just two years after Tropical Storm Erika, inflicted damage and losses of 90% of our national GDP. The scale and frequency of the damages and losses means there is no commercial premium we could pay that would insure us against the magnitude of these injuries.

The science of climate change shows that the warming of the seas is leading to more rapidly intensifying and wetter storms. Consequently, no commercial insurance firm would offer the insurance we need. Insurance works best when risks are uncorrelated and random. We must now accept the fact that with climate change this is guaranteed to change. Indeed we need to worry that premiums on what they are currently prepared to insure will increase significantly; impacting the cost of recovery as many donors will insist on insurance for many things. Ultimately the ***only route available to us is to build a nation resilient to climate change rather than to insure against damages and losses caused to one that is not. That is why we are committed to creating the first climate resilient nation. It is not an ill-considered promise. It is essential to our existence. We are prepared to be the game changer! We also know that resiliency is not just about buildings. It is about sustainable livelihoods. It is about resilient networks of energy and communications. It is about resilient agriculture and irrigation systems.***

Even though Dominica was severely affected by the impacts from extreme events during this reporting period, nonetheless, the country made progress on commitments to reduce greenhouse gasses in keeping with obligations under the UNFCCC. On the 30th September 2015, the Commonwealth of Dominica, being committed to the successful conclusion of negotiations under the Ad-Hoc Working Group on the Durban Platform for Enhanced Action (ADP) in order to adopt, at the 21st meeting of the Conference of Parties (COP21) in Paris, communicated its *Intended Nationally Determined Contribution* (INDC), in accordance with the relevant paragraphs of Decisions 1/CP.19 and 1/CP.20, towards achieving the ultimate objective of the Article 2 of the Convention. Dominica's INDC indicated that for the country, there is little distinction between adaptation and mitigation measures – an integrated response is being implemented to build climate resilience in vulnerable communities, while enabling Green Growth through the transition to sustainable energy technologies.

Recognising Dominica's common but differentiated responsibility and limited capabilities to address climate change, Dominica committed to progressively reduce total gross greenhouse gas (GHG) emissions below 2014 levels (164.5 Ggs est.) at the following reduction rates:

17.9% by 2020; 39.2% by 2025; and 44.7% by 2030.

By 2030, total emission reductions per sector will be as follows:

- Energy industries – 98.6% (principally from harnessing of geothermal resources);
- Transport – 16.9%;
- Manufacturing and construction – 8.8%;
- Commercial/institutional, residential, agriculture, forestry, fishing – 8.1%;
- Solid waste – 78.6%.

Benefiting from sound management practices, it was expected that Dominica forests would continue to sequester at least 100 Ggs of national GHG emissions on an annual basis during the period 2020 to 2030. Additionally, the commercial development and continued harnessing of Dominica's geothermal resources will, from 2025 onwards, enable the country to export significant amounts of renewable energy (estimated to exceed 200 Ggs annually) to the nearby French Territories of Martinique and Guadeloupe, thereby contributing to global efforts to reduce GHG emissions.

This INDC contribution is conditional upon receiving timely access to international climate change financing, technology development and transfer, and capacity building support for priority adaptation and mitigation measures. Dominica's INDC will remain provisional pending confirmation of timely access to international climate change financing, technology development and transfer, and capacity building support for priority adaptation and mitigation measures detailed in the INDC. Dependent upon COP21 outcomes, Dominica reserved the right to revise the INDC. The Government of Dominica signed the *Paris Agreement* on the 22nd April 2016, and lodged its instrument of ratification on the 21st September 2016.

This *Third National Communication* reports on the period from 2005 until the end of 2017, and includes an assessment of greenhouse gase (GHG) emissions during this time, together with an update concerning activities that have been undertaken to reduce Dominica's carbon footprint while building climate resilience, in part though measures to implement Dominica's ***Low Carbon Climate Resilient Development Strategy*** including though building the legal and institutional capacity to manage impacts from climate change.

This *Third National Communication* report has been prepared with financial support from the Global Environment Facility (GEF) under the *Umbrella Programme for National Communication to the UNFCCC* that was approved in 2013. The project provides financial and technical support for the preparation of National Communications (NCs) to the United Nations Framework Convention on Climate Change (UNFCCC) in 14 non-Annex I Parties that have completed preparation of their current national communications. The project seeks to strengthen the information base and institutional capacity of the national institutions involved in the development of national communications in order to integrate climate change priorities into development strategies and relevant sector programs. It will also ensure continuity in the strengthening of national capacities and institutional mechanisms for the preparation of National Communications by building on previous achievements and addressing gaps. The Project is implemented by the United Nations Environment Programme (UNEP) and participating national governments.

The GEF project directly addresses Article 12.1 of the UNFCCC which stipulates that Parties to the UNFCCC shall communicate to the Conference of Parties (CoP) through the secretariat, the following elements of information: (a) A national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, to the extent its capacities permit, using comparable methodologies to be promoted and agreed upon by the Conference of the Parties; (b) A general description of steps taken or envisaged by the Party to implement the Convention; and (c) Any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication, including, if feasible, material relevant for calculations of global emission trends. The project also responds to relevant COP decisions requesting the GEF to ensure continuous financial and technical support to Non-Annex I Parties for the preparation of their NC.

The project is designed to complement other ongoing and planned projects and programmes such as some of those outlined above without duplication. The project consists of the two components namely:

- Component 1: National stocktaking and stakeholder consultations;
- Component 2: Preparation of National Communication.

While these two components are bottom-up and support activities at country level, UNEP will provide enhanced administrative and technical support to participating countries in the course of implementing Components 1 and 2 to support realization of the programme’s objective. UNEP has played a pivotal role in assisting country teams to setting-up appropriate national implementation modality, supervising implementation, and mitigating project risks to ensure effective work delivery.

Chapter 2: National Circumstances

2.1. General

Dominica is located at 15 degrees North and 61 degrees West, occupying a central position in the eastern Caribbean archipelago. The country is bordered by the French Territories of Guadeloupe and Martinique to the north and south respectively. The island is approximately 750.6 square kilometers (290 square miles) and is the largest in the Windward and Leeward groups of the Eastern Caribbean. Dominica is part of a group of 47 countries and territories that have been classified by the United Nations (UN) as Small Island Developing States (SIDS) that face a specific set of challenges and are especially highly vulnerable to the effects and impacts of climate change.

Figure 2.1: Map of Dominica

Dominica is volcanic in origin and is characterized by very rugged and steep terrain with approximately ninety miles of coastline. The northern half of the island is dominated by the country's highest summit, Morne Diablotin, which is the highest and largest volcano in Dominica, and the second highest mountain in the Eastern Caribbean, measuring 22 km x 18 km at its base and towering to a height of 1447 meters. A chain of mountains extends from the islands center to the south and the topography is characterized by a number of ridges and steep river valleys with gently sloping lands being restricted to narrow coastal strips, particularly in the center and northeast of the island. The island's volcanic natural history remains evident in continuing seismic activity and in scenic attractions such as the Valley of Desolation and the Boiling Lake, which together with dense forests populated with an abundance of natural lakes and waterfalls, provide the basis for a growing eco-tourism industry. Dominica has a forest area of 45 000 hectares – constituting more than half of the island's 75 000 hectare over all land area.

2.2. Natural Resources and Biodiversity

Dominica has rich volcanic soil and is well served by over 365 streams and rivers. The high mountains and deep ravines are covered in rich tropical forests. Since 1975, an extensive system of national protected areas provides a significant carbon sink and affords protection for approximately 20% of the national territory. Protected areas include one marine park, two large forest reserves (Central and Northern), and the Morne Trois Pitons National Park, a UNESCO World Heritage Site.

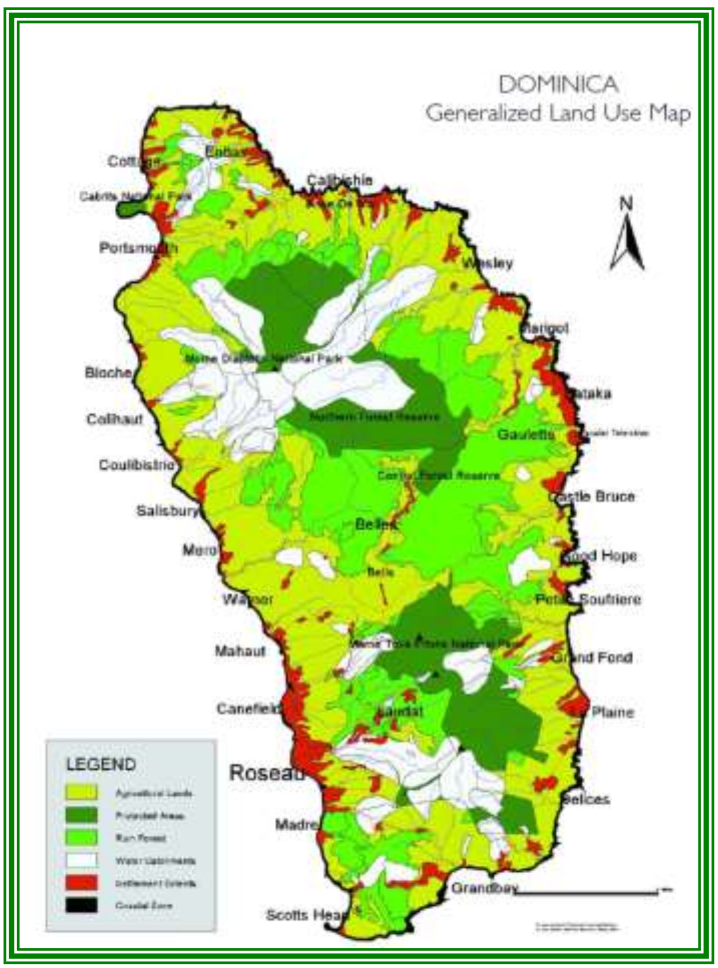
The island has a rich and diverse flora and fauna, which are influenced by its geography and history. The 'Nature Island' boasts of the most extensive natural forests in the entire Eastern Caribbean, being home to the most diverse assemblage of wildlife among the smaller Caribbean islands. The vegetation types (flora) include Littoral Woodland, Elfin Woodland, Semi-deciduous Forest, Mature Rain Forest, Montane Forest, Scrub Woodland and Savannah. Other natural vegetation types are influenced by soil conditions including wetlands and fumarole vegetation. Dominica's fauna includes:

- 179 species of birds;
- 55 species of butterflies;
- 20 species of crabs;
- 11 species of crayfish and shrimp;
- 3 species of amphibians;
- 17 species of reptiles (4 snakes);
- 18 species of mammals;
- 11 species of stick insects; and
- ~45 species of inland fish.

Dominica's biodiversity accounts for 48% of local food supply which comes in the form of wild meat, fish (from the rivers and sea), fruits, root crops and the wide range of domestic agriculture products. Additionally, biodiversity provides energy in the form of fuel wood and charcoal, raw material for the craft industry, timber for the local market, and a host of products that contribute to the quality of life in Dominica. The country's biodiversity provides the key natural resources to support the economy, with agricultural production accounting for 12.3% of total GDP, tourism contribution to the GDP was 26.4 % in 2014 (> 60 percent of this amount is attributed to biodiversity), while water resources contribute 5.9% of GDP (not including contributions from hydroelectricity). Timber extraction (for lumber and charcoal) netted an average of $3.67 million per year for the ten-year period 2002 to 2012. In-situ biodiversity in the form of protected areas/ forests occupies approximately 70% of the national land space.

Twenty-five percent of Dominica's forest lands are legally protected either as forest reserves or National Parks. Dominica has two (2) declared Government Forest Reserves namely the Central Forest Reserve (410 hectares) established in 1951 and the Northern Forest Reserve (5,475 hectares) established in 1977. These two Forest Reserves in the north-central part of the island cover over 11% of Dominica's land area. Three National Parks have been designated. The Morne Trois Pitons National Park (6,872 hectares) was established in 1975, the Cabrits National Park (5,388 hectares), which includes a marine component, was established in 1986, and the Morne Diablotin National Park (3,335 hectares) was established in 2000. The Morne Trois Pitons National Park was officially declared a UNESCO World Heritage Site in 1998. Management Plans have been developed for the three National Parks. In 1998 an expanse of the marine waters of the south of the island was designated as the Soufriere Scotts Head Marine Reserve (SSMR). The status granted to this marine area and adjacent fringing coastline was, among other efforts, an attempt to provide protection as well as to zone areas of the marine space for designated sustainable marine related activities.

Figure 2.2 – Protected Areas/Forests in Dominica (Source: Dominica Biodiversity Strategy and Action Plan 2014-2020.)



2.3. Population

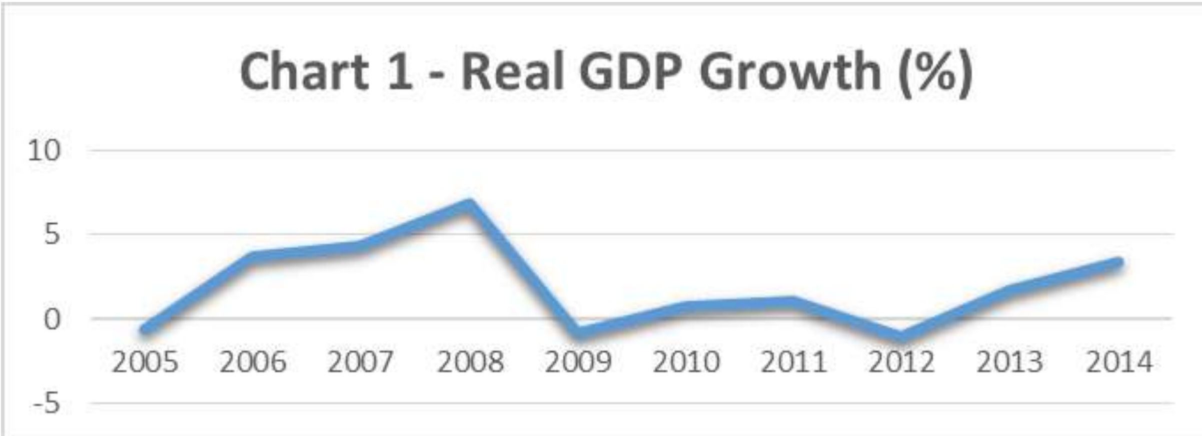
Dominica was originally populated by Amerindian peoples, known as Kalinago or Caribs, and is

the only island in the Caribbean still to possess distinct communities of these indigenous people of the Caribbean. Population estimates for 2011 indicate that Dominica had a population of approximately 71,293. persons (a decline from 74,750 in 1994), including two thousand Kalinago, the remaining survivors of the first inhabitants of the island. The total population comprises 36,411 males and 34,882 females The total population also represented a net decrease of 434 or a slight 0.6 percent decline over the 2001 head count and a fall below the 2010 mid -year population estimate of 72,72. The population is mostly of African and mixed African/European descent, with European, Syrian and Indigenous minorities. Dominica ranks as one of the top five countries in the world with the highest nett emigration, with the size of the Dominican diaspora more than double the country's existing population. After the devastation caused by Hurricane Maria in September 2017, an estimated 20,000 persons left Dominica to seek education and employment in neighbouring countries.

Topographic conditions have forced human settlements onto narrow coastal areas particularly in the south and west with approximately 44,000 persons (62%) living along the coast prior to Hurricane Maria. The largest community is Roseau (the capital city) and its environs with 14,847 persons representing almost 21% of the total population. In 2017, 40% of the population resided in rural areas.

2.4. Economy

With gross domestic product (GDP) standing at US$517 million (2014 - IMF estimates), the Dominica economy reflects many of the traditional features of a small open economy. This includes a high level of dependence on external trade as a proportion of GDP, dependence on single sector export products (in this case agriculture) and tourism revenue, high levels of underemployment and unemployment, and dependence on foreign capital (both public and private sector) for investment into productive sectors and for infrastructural development. Over the past 10 years, economic growth in Dominica averaged approximately 3.7% per annum, dropping to 1.5% by 2015 before suffering further decline after Tropical Storm Erika (2015) and Hurricane Maria (2017) resulting in a 9.5 percent decline in GDP for 2017. Prior to Hurricane Maria, the population of the country has remained relatively unchanged over recent years (approximately 70,000), and is not expected to increase in the next 10-15 years. Since the year 2000, contributions to GDP have increased in the agricultural, private education and hospitality industries, with declining trends in manufacturing, real estate and banking. In 2016, the top imports to Dominica were refined petroleum, soap, medical instruments, low voltage protection equipment, and gravel and crushed stone. Dominica's main export of agricultural goods include bananas, cereal and pellets, tropical fruits, cassava, citrus, beer, pasta, spices, and vegetables. Although the economy is described as predominantly agricultural, the country is actively exploring prospects in tourism, and is also developing the production of geothermal energy.



The vulnerability of Dominica's agricultural sector – which together with tourism is the mainstay of the country's economy - is manifested in the risks presented by natural disasters and climate extremes, as well as in the sectors vulnerability to climate variability and external economic shocks. The World Bank points out that Dominica's real agricultural sector product and agriculture's share of GDP has fallen consistently with each major natural disaster with the sector failing to recover to previous levels of relative importance. Most of this decline is attributable to the crop sector, and within that sector, to the decline in banana production. Otherwise there has been significant growth only within the small livestock sub-sector. The World Bank indicates that "the post disaster shift out of agriculture seems to be explained by a combination of a further reduction in larger scale production (failure to invest fully in replacement), a shift of small shareholders into employment in other sectors, and also off-island migration".

Agricultural production accounted for 12.2% of total GDP, and overall the sector is estimated to have declined by 10.6 percent in 2010 on the heels of a 1.5 percent growth rate for 2009. The performance of the crops sub-sector was severely affected by the extended drought in 2010. Agriculture's decline has been particularly marked since Hurricane Hugo. Crop sector product in real terms in the late 1990s was 20% below the 1988 peak caused primarily by the decline of the banana industry, which has maintained this pattern during the 2000s. Agricultural access roads have been severely damaged or destroyed by Tropical Storm Erika in August 2015, which resulted in losses to the agriculture sector of US$30.83 million (est.), creating additional challenge to the sector. Similarly, after Hurricane Maria much of the agricultural infrastructure and equipment was damaged or destroyed including buildings, animal husbandry facilities, agricultural roads and croplands. Sector recovery will depend heavily on the reconstruction of infrastructure in order to rehabilitate the sector and reestablish the farm- to-market transportation network. For a country that could be self-sufficient and provide food to neighbouring countries, Dominica's food imports constitute an increasing burden on the economy, and threaten food security. Impacts from climate change, affecting agricultural productivity, continue to aggravate this situation.

With the rapid decline in the major cash crop (bananas), many farmers began moving into the fishing sector, which employs approximately 2000 registered fishermen (40% full-time). There is a much greater demand for fish at the present time as a major source of protein. Dominica's fishery resources are relatively diverse including near-shore demersal and pelagic species, as well as deep-water pelagics and various crustaceans and other marine species. The Dominica fishing industry is small-scale and of an artisan nature. All the fish caught is for local consumption. Most fish landed in Dominica is sold directly to the public at the landing sites. Already fishery resources face considerable stresses from a number of land-based sources of pollution. Existing climate stresses especially hurricane/tropical storm systems and warming oceans present significant challenges for the health and sustainability of the ecosystems that sustain the islands fisheries. The fisheries sector suffered considerable loss and damage during Tropical Storm Erika and Hurricane Maria. During Hurricane Maria, 128 fishing vessels were damaged or destroyed, with a total cost for repair and replacement of vessels and engines estimated as EC$4.52M (US$ 1.68M). Other losses included fishing gear and vendor equipment estimated EC$0.87M (US$ 0.32M). Infrastructural damages to the sector (both the government fisheries buildings as well as the fisheries cooperatives) are estimated to be EC$1.14M (US$0.42M), this includes damage to roofs, fuel pumps, ice-machine rooms, freezer storages and other supporting infrastructure. Climate change, including increasing ocean acidification and changes in sea temperatures, are affecting fish resources and migration patterns with consequent impacts on the sustainability of Dominica’s fishery sector, livelihoods, human health and prospects for food security. Climate change impacts on Dominica’s vibrant diving and whale-watching industry are yet to be determined.

The island has always been in a vulnerable position economically, socially, culturally, and environmentally. Economic development, in particular, is significantly affected by both natural and man-made external factors as is increasingly evidenced by the negative impact on the local economy of changes associated with such international phenomenon as globalization and trade liberalization. The historic dependence of the economy on the constricting banana industry exposed its high economic vulnerability. Attempts to diversify are slow, however recent trends indicate that the island is making progress in its move towards tourism/ecotourism, as it markets its unique environment and culture. In doing so Dominica has become more acutely aware of the need to protect the environment and of the growing threat to its vulnerable natural resources presented by climate change.

Dominica’s economic performance over the past ten years has reflected its vulnerability to natural hazards and economic shocks as real growth averaged less than 2% per annum. The country recorded its highest growth period during 2006-2008 where real GDP increased by an average of 5% due to heightened public sector investment particularly following the passage of Hurricanes Dean (August 2007) and Omar (October 2008). Subsequently, from 2009-2013 economic performance was lackluster as the economy grappled with the effects of: (i) the Global Recession which was manifested in lower remittances, tourist arrivals and foreign direct investment; and (ii) natural hazards due to the passage of Tropical Storm Ophelia (September 2011), the effects of the 2013 Christmas Eve trough, the passage of Tropical Storm Erika (August 2015) and Hurricane Maria (September 2017), and other more localized hazard events such as flooding. As a result of the relatively weak private sector activity, government took on a more active role in supporting employment generation; in 2014 services provided by the state along with private education were the main drivers of growth.

The prevailing economic situation has given rise to sluggish growth and little improvement in the levels of poverty. As such, the government was compelled to establish a Programme of Economic Stabilization and Recovery in early 2001, which was aimed at, among other things, maintaining fiscal stability and energizing economic growth. The stabilization programme, which imposed stringent austerity measures, was intended to reduce public sector expenditure to sustainable levels in line with required standards set by international agencies such as the International Monetary Fund (IMF) and World Bank (WB). However, the global economic recession continued to affect the country's economy with a 0.3% decline in economic growth being recorded for 2010, a 16% decline in tourist receipts, a 51% reduction in family remittance inflows, and a 18% reduction in foreign direct investment. These declines were partly offset by a 5% increase in agricultural production.

Economic growth declined by 0.3 % in the fiscal year 2009-2010, following years of rough economic conditions with a decline in tourism receipts by about 16 % and reduction in family remittance inflows by about 51 %. Dominica currently depends on government services (22.3%), agriculture (17.6% GDP), financial services (15.7%), and transport & communication (14.3%) as the main drivers behind its economy.

During the period covered by this report, Dominica's economy was battered by two extreme events. On the 27th August 2015 Tropical Storm Erika passed over Dominica producing extraordinary rainfall with high intensity. Owing to the mountainous island topography and the saturated condition of the soil, the heavy rainfall resulted in intense and rapid flooding. Dominica suffered severe infrastructural damage, primarily related to transportation, housing and agriculture with the worst damage occurring in the south and south east parts of the island. Tropical Storm Erika resulted in total damage and loss of EC$1.3 billion (US$483 million), equivalent to approximately 90% of Dominica's Gross Domestic Product (GDP). On the 18th September 2017, Hurricane Maria hit Dominica with catastrophic effect. Hurricane Maria was one of the most rapidly intensifying storms in recent history, intensifying to a category 5 hurricane roughly 24 hours after being upgraded from a tropical storm. As the hurricane passed over the center of the island, Dominica was exposed to extraordinary winds for more than three hours. This was accompanied by intense rainfall, which provoked flashfloods and landslides. The impacts of Hurricane Maria were severe for both the country's economy as well as the human development of its citizens. As of the 8th November 2017, 30 persons had lost their lives as a result of Hurricane Maria (26 identified and 4 unidentified), and 34 were declared missing. A significant proportion of the labor force remains unemployed as an immediate consequence of Maria, with estimates that the decline in the production of goods and services may continue for one to two years. The Post-Disaster Needs Assessment (PDNA) concluded that Hurricane Maria resulted in total damages of EC$2.51 billion (US$931 million) and losses of EC$1.03 billion (US$382 million), which amounts to 226 percent of 2016 gross domestic product (GDP). The identified recovery needs for reconstruction and resilience interventions, incorporating the principle of 'building back better' where possible, amount to EC$3.69 billion (US$1.37 billion).

The impact of these two events has been devastating to Dominica's economy, resulting in a 9.5 percent decline in GDP for 2017. In June 2016, total public debt stood at $1.1-billion, consisting of external debt of $776.4 million and domestic debt of $278.9 million, and national debt to GDP ratio stood at 72 percent, although this is a marked improvement from the situation in 2003 when national debts was 130% of GDP. Tropical Storm Erika and Hurricane Maria have compelled the Government to increase borrowing in order to finance recovery measures.

Reconstruction costs have been estimated at US1.3 billion US dollars and it has been estimated that Dominica will require at least five (5) years to recover with negative growth expected over much of that period. After Erika and Maria, a marked deterioration of the country's fiscal situation is evident with a decline in export earnings, a decline in tax revenues, and unsustainable debt. Dominica was declared as high risk for debt stress as central government debt soared to 88% of GDP and external debt soared to 99.6% of GDP.

The fiscal situation exacerbated weaknesses in the financial sector which was characterized by under capitalization, low productivity, high levels of underperforming loans and the looming impact of de-risking and black-listing. Dominica thus faced a flight of investment capital and stymied foreign direct investments due to perceived increased investments risk. A case in point; the decision made by Ross University to relocate its services to Barbados in the wake of the destruction caused by Hurricane Maria. This single decision was a significant blow to Dominica's private sector, and potential foreign investors indeed received a very negative investment signal. Thus, in the wake of Hurricane Maria, the Dominica private sector can best be described as decimated.

Another important consideration for Dominica's macroeconomic reality was the demise of the Petrocaribe arrangement following political and economic turmoil in Venezuela. Dominica was thus exposed to the higher costs of imported fossil fuel to meet its energy needs - despite the country's considerable renewable energy potential - as much of the country's infrastructure lay in ruins. It meant therefore that in addition to being forced to incur further debt for capital infrastructure reconstruction, Dominica was also forced to incur debt for food, fuel, basic necessities and other recurrent expenditure.

The policy response to this macroeconomic situation was clear. Dominica vowed to become the world's first climate resilient country through a comprehensive program to "Build Back Better" as championed by the Island's Prime Minister. A Climate Resilient Executive Agency, a Policy Advisory Board and a Public Private Sector Investment Committee were created to oversee the resilience building process.

The cornerstone of the rebuilding process included several aspects as follows: Grant based reconstruction resources from a range of donors; insurance facilities and bilateral arrangements; debt reconstruction including debt forgiveness; strengthening of the citizen by investments programs; investment in climate resilient infrastructure; investment in critical social infrastructure; cost effective fiscal policies and reform; expenditure controls; controls on extending external debt; diaspora engagement; and establishing legal and regulatory frameworks to address the threats, causes and consequences of climate change.

2.5. Socio-economic Situation

Despite high human development – the 2014 United Nations Development Program Human Development Index ranked Dominica as 93 of 187 countries – poverty remains a pervasive development issue. According to the latest Country Poverty Assessment (2008-2009), 28.8 percent of the population lives below the locally defined poverty line (falling from 39 percent in 2003), 3.1 percent of the population was deemed to be indigent (declining from 10 percent in 2003) and 11.5 percent was deemed vulnerable. Poverty rates among males and females were proportional – 28.8 percent of males were classified as poor with 28.9 percent of females classified as such. The Gini coefficient of inequality was estimated to be at 0.44 in 2008 – the richest 10 percent of the population accounted for 37.2 percent of the consumption while the poorest 10 percent accounted for only 2 percent of consumption expenditure. The main poverty influences are due to external factors, including reductions in banana export protections, surge in food and energy prices, the global economic crisis and the regularity of natural disasters.

Dominica continues to work towards improving the social conditions of its citizens through infrastructural investments, economic diversification and employment generation, yet its population and economy remains highly exposed to natural disaster events and catastrophic risk. Disasters stemming from natural hazards such as high wind exposure, floods and landslides have destroyed or damaged critical infrastructure and set back hard earned development gains – disaster recovery and reconstruction have absorbed an increasingly large share of annual budgets imposing substantial costs on the country's economy.

Rates of poverty in Dominica reflect the continuing decline in banana production as well as stagnation in the country's other sectors. In Dominica, 29% of households and 40% of the general population lived in poverty as most recently reported in 2003. 11% of households and 15% of the general population lived in indigent poverty. An average of 50% of Dominica's children live in poverty. Fewer than half the households with children have two resident parents. In rural areas, 1 in every 2 households is poor. More than 37 percent of households in Dominica do not have access to piped water and 25% of households have no access to toilet facilities. With total government debt currently almost equal to GDP, Dominica also struggles with structural unemployment and under-employment. The most significant differences that exist between the poor and non-poor population is educational attainment and unemployment. The rate of unemployment for poor households is 40% while non-poor households' rate of unemployment is 16%. This data demonstrates the correlation between income/employment and poverty in Dominica.

The economy's susceptibility to a variety of natural hazards is underscored by its rank as 12th on the list of one hundred and eleven (111) countries on the composite vulnerability index of the Commonwealth Secretariat and the World Bank (WB). Recent disaster trends have also demonstrated that areas with the highest rates of poverty tend to be more harmed than others when faced with disasters such as flooding and landslides. As climate change continues to increase the frequency and intensity of the extreme hazard events, the most vulnerable among the Dominican population are expected to be especially impacted.

The country's social infrastructure and services were not spared the devastation from recent extreme weather events. Several deaths were recorded and significant damage to education, health, housing and Dominica's entire social fabric. The destruction exacerbated the already high poverty rates and unemployment rates and significantly reduced income earning potential.

In the wake of Hurricane Maria, it was estimated that in excess of twenty thousand persons migrated from Dominica taking with them the skills and expertise necessary for reconstruction. It was also revealed that with the migration of Dominicans there was an influx of Haitians and other foreign nationals which has the potential to create other social problems. The inflow of labor from Haiti and elsewhere was seen by many as a potential area of concern for long term social stability. Many called for an aggressive diaspora engagement policy to induce citizens of Dominica to return to the country.

The recurrence of severe weather events on Dominica due to climate change and the impact of natural disasters call for measures to strengthen disaster recovery and response, and to build climate resilient systems. Investments in the natural and built environment were seen as an imperative. There is undisputed high political will to invest in resilient social infrastructure. Further the abundance of natural capital in Dominica is also undisputed and indeed is seen as a basis for recovery.

Thus, the implementation of the Sustainable Development Goals (SDGS) is seen as a beacon for social recovery of Dominica. Dominica is seen as a caring society and coupled with the international goodwill in the face of its vulnerability, Dominica has the political capital to become a climate resilient economy. The old “Nature Island” brand and the new climate smart country branding is seen as entirely complementary.

2.6. Energy Use

Dominica has no petroleum resources, and energy required to sustain development in the country is imported. Annual import costs for energy continue to rise and are currently EC$116.65 million (US$43.39 million) representing 11.92% of GDP (2014 – World Bank estimates). Electricity constitutes the primary source of commercial energy for industrial and other uses in Dominica, while approximately 8000 cubic meters of woodfuel are used domestically. The main end users of electricity are domestic, commercial and institutional customers and the pattern of consumption demonstrates the low energy use of industry and other non-domestic consumption at this time. The other main source of energy use in Dominica is in the road transport sector. As in most other developing countries road transport consumes an increasing amount of petroleum.

The country presently (2017) has an installed capacity of 26.74 megawatts (MW) consisting of 6.64MW (28.5%) of hydropower and 20.1 MW of diesel powered units. The generation mix is characterized by seasonal fluctuations in supply from hydro-generation as a result of changes in precipitation during the rainy season. Peak demand has averaged approximately 16 MW over the past three years (up to September 2017 when Hurricane Maria caused total devastation to the electrical grid and almost total loss of supply to most of the country), with average demand of 11.5 MW. Minimum overnight demand has averaged 7.3 MW over the past 3 years, requiring approximately 8 MW of generation online (9.6% losses).

From 2012 to 2014, minimum instantaneous demand has varied between 6MW and 8.5MW, averaging around 7.3MW for the past 3 years. Some large consumers of electricity (hotels, manufacturers, universities) self-generate using diesel engines as this provides lower-cost electricity than provided by the domestic electrical utility. The Independent Regulatory Commission (IRC) has established a limit of 1MW of grid connected intermittent renewable energy, of which approximately 0.5 MW has already been installed. An additional 125kw community renewable energy facility is being considered.

Electricity sales have grown on average 3.7% per annum over the past 10 years, with much of this between 2008 and 2010. Over the past 3 years (2015-2017) there has been no growth due to the depressed economic climate resulting from extreme events (Erika and Maria). Corresponding to this has been a decline in electricity consumption in the domestic sector. The proportion of electricity sold in the commercial sector has increased, which reflects growth in the hospitality, tourism and higher education sectors. The 20 year forecasts for electrical sales provided by the Dominica Electric Company (DOMLEC) indicates average growth rates of 1.3% and 0.8% for yearly electricity generation and peak demand respectively, based on assumed economic growth rate of 1.6%. As of the date of publication of this report, these forecasts have not been revised to address the economic realities facing Dominica after Tropical Storm Erika and Hurricane Maria.

As with all other island states and territories in the Caribbean, Dominica is affected by the global crisis caused by its dependency on imported petroleum products and the constant fluctuations in oil prices. High electricity costs (the highest in the Caribbean) constitute a real obstacle for numerous sectors, with the direct and indirect consequence of curtailing growth and parallel activities linked to the country’s sustainable development. Dominica recognises that current high costs associated with importation of fossil fuel-based energy is unsustainable, a draw on the economy, diverts much needed resources from priority poverty reduction and social development programs, and reduces the availability of funds needed to address impacts from climate change and natural disasters.

The Government of Dominica in seeking to reduce the increasing costs of electricity generation and ensure a cleaner, more environmentally friendly energy source is aggressively exploring the possibilities of alternative energy. While hydroelectric generation does occur (potentially contributing up to ~ 38% of electricity generation), and Dominica has considerable additional potential, hydro-power development is severely affected by changing precipitation patterns association with climate change. Dominica, being a volcanic island, also has tremendous potential for geothermal energy. Site assessments and feasibility studies have been carried out that indicate that the energy capacity in the Roseau Valley Geothermal Resource area is at least 300 MW. The current production capacity based on test wells already drilled is approximately 10 MW. Further generation capacity can be added with the drilling of additional production wells as assessed and necessary.

A limited amount of solar and wind energy is used in Dominica, mainly at the residential and commercial levels for both water heating and electricity production. It is hoped that hydro, solar, wind, wave and biomass as alternative energy sources, will eventually be considered on a commercial scale. Dominica’s ***Low Carbon Climate Resilient Development Strategy***, *National Energy Policy* (draft) (2014), *Sustainable Energy Plan* (draft) (2014), and *Intended Nationally Determined Contributions* (INDC) (September 2015) establish indicative targets for renewable energy in Dominica.

2.7. Climate

Dominica's climate is characterized as tropical maritime with dominant influences being the Atlantic Ocean, the Caribbean Sea, and the northeasterly trade winds. As a result of its mountainous terrain the island possesses a number of micro-climates. Rainfall is distributed between a dry season from December to May and a rainy season from June to November. The western Caribbean coast is in the rain shadow of the various mountain ranges and average rainfall along that coast is significantly less than in interior locations. Dominica's rugged topography results in considerable amount of orographic rainfall making the island susceptible to landslides particularly in mountainous areas. The dry season is from February to April and the rainy season is from June to October. The spring months, from February to April, are the driest. The heaviest rains fall during late summer and fall (August to December). The average yearly rainfall ranges from about 1,900 mm on (coast) to 5,000 mm (inland). Hurricanes coming in from the Atlantic Ocean can be expected during summer months, usually between June and October. The peak of hurricane season is late August to early September.

The island's climate is characterized by consistently warm year-round temperatures with a daytime average of 26-27°Celsius (C) in coastal areas decreasing to 19-21° Celsius in mountainous areas, while night-time temperatures vary from 18-22° Celsius on the coast and 10-12 ° Celsius at higher elevations.

The annual variation in maximum, minimum and mean temperatures is shown in Figures 2.3 and 2.4.. Dominica has an average temperature of 27°C (80°F). The annual range is small for the mean temperature (~3 degrees), with peak temperature values occurring between July and August. Maximum temperature values may reach as high as 31° C and peak slightly later in the year, while minimum temperature values may drop to less than 22°C in the mean in January/February. Diurnal ranges are usually no greater than 3°C in most places.

The steep interior slopes of Dominica also alter temperatures. During the warmest period of the year a maximum of 33°C may be observed along the coast compared to 27°C in the mountains. In the nights, minimum temperatures of 18 ° C and 13°C respectively are not uncommon.

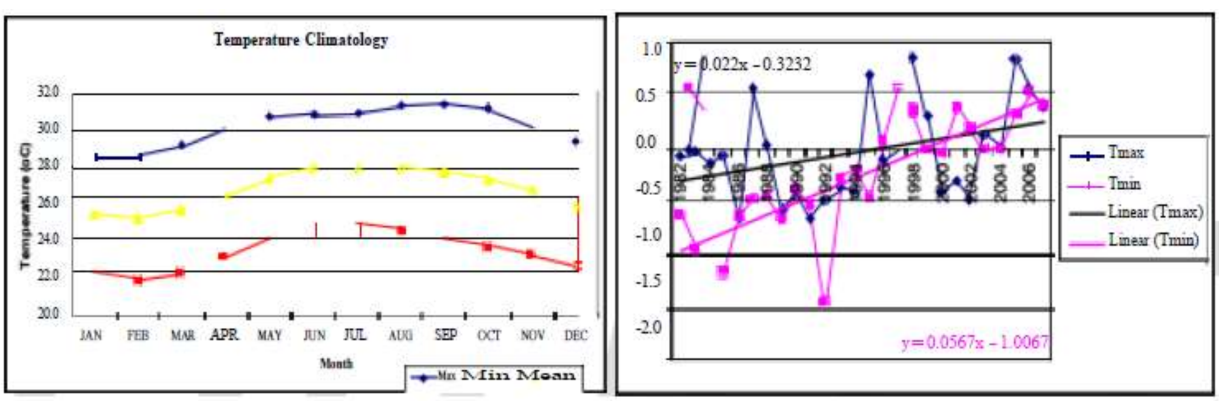


Figure 2.3 - The climatology of minimum, maximum, and mean temperature for Dominica (Melville Hall Airport 1982 -2007). Units are ° C. (b) Annual maximum and minimum temperature anomalies for Dominica (Melville Hall Airport 1982 -2007). Anomalies are with respect to a full period. Trend lines added.

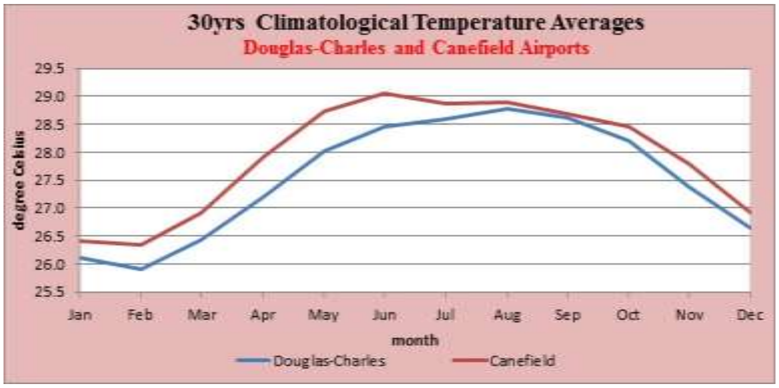


Figure 2.4: Annual Temperature Averages

Rainfall patterns display considerable variability both on annual and locational basis. Nevertheless, Dominica's mountainous terrain makes it the wettest island in the eastern Caribbean with annual rainfall totals exceeding 10,000 mm (400 inches) in some of the higher elevations. The island experiences a dry season between the months of February to June, with November being statistically the wettest month. Relative humidity remains high throughout the year consistently averaging above 85% in mountainous interior areas. Generally rainfall is less on the islands western Leeward coast which, based on the prevailing winds, is within a rain-shadow of the mountainous interior.

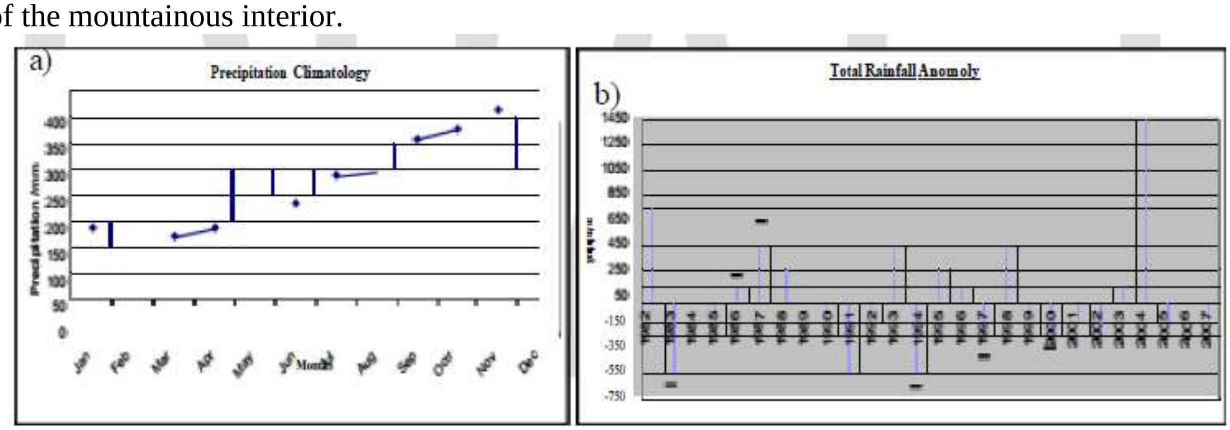


Figure 2.5: Mean annual monthly rainfall. Units are mm/month. (b) Rainfall anomaly with respect to full base period. Units are mm.

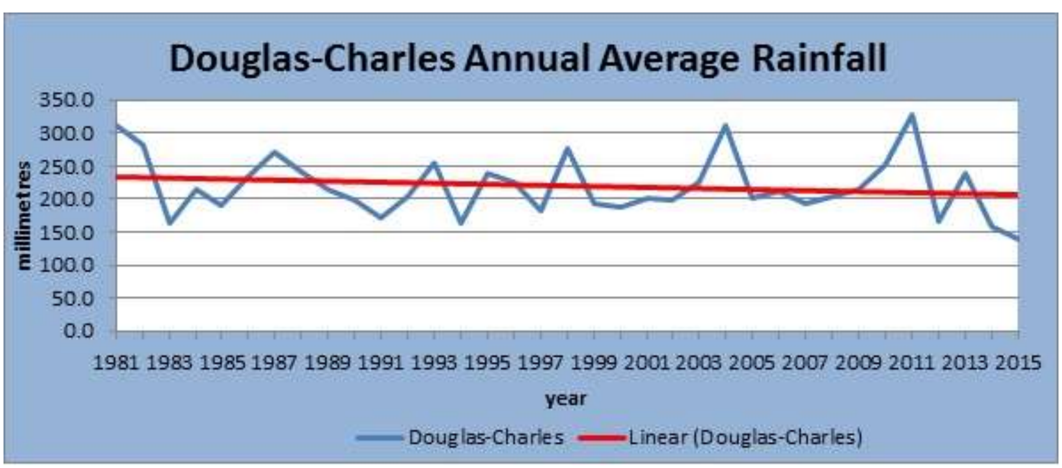


Figure 2.6: Rainfall data for Melville Hall Airport (1981 -2015)

The island lies within the Atlantic hurricane belt. A Report by the World Bank (*Dominica: Natural Disasters and Economic Development in a Small Island State.* World Bank. October 2001.) provides the following summary concerning Dominica's historical exposure to hurricanes and tropical storms for the period from 1886 to 1996:

Figure 2.7. General Tropical Storm and Hurricane Statistics for Dominica from 1886 to 1996 (Source: World Bank)

Number of storms	61
Years with storms	45
Years with multiple storms	13
Years with multiple hurricanes	1
Category 0, tropical storms	40
Category 1, hurricanes	13
Category 2 "	3
Category 3 "	3
Category 4 "	2
Category 5 "	0

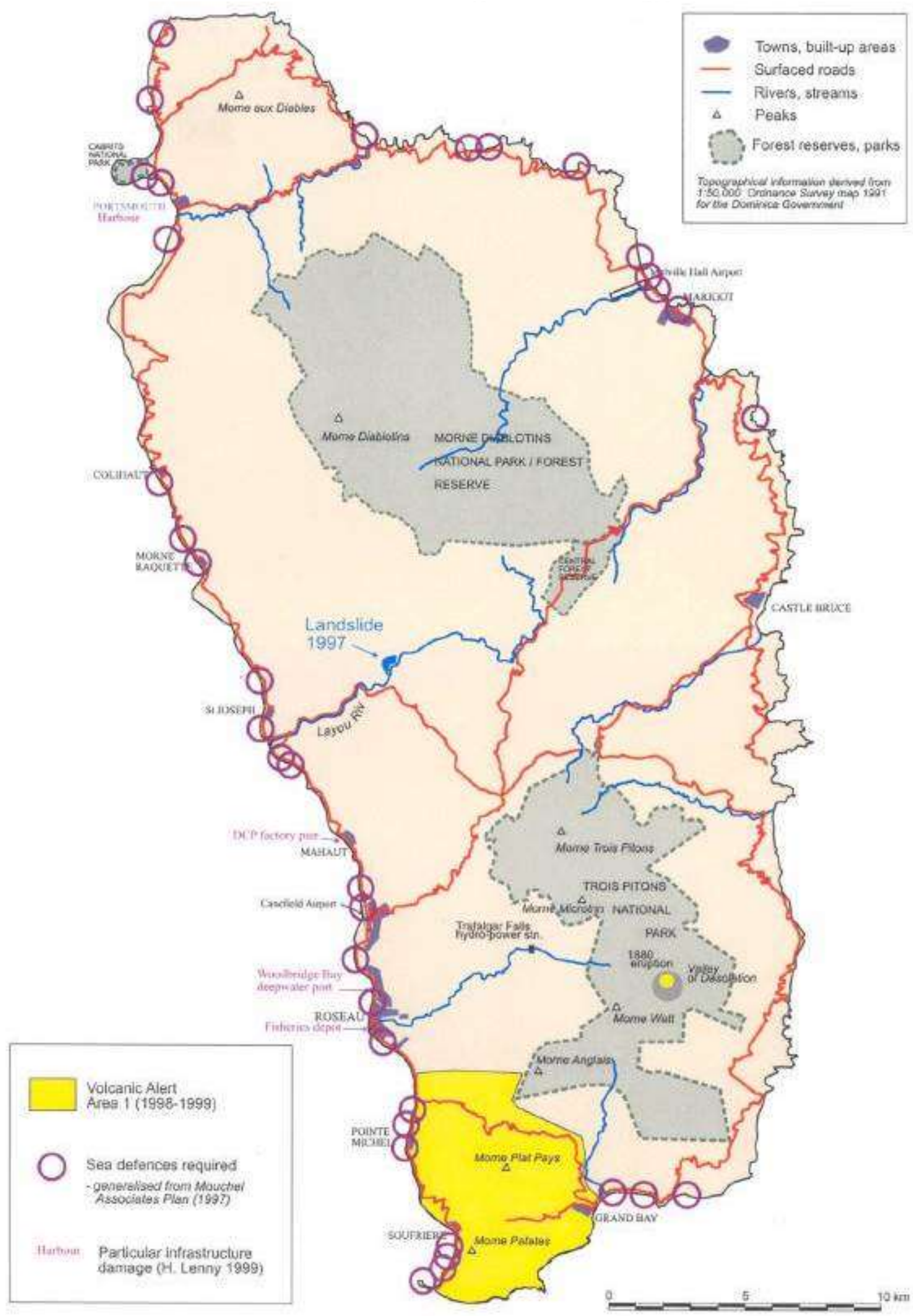
Since the late 1970s the island has been severely affected by a number of hurricanes and tropical storms. In 1979 Hurricane David caused extensive destruction particularly in the southern parts of the island. Hurricane Frederick, which closely followed, and Hurricane Allen in 1980 exacerbated the effects of David. In 1995, Hurricane Luis also caused wide-spread damage and in August 2007 Hurricane Dean struck the island causing widespread damage to agricultural outputs as well as to road infrastructure estimated at almost 20 percent of GDP. Tropical Storm Erika (2015) and Hurricane Maria (2017) together have caused damage amounting to in excess of 300% of GDP.

2.8. Hazards and Disasters

Dominica is vulnerable to numerous natural disasters arising from meteorological events (high wind, excess rainfall and hurricanes) and geophysical events (earthquake, volcano and tsunami). These recurrent events have significantly harmed both the population's socioeconomic well-being and the country's general economic and fiscal stability. Particularly damaging are events associated with excessive or prolonged rainfall, which provokes flooding and landslide activity. The highest elevations are located in the island's interior, and (due to orographic rainfall effects) these areas typically receive the highest rainfall. As river systems drain radially from the island's center to the coast, transit time for rainfall runoff is relatively short. This effect, coupled with the steeply sloping topography, creates the potential for flash floods.

With regards to physical vulnerability, steep topographic conditions and rugged interior dominate the island landscape, which has led to human settlements and physical development being highly concentrated along narrow coastal areas (particularly in the south and west). A significant proportion of Dominica's population as well as assets are therefore highly vulnerable to hurricanes as well as high-intensity rainfall, wind and storm surge events – see Figure 2.8. The island's mountainous landscape presents significant engineering challenges, particularly for road construction. In addition to the island's steep topography, underdeveloped and damaged infrastructure has been a key challenge to reducing vulnerability to disasters. Critical public infrastructure such as roads, bridges, and water supply systems as well as health and education facilities remain vulnerable to climate change–related impacts, including flooding and landslides. This vulnerability arises in part from the failure to consider natural hazard and disaster risk in designing and constructing infrastructure, and from deferring maintenance.

Figure 2.8: Dominica - Natural Hazard Vulnerability



Hydrometeorological disasters have historically imposed significant costs on the Dominican economy, leading to major declines in GDP growth and general productivity. The average annual economic losses associated with extreme hydrometeorological events are equivalent to roughly 7.4 percent of GDP. Singular events like Hurricane Dean (2007) caused extensive damage to the island, estimated at 58% of GDP, or US$162 million, with significant damage to buildings and infrastructure. More recently in 2011, record level flooding and landslides associated with heavy rain caused in excess of US$100 million in damage. In April 2013, heavy rains caused landslides, flooding and a 40-foot deep split in a section of the East Coast main road resulting in two deaths, and more recently in December 2013 heavy rains caused widespread damage to infrastructure and housing with damage estimates in the range of US$20 million. Tropical Storm Erika (2015) and Hurricane Maria (2017) together have caused additional damage amounting to in excess of US$1.85 billion which exceeds 300% of GDP.

2.9. Policy, Legal and Institutional Framework

Recognising the threats posed by climate change, Dominica has, over the last two decades, undertaken a number of initiatives to respond to this threat. Dominica ratified the *United Nations Framework Convention on Climate Change* (UNFCCC) in March 1994, and joined the community of nations committed to combating global climate change. In December 2001, Dominica submitted its *Initial National Communications* (INC) to the UNFCCC in fulfilment of its obligations under Article 12 of the Convention. This process was followed by the development of a *National Climate Change Adaptation Policy*, formulated with support under the Caribbean Planning for Adaptation to Climate Change (CPACC) Project, which was adopted by the Cabinet in 2002.

Dominica has established a strong track record on climate change adaptation, and in this regards was one of the few countries chosen to pilot adaptation measures under the Special Program on Adaptation to Climate Change (SPACC). Additionally, as a collaborative initiative between the SPACC program and the GEF-funded Sustainable Land Management (SLM) project, Dominica has pioneered: (a) the vulnerability mapping and “climate proofing” of National Parks Management Plans; and (b) community-based vulnerability mapping and the development, through community engagement and input, of community adaptation plans. Dominica has a history of successful implementing projects supported by multi-lateral partners upon which the ***Low-Carbon Climate-Resilient Development Strategy*** builds upon.

Many policy documents have been developed and/or approved by the Cabinet of Ministers that are specific to climate change or that incorporate or specifically mention climate change (Table 2.1). This are important milestones in the ongoing process to integrate climate change issues and concerns into the national development processes. Dominica is also a part of OECS, ALBA, CARICOM and AOSIS where efforts are being expended to ensure that climate change is addressed as a critical policy issue.

In addition to these policy documents that were prepared through extensive consultative processes, climate change has also received attention in recent budget addresses delivered by the Prime Minister of Dominica over the years. There have also been specific Cabinet Conclusions that are of relevance to climate change. The various climate change and other projects undertaken by Dominica, including the INC, SNC, SLM, SPACC and PPCR Projects support policy efforts to integrate climate change into national development processes. Dominica's ***Low-Carbon Climate Resilient Development Strategy*** is expected to reinforce this integration and lead the transformation to a low carbon climate-resilient Dominica.

Table 2.1: Key National Policy Documents that Incorporate or make Specific Reference to Climate Change

Year	Policy Document
2015	Dominica *Intended Nationally Determined Contribution* (INDC)
2014	Draft *Climate Change, Environment and Natural Resources Management Bill*
2012	Dominica ***Low Carbon Climate Resilient Development Strategy***
2012	Dominica ***Strategic Program for Climate Resilience*** (SPCR)
2012	Growth and Social Protection Strategy
2010	*Montreal Protocol (Substances that Deplete the Ozone Layer) Regulations*, 2010
2010	National Strategy for Health
2010	Sector Strategy, Natural Resources and Energy Sector Plan
2010	Tourism Policy 2010
2010	Draft Environmental & Planning Regulations for Renewable Energy
2010	Draft *Geothermal Development Bill*
2010	*National Energy Policy* (Draft)
2010	*National Integration Water Resources Management Policy* (Draft)
2009	*Dominica Forestry Policy*
2009	***Disaster Management Plan***
2009	*National Emergency Management Policy*
2009	*National Shelter Policy*
2007	National Policy for the Agriculture – Environment (Agri – Eco) System, 2007 – 2025,
2006	Growth and Social Protection Strategy
2005	National Biosafety Framework
2005	Draft National Implementation Plan on Persistent Organic Pollutants
2004	*National Environment Policy/National Environment Management Strategy*
2002	Dominica's ***Policy on Planning for Adaptation to Climate Change***
2002	*National Biodiversity Strategy and Action Plan*
1998	Plan to reduce the vulnerability of school buildings to Natural Disasters

In Dominica, there are over 105 pieces of legislation relating to the environment and natural resource management some dating back over one hundred years - these can be broadly broken down into 5 categories (legislation dealing with human health, marine resources, terrestrial resources, human development and aquatic resources) and focus on dealing with a specific problem rather than taking an integrated approach to managing natural resources and the environment in a sustainable manner. There have been a number of reviews of Dominica's environmental and resource management legislation over the past 15 years which have all come to the conclusion that comprehensive environmental and natural resource management legislation is an urgent priority in order to prevent irreversible environmental damage to the natural resources upon which Dominica relies for sustained economic and social development. The existing legislation is outdated - many of the Acts pre-date the signing of international environmental agreements by Dominica that enshrine new and evolving environmental principles/concepts and concerns such as climate change and the sustainable use of natural resources, and the greater appreciation of the interconnectedness of environmental protection with other facets of development.

There are substantial gaps and overlap between existing legal mandates for natural resource management amongst various ministries with resultant confusion over jurisdiction roles – more particularly there is no legal basis to ensure:

- functional co-ordination amongst various Departments/agencies to ensure sound and coordinated environmental protection and the sustainable management of finite resources for Dominica's long term benefit;
- site-specific coordination in the management of natural resources.

Save for a few pieces of legislation, the present legal framework in Dominica does not meet Dominica's obligations under the 27 Multilateral Environmental Agreements (MEAs) to which the country is a signatory – most notably the agreements dealing with Climate Change, Pollutants and Hazardous Substances, Biodiversity, Biosafety. Dominica's physical planning legislation deals largely with terrestrial resources leaving inadequate regulatory control over aquatic, coastal or marine resources. There is no legally established institutional framework for coordinating environmental protection and natural resource management in Dominica. There is no legislation to ensure environmentally sound and sustainable management of natural resources outside forestry and parks areas. There is no legislation for the management of marine pollution, biosafety or hazardous substances, and there is no legislation to control Greenhouse Gas (GHG) emissions or promote energy efficiency and the use of renewable energy.

A recent review undertaken under the GEF-funded *Sustainable Land Management* (SLM) project determined that consolidated Environmental and Natural Resource Management legislation is required as an urgent national priority in order to address the following gaps and deficiencies:

- ➢ legislation is required to address pollution and hazardous substances, climate change, introduction of new technologies and to implement Multilateral Environmental Agreements (MEAs) to which the country is a signatory;
- ➢ legal establishment of a department or agency is required to facilitate functional site-specific co-ordination for effective environmental protection and natural resource management, and to ensure the climate proofing of development activities;

- the establishment of effective and coordinated site-specific management of natural resources and environmental protection.

In 2012, Cabinet approval was obtained to commence the consultation process to develop and draft comprehensive *Climate Change, Environment and Natural Resource Management Legislation* for Dominica in collaboration with the Office of the Attorney General. This new legislation is expected to establish key legal and institutional frameworks needed to effectively implement **Dominica's *Low-Carbon Climate Resilient Development Strategy*** (see below). Government expects to enact this new legislation by the end of 2019.

Proposed Climate Change, Environment and Natural Resource Management Legislation

Proposed legislation is to establish the legal and institutional framework to support the transitions to a climate resilience low carbon development path, in part through the following provisions:

1. Legally establish Council on Environment, Climate Change and Development (section 8) to coordinate government response to climate change (section 14);
2. Legally establish the National Climate Change Committee (section 30) with mandate to regularly update Climate Change Policy and coordinate commitments under United Nations Framework Convention on Climate Change (UNFCCC);
3. Council on Environment, Climate Change and Development to establish National Emergency Planning Organisation Advisory Committee (section 34) to coordinate government response to natural and man-made disasters;
4. Legally establish the National Emergency Management Office (section 35) with mandate to coordinate disaster contingency planning and management (section 36);
5. Requires National Disaster Response Equipment Inventory and Contingency Plan (section 37) and Disaster Response Measures (section 38);
6. Requires that climate change be considered as part of Environmental Impact Assessment (EIA) process (sections 39-44);
7. Promotes energy conservation and renewable energy measures (sections 46-48) that reduces dependence upon imported fossil fuels in keeping with commitments under UNFCCC and Paris Agreement thereby building resilience in remote communities affected by disruptions to electrical supply caused by extreme weather events;
8. Establishes measures to manage and reduce pollution (sections 50 to 61 and Parts X and XI) which is required to enhance ecosystem resilience to better withstand and adapt to impacts from climate change;
9. Establishes measures to improve the management and increase resilience of critical ecosystems and habitats (Part XII to Part XV) including oceans and forest which are vital carbon sinks, and water which is critical for human health and livelihoods;
10. Establish legal and institutional framework for "direct access" to international climate change financing.

A variety of stakeholders in a wide range of institutions play an important role in climate change related activities in Dominica. The continued and active involvement of these stakeholders is necessary if Dominica is to achieve it commitments to stabilize Green House Gas emissions and more importantly for successful implementation of both mitigation and adaptation measures. These institutions come from the public, private and civil society sectors.

Up to the end of 2017, the Ministry of Health and the Environment (MOHE) had primary institutional responsibility for environmental management, sustainable development and climate change matters in Dominica with the Environmental Coordinating Unit (ECU) of the MOHE serving as the technical focal point for all multi-lateral environmental agreements, including the UNFCCC, the United Nations Convention to Combat Desertification, and the Convention on Biological Diversity. The ECU also has direct responsibility for coordinating all activities related to the conventions nationally. The ECU's mission statement "is to function as the coordinating, facilitating, administering and collaborating body for all environmental management and sustainable development management programmes, projects, and activities in the Commonwealth of Dominica". However, whilst the unit has this responsibility, it has no legal power to enforce these obligations.

The Environmental Co-ordinating Unit (ECU) was established in 1999 and also serves as a clearinghouse mechanism for other international agreements not directly under its control, such as International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the United Nations Convention on the Law of the Sea (UNCLOS), the Cartagena Convention, the Basel Convention and the Stockholm Convention. However, the ECU has no legislative authority to execute obligations under such agreements. In addition, the Unit remains chronically under-staffed. Compounding this problem, all records and documents (electronic and hard copies) held by the ECU have been lost when the offices, equipment and computers of the ECU were destroyed during Hurricane Maria.

The Forestry, Wildlife and Parks Division is a Division of the Ministry of Agriculture, Fisheries and Forestry and has a long history of being responsible for terrestrial environmental management. The Forestry Division, established in 1949, has a sound history of protecting Dominica's pristine environment, dating back to the early 1950's. This Division is generally responsible for forest, wildlife, watershed and National Parks management.

The Fisheries Development Division (FDD) undertakes fisheries, coastal and marine management, including management of marine reserves and marine protected areas. Much of the work of the FDD is pursuant to the requirements of the United Nations Convention of the Law of the Sea (UNCLOS). This department is tasked with the management of the marine resources for the benefit of the people of Dominica, including sustainable use and development of fisheries and other living coastal and offshore resources. Management is based on the recognition that the marine resources are significant to national development, the sustenance of livelihoods, the generation of employment, and food and nutrition security.

The Division of Agriculture of the Ministry of Agriculture, Fisheries and Forestry focuses on agriculture programmes, soil conservation, research, agroforestry and agronomy. In regards to climate change resilience, the objective of the Division is to build an agriculture sector resilient to the vulnerabilities and effects of climate change and other mitigating factors or occurrence, whether environmental, economic or political. This includes areas of risk management, analysis/measurement and mitigation. Building climate resilience in the agricultural sector will be achieved though:

- Developing an adaptive strategy to minimize risk to the sector;
- Developing and adopting adaptation measures to increase resilience to natural and other shocks;
- Developing and transferring climate proofed technologies for use by farmers;
- Developing an efficient system to assess losses due to climatic conditions and diseases and pests;
- Building partnerships for capacity building and institutional strengthening for climate change interventions;
- Employing biological and other sustainable management methods for pests and diseases;
- Strengthening micro- and other financing systems, farm safety and security, and risk management;
- Achieving biodiversity and environmental integrity.

The Pesticide Control Board manages the importation, use and safety of pesticides in Dominica, and advises the Minister of Agriculture and the ECU on the regulation of pesticides.

The Ministry of Communication, Works and Housing also plays a role in environmental management through two Divisions, namely the Division of Works which has responsibility for roads and related infrastructure, and the Housing Division.

The Physical Planning Division is responsible for the orderly development of land, including preparation of physical development plans. This division also processes applications for development and regulates construction of buildings and other structures. In this capacity, the Division administers an environmental impact assessment (EIA) process in collaboration with the ECU.

Under the Ministry of Health and Environment, the Environmental Health Division monitors water supply systems, liquid and solid waste disposal systems, provides building control services, investigates communicable diseases, implements food safety and disaster preparedness programmes, enforces health and safety, and implements institutional and recreational hygiene standards. It also has responsibility for developing occupational health standards.

Disaster preparedness is organized within the Ministry of Communications, Works and Housing (MCWH). This arrangement brings most of the public sector's disaster mitigation and rehabilitation expenditure and preparedness under one Ministry. The national Office of Disaster Management (ODM) is currently a small unit within the MCWH, headed by an Assistant National Disaster Coordinator, who carries out most responsibilities, as there is no National Disaster Coordinator, apart from the Permanent Secretary, MCWH. The unit is insufficiently staffed, as reflected in the implementation of the World Bank's disaster preparedness project. The considerable strengthening of the ODM is proposed under this project. Dominica has a National Disaster Plan and multi-hazard plans. The National Disaster Plan, which was issued in 1996, is a substantial and detailed document, which is basically concerned with disaster preparedness. It outlines the duties and responsibilities of various government, civil and private organizations such that the country will be in a constant state of preparedness, that necessary precautions can be taken after warning of an imminent hazard, that immediate relief efforts are effective, and that post-disaster restoration of essential services is as rapid as possible. In contrast, the Plan largely overlooks responsibilities with regard to long-term hazard mitigation and prevention, despite the foreword stating that the effects of Hurricane David 'could have been mitigated and that recovery would have been faster and more orderly if we had all been prepared' (GoCD, 1996b: 2).

According to the Plan, each Government agency is also responsible for drawing up its own internal disaster manual but it is not clear to what extent this has actually been done. It also focuses on immediate and shorter term, primarily humanitarian, requirements. The Plan provides little guidance on measures to address the economic impacts of disasters and promote economic recovery after the event. The few notable exceptions are where aspects of disaster mitigation are addressed relate to the need for hurricane proofing of buildings (p37) and for the protection of beaches and dive areas against pollution, including dispersed oil.

The Department of Local Government and Community Development and the Government Information Service are also tasked with arranging dissemination of information on disaster prevention, but the scope and nature of this material is not indicated.

The Ministry of Agriculture is assigned responsibility for developing a sectoral plan for the relocation and care of livestock in the hazard areas and for assisting relocated people in continuing agricultural related activities. There is, however, no mention of measures to protect non-capital assets (e.g. fishing equipment) that are important for sustaining livelihoods. The Plan also recognizes the adverse impact that an evacuation could have on the private sector and indicates that assistance has is provided to private sector organizations to develop plans specific to their requirements. It anticipates that ‘these plans will focus attention on distribution services and the establishment of linkages with local and international agencies for the provision of emergency supplies’ (p19).

In regards to climate change mitigation, the Energy Unit in the Ministry of Trade, Energy and Employment is responsible for energy policy and for coordinating the development of Dominica’s geothermal resources. The ECU has been the lead agency responsible for coordinating the development of various climate change mitigation strategies, including the Dominica *Low Carbon Climate Resilient Development Strategy* and the *Intended Nationally Determined Contributions* (INDC).

The Ministry of Planning, Economic Development and Investment was appointed in December 2017 as the National Designated Authority (NDA) to the Green Climate Fund (GCF).

A number of statutory corporations play an important role in environmental management and climate change planning. The Dominica Electricity Services Ltd. (DOMLEC) is the only electricity utility company in the country, and is responsible for the generation, transmission and distribution of all electricity on the island.

The Dominica Solid Waste Management Corporation is responsible for all solid waste disposals throughout the island. It controls the establishment and management of waste dumpsites and collection points.

The Dominica Water and Sewage Company (DOWASCO) a Statutory Body responsible for water and sewage development, has put in place reliable, safe and sustainable water facilities at all major communities and population centres. Small reservoirs and water catchment areas have been developed island-wide. In the capital of Roseau, a recently completed sewer system has been commissioned.

The Dominica Bureau of Standards (DBOS) which is placed within the Ministry of Trade, also renders institutional support to the development of viable standards to industry which has positive implications for the environment.

Other organizations involved in environmental management and climate change programming include the National Association of Non-Governmental Organisations (NANGO), which is the principal NGO operating in Dominica. It is made up of all registered Non-Governmental Organizations in the State. NANGO has played a pivotal role in many environment related development process such as the development and implementation of the *National Biodiversity Strategy and Action Plan* (NBSAP) and the *Dominica Low-Carbon Climate Resilient Development Strategy*, and are actively represented on many environmental committees. A few Government agencies and NGOs work closely together in environmental management and climate change programming, such as NANGO and ECU.

Community Based Organisations (CBOs) are few in number and include the Local Authority Management Area (LAMA) of the Scotts Head – Soufriere Marine Reserve (SSMR). This organization is mandated by statutes, derived from the powers vested under the *Fisheries Act* of 1987, to develop measures and manage a section of Dominica’s ocean space and its resources for the benefit of the fishing community while making allowances for the other parties that interact with the same resource base. This CBO works through the direct involvement of groups from three adjacent communities and a variety of other independent private sector stakeholders. This organisation has a strong environmentally-inclined educational, research, monitoring and control focus.

Chapter 3: Greenhouse Gas (GHG) Inventory

This section presents the outcomes of the inventory of Greenhouse Gas (GHG) emissions for the years 2006 to 2017 inclusive as a component of Dominica's *Third National Communication* (TNC). The GHG inventory includes information for the year 2005 which was the last year reported in the *Second National Communication* for Dominica.

The greenhouse gas inventories were compiled using the 2006 *Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories*. The gases included in the current inventories are the direct GHGs found in Dominica namely, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and partially fluorinated hydrocarbons (HFCs) and the indirect GHGs – non-methane volatile organic compounds (NMVOC), and sulphur dioxide (SO_2).

3.1. Greenhouse Gas Inventory - Results

Estimates of the GHG inventories for 2005 and 2006 to 2017 are summarized in Table 3-1 (for some of the GHG's) and Table 3-2 (for CO_2 only).

Table 3.1 Comparisons of GHG Emissions (Gg) for 2005 to 2017

Year/Emissions	CO_2	CH_4	N_2O	NMVOC	SO_2	HFCs
2005	119.00	1.56	0.097	2.30	0.218	0.003
2006	122.01	1.32	0.0054	0.172	0.250	0.042
2007	128.46	1.32	0.0054	0.074	0.274	0.056
2008	122.46	1.37	0.0055	0.142	0.248	0.060
2009	133.78	1.33	0.0054	1.110	0.282	0.049
2010	141.56	1.33	0.0054	0.043	0.299	0.046
2011	149.80	1.35	0.0054	0.850	0.316	0.045
2012	158.91	1.37	0.0054	0.583	0.335	0.053
2013	161.02	1.37	0.0054	0.358	0.339	0.046
2014	167.23	1.38	0.0053	0.645	0.355	0.051
2015	170.14	1.38	0.0053	0.524	0.362	0.049
2016	169.83	1.38	0.0053	0.481	0.356	0.049
2017	156.20	1.55	0.0048	0.455	0.305	0.046

The percentage contributions of CO_2 emissions by subsectors within the energy sector for the base year 2006 utilizing the Sectoral Approach is presented in Table 3-2. Energy Industries (35%) and Transportation (42%) subsectors are the main contributors, accounting for roughly 77% of total emissions from the sectors. The contributions from these sectors are similar in the years assessed and accounted for between 75% and 80% of the CO_2 emissions while the Other Sectors comprising residential, commercial and forestry and fishing subsectors (14%) and Manufacturing Industries & Construction sector (9%) respectively accounted for the remainder.

Table 3.2 Comparisons of CO_2 Emissions (Gg) for 2005 to 2017

Sectorial Categories	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Energy	119.0	122.01	128.46	122.46	133.78	141.56	149.80	158.91	161.02	167.23	170.14	169.83	156.20
Fuel Combustion (sectoral Approach)	119.0	121.01	123.46	120.46	130.78	141.56	145.80	154.91	160.02	164.23	170.14	162.83	153.20
1A.1. Energy Industry (electricity)	41.8	42.70	44.96	42.86	46.82	49.55	55.43	63.56	53.14	50.17	56.15	54.35	46.86
1A.2. Manufacturing Industries & Construction	11.0	11.10	11.69	11.14	11.37	12.03	12.73	13.51	13.69	14.21	9.24	6.01	4.08
1A.3. Transport (road transportation)	46.8	51.24	53.95	51.43	54.85	56.62	59.92	60.38	64.41	70.24	69.76	71.33	67.17
1A.4. Other Sectors	19.5	16.96	17.86	17.02	20.74	23.36	21.73	21.46	29.78	32.61	35.00	38.15	38.09
a. Commercial /Institutional	15.4	10.25	10.80	9.67	12.71	14.86	12.74	11.92	20.12	22.58	24.79	27.96	28.71
b. Residential (LPG)	3.29	5.49	5.78	5.51	6.02	6.37	6.74	7.15	7.25	7.53	7.66	7.64	7.03
c. Agriculture/ Forestry/ (mainly Fishing)	0.76	1.22	1.28	1.84	2.01	2.12	2.25	2.38	2.42	2.51	2.55	2.55	2.34

The transport sector has the largest CO_2 emissions (from a low of 51.24 Gg in 2006 to a high of 71.33 Gg in 2016) and accounts for an estimated 40% of the emissions between 2006 and 2017.

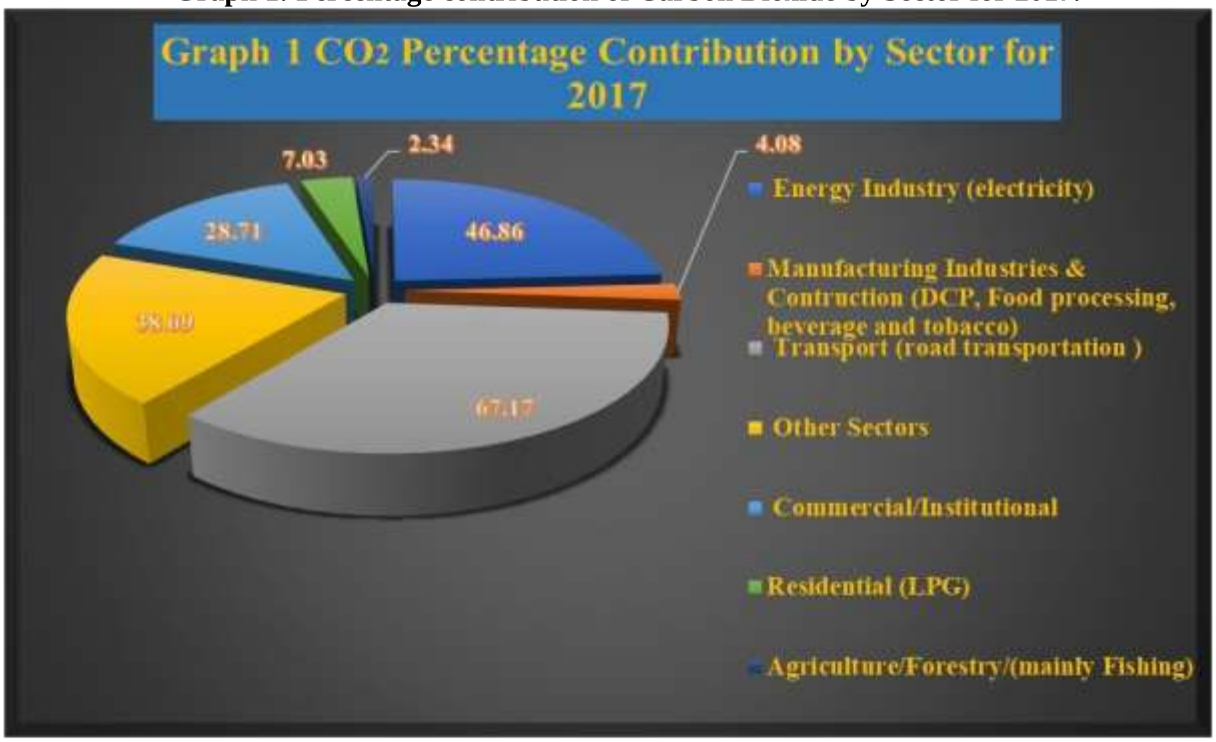
The Energy sector registered a 27.3% increase from 2006 to 2016 moving from 42.70 Gg to 54.35 Gg. This sector also recorded 50.55 Gg on average over a 11 years period, with 2012 registering the highest increase based on decreased use of hydro and increased diesel generation in that year[1]. In 2012, there was an operational issue with the Padu hydro-turbines with one of the units at New Trafalgar being out of service as it developed a fault, thereby causing a reduction in output of hydro-electricity, hence diesel was mainly used for power generation by DOMLEC. In addition, variance in electricity over the period was based on trending from hydro to diesel generation over the period.

Transport, Other, Manufacturing and Construction Sectors recorded an average of 60.94 Gg, 26.06 Gg and 10.94 Gg over the 11 years period. Transport and Others Sector registered their highest increases in 2016 of 71.33 Gg and 38.15 Gg, while Manufacturing and Construction sector recorded the second lowest of 6.01 Gg in that same year.

[1] DOMLEC Performance Report 2016, Pg.23 Figure 4a.

Graph 1 below illustrates CO_2 percentage contribution by sector with Road Transportation recording the highest (67.16%) followed by Energy Industries (46.86%).

Graph 1: Percentage contribution of Carbon Dioxide by Sector for 2017.



3.2. Uncertainties

Uncertainties in the inventory arise from both emission factors and the activity data. Approved statistical adjustments were undertaken with activity data to facilitate accuracy and consistency in reporting. Since default emission factors were used, their uncertainties are those recommended in the *2006 IPCC Guidelines for National GHG Inventories*.

Uncertainties in the activity data were due mainly to the inconsistencies in the available data sets, either because records were not effectively maintained and/or not compiled at all. In such cases statistical analysis was conducted using Table 3.1 (Strategies for dealing with different causes of uncertainties) contained in *Volume 1: General Guidance and Reporting* and best estimates.

3.2.1. Energy Sector

The *Initial National Communication* (INC) included fuel import data (for Reference Approach calculations), end use emissions by fuel and estimates of CO_2 emissions for the energy sector. Detailed information on the fuel consumption for the energy subsectors was not available, hence expert opinions were used and estimates were made. The INC CO_2 emissions included estimates for naphtha and lubricants. It was assumed that the naptha was Spraytex that was used for banana leaf spot disease control which is not burned but is volatile and 50% are oxidised. NMVOC emissions from Spraytex were reported in the Solvent and Other Product Use sector. Emissions for the Energy Sector indicated increases in the later years relative to 2005 and this is consistent with increases in electricity generating capacity, electricity consumption and the motor vehicle fleet (see table 3.7. for licensed motor vehicles).

3.2.2. Methane

The original estimates for methane emissions (1.56 Gg) were higher in 2005 due to the high value for waste disposal on land (1.56 Gg in 2005 compared to 1.32 Gg in 2006) mainly due to improved industrial and domestic waste-water handling.

3.2.3. Nitrous Oxide

Nitrous oxide emissions in 2006 were reported as 0.0054 Gg from the waste sector, whereas in 2005 was report 0.097 [2]using 1996 IPCC guidelines.

3.2.4. Land Use Change and Forestry

The INC and SNC provided estimates for land use and forestry and carbon sequestration from these activities since no current data was available. A more comprehensive assessment for land use and forestry and carbon sequestration from these activities is provided in Chapter 4.

3.3. CO_2 Emissions

3.3.1. Methodology

Two methods were used to calculate the CO_2 emissions. These are the Reference Approach and the Sector Approach, the latter being an end-use or bottom-up approach and the former, a top-down approach based on aggregate fuel supply.

Dominica does not produce any primary or secondary fossil fuels. Secondary liquid fuels - gasoline, jet and cooking kerosene, gas oil/diesel, residual (heavy) fuel oil (Bunker C) and liquefied petroleum gas (LPG) and small quantities of ethane, naphtha and shale oil - are imported for local consumption. Lubricants and bitumen are also imported.

Activity data were obtained from several sources, namely:

a) The International Trade Center (https://www.trademap.org/);
b) Customs and Excise Division Dominica (http://customs.gov.dm/);
c) Central Statistical Office (CSO) Dominica, provided fuel import data and other sectors data from 2000-2016;
d) Imports and sales, gasoline and diesel for 2006-2017 were provided by West Indies Oil and Rubis West Indies Limited;
e) Annual fuel consumption data for electricity generation for 2005 to 2017 were obtained from Dominica Electricity Limited (DOMLEC);
f) Information was obtained from DCP and Fresh Company, Dominica Brewery Beverage Limited, Bello, Shillingford Estate concerning production for Industrial Waste Water;
g) UNFAO website for household consumption of Protein;

[2] Inclusive of agricultural sector data.

h) Information was obtained from Dominica Solid Waste Management (DSWM) concerning tonnage of waste matter brought to the landfill on an annual basis (21,000-25,000 kg which is partially estimated since their scale was occasionally non-functional);

i) Environment Coordinating Unit (ECU) for 2014, 2015, and 2017 data on HFC's emission (air conditioning and refrigeration units);

j) For quantity of road paved no data was available by year, hence import data was used for bitumen;

k) IPCC default emission factors were used in calculating emissions estimates in sectors where information was limited and/or not available.

3.3.2. Comparison of the Reference and Sectoral Approaches

The total national CO_2 emissions estimated by the Reference and Sectoral Approaches are summarized in Table 3.4. Data for the Reference Approach were based on import data with statistical adjustment for accuracy and consistency. Concurrence between the two approaches varies slightly and ranges from 0% to 4% for most of the years (Table 3.5.). For the Sectoral Approach data, expert opinions were mainly used with a degree of statistical analysis.

Although Hurricane Maria devastated Dominica in September 2017, nonetheless fuel (mainly motor vehicle) consumptions and imports were still higher in 2017 primarily based on higher 9 month (January to September) increments in 2017 compare to 2016, shown in Table 3.3 below. Also, a large percentage of Gas/Diesel oil was used in electricity generation, which was disrupted significantly as shown in Table 3.4.

Table 3.3. Imports and Consumption of Fuel Products in Tons, 2006-2017 (Tons)

Sub Category	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Motor Gasoline	13,839	13,410	13,946	14,365	15,227	16,140	17,109	17,451	17,800	18,067	18,609	19,074
Jet Gasoline	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Jet Kerosene	441	458	477	491	511	531	552	558	563	575	586	604
Gas/ Diesel Oil	22,565	24,822	22,340	25,467	26,995	28,615	30,332	30,635	32,167	32,810	32,154	27,331
Liquefied Petrolium Gases	2,547	2,750	2,833	2,847	2,932	3,020	3,262	3,295	3,393	3,397	3,431	3,534

Source: Imports data from custom with adjustment based on inconsistencies, 2006-2017

Table 3.4. Imports and Consumption of Fuel Products in Tons, 2006-2017 (Gg)

Sectorial Categories	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Energy	119.00	122.01	128.46	122.46	133.78	141.56	149.80	158.91	161.02	167.23	170.14	169.83	156.20
Fuel Combustion (sectoral Approach)	117.00	121.01	123.46	120.46	130.78	141.56	145.80	154.91	160.02	164.23	170.14	162.83	153.20
1A.1. Energy Industry (electricity)	41.65	42.70	44.96	42.86	46.82	49.55	55.43	63.56	53.14	50.17	56.15	54.35	46.86
1A.2. Manufacturing Industries & Construction	10.83	11.10	11.69	11.14	11.37	12.03	12.73	13.51	13.69	14.21	9.24	6.01	4.08
1A.3. Transport (road transportation)	49.98	51.24	53.95	51.43	54.85	56.62	59.92	60.38	64.41	70.24	69.76	71.33	67.17
1A.4. Other Sectors	16.54	16.96	17.86	17.02	20.74	23.36	21.73	21.46	29.78	32.61	35.00	38.15	38.09
a. Commercial /Institutional	10.00	10.25	10.80	9.67	12.71	14.86	12.74	11.92	20.12	22.58	24.79	27.96	28.71
b. Residential (LPG)	5.36	5.49	5.78	5.51	6.02	6.37	6.74	7.15	7.25	7.53	7.66	7.64	7.03
c. Agriculture/ Forestry/(mainly Fishing)	1.19	1.22	1.28	1.84	2.01	2.12	2.25	2.38	2.42	2.51	2.55	2.55	2.34

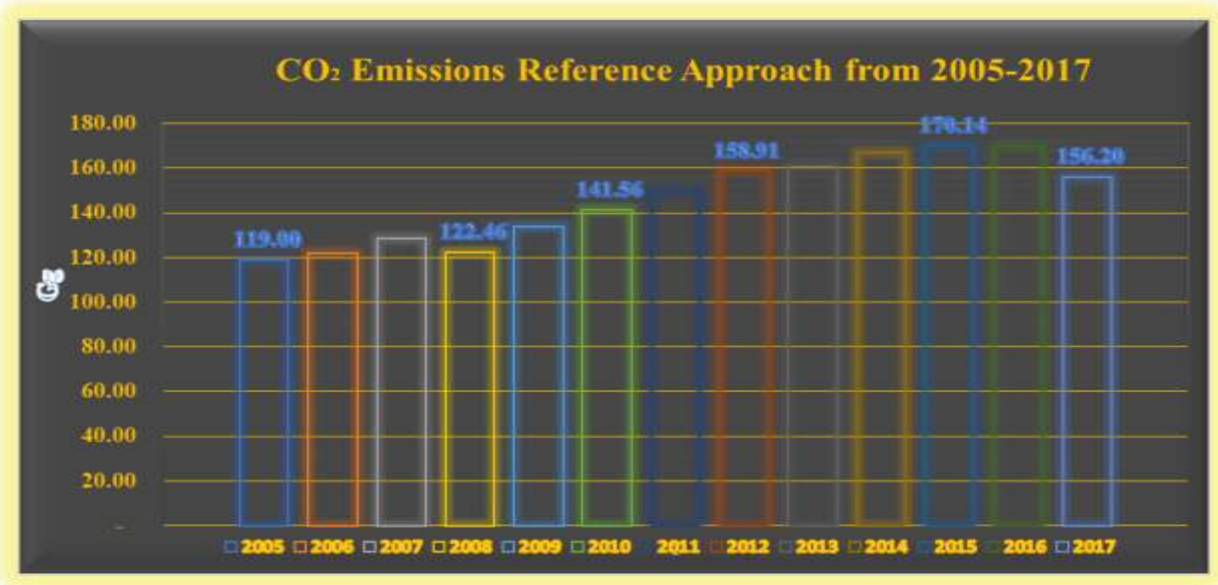
Source: Imports data from custom with adjustment based on inconsistencies, 2010-2017

Table 3.5. Comparison of CO_2 Emissions (Gg) for the Reference and Sectoral Approaches

Sectorial Categories	2000	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Reference Approach	106.00	122.01	128.46	122.46	133.78	141.56	149.80	158.91	161.02	167.23	170.14	169.83	156.20
Sectoral Approach	106.00	121.01	123.46	120.46	130.78	141.56	145.80	154.91	160.02	164.23	170.14	162.83	153.20

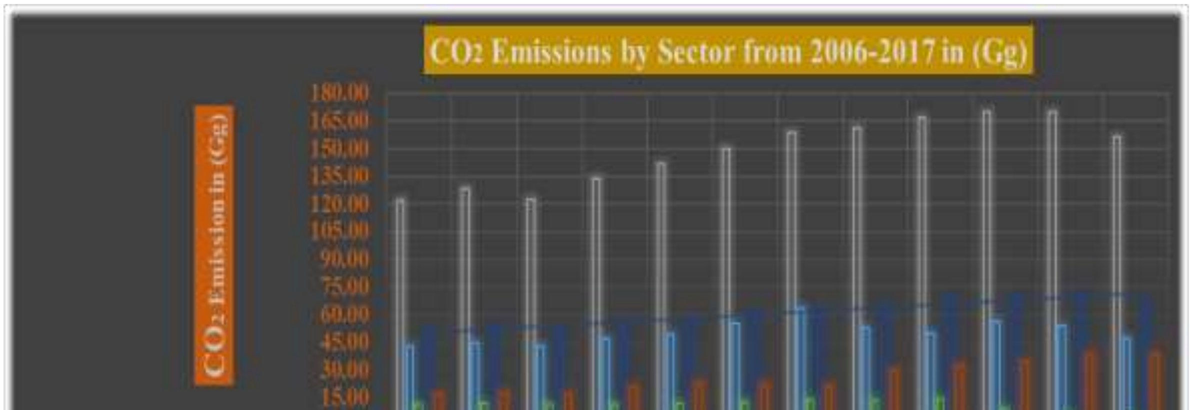
Source: Imports data from custom with adjustment based on inconsistencies

Graph 2: Reference Approach Emissions in Gg from 2005-2017.



Source: Imports data from custom with adjustment based on inconsistencies, 2006-2017

Graph 3: CO_2 Emissions (Gg) by Sector from 2006-2017.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Energy	122.01	128.46	122.46	133.78	141.56	149.80	158.91	161.02	167.23	170.14	169.83	156.20
1. Energy Industry (electricity)	42.70	44.96	42.86	46.82	49.55	55.43	63.56	53.14	50.17	56.15	54.35	46.86
2. Manufacturing Industries & Contruction	11.10	11.69	11.14	11.37	12.03	12.73	13.51	13.69	14.21	9.24	6.01	4.08
3.Transport (road transportation)	51.24	53.95	51.43	54.85	56.62	59.92	60.38	64.41	70.24	69.76	71.33	67.17
4.Other Sectors	16.96	17.86	17.02	20.74	23.36	21.73	21.46	29.78	32.61	35.00	38.15	38.09

Source: Imports data from custom with adjustment based on inconsistencies, 2006-2017

3.3.3. Energy Sector

The emission of CO_2 from 2006-2016 indicated a 39.2% increase over the period due to increase in electrical use, and an 8% drop from 2016-2017, mainly due to the passage of Hurricane Maria when less electricity was generated and/or due to limited road access where fewer motor vehicles were used from September 18, 2017 to 31st December 2017.[3]

Electricity generation (Energy Industries/DOMLEC) was the second highest contributor of CO_2 moving from a low of 42.70 Gg to a high of 54.35 Gg recording a 27.30% rise over the 11 years period. However, from 2016-2017 a 14% drop was recorded moving from 54.35 Gg to 46.86 Gg, mainly due to the passage of Hurricane Maria. After professional discussion and extensive assessment, it can be noted that there is a dire need to compile fuel (i.e., gasoline, diesel and LPG etc.) sales data to various end users (service stations, manufacturing, commercial/institutional and agriculture/forestry/fishing, tourism, etc.) to improve, verify and validate the emissions estimates by sectors and sub-sectors.

There are no reported data for the amounts of charcoal used or produced but census data reported in the Country Poverty Assessment (2008/9) and a survey of living conditions (Betti et al 2006) for 2001 indicate that 5% of households used charcoal and 13% use wood for cooking. Though this figure would be lower based on increased use of LPG's based on import figures and expert opinions.

Sectorial Categories	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1. Energy	122.01	128.46	122.46	133.78	141.56	149.80	158.91	161.02	167.23	170.14	169.83	156.20
Fuel Combustion (sectoral Approach)	121.01	123.46	120.46	130.78	141.56	145.80	154.91	160.02	164.23	170.14	162.83	153.20
1A.1. Energy Industry (electricity)	42.70	44.96	42.86	46.82	49.55	55.43	63.56	53.14	50.17	56.15	54.35	46.86
1A.2. Manufacturing Industries & Construction	11.10	11.69	11.14	11.37	12.03	12.73	13.51	13.69	14.21	9.24	6.01	4.08
1A.3. Transport (road transportation)	51.24	53.95	51.43	54.85	56.62	59.92	60.38	64.41	70.24	69.76	71.33	67.17
1A.4. Other Sectors	16.96	17.86	17.02	20.74	23.36	21.73	21.46	29.78	32.61	35.00	38.15	38.09

Table 3.6. Summary of Energy Sector CO_2 Emissions (Gg) from 2006-2017

[3] https://reliefweb.int/report/dominica/dominica-hurricane-maria-situation-report-no-1-25-september-2017

3.3.4. Transport Sector

The transport sector accounted for the largest amount of CO_2 emissions (ranging from a low of 51.24 Gg to a high of 71.33 Gg) from 2006-2016, while 2017 witnessed a slight drop to 67.17 Gg. As in most other developing countries, road transport consumes an increasing amount of petroleum, particular private cars and buses as noted in Table 3.7 below. This table shows the number of vehicles licensed between 2007-2017. An 11% increase in private vehicles was recorded, which represented the largest share of licensed vehicles during the period.

Table 3.7. Number of Motor Vehicles Licensed 2007-2017

CLASSIFICATION OF LICENCED MOTOR VEHICLES								
YEAR	**PRIVATE CARS**	**TAXIS**	**BUSES**	**MOTOR CYCLES**	**TRUCKS**	**SUVs**	**TRACTORS**	**TOTAL**
2007	9,721	368	1,343	269	2,291	3,972	23	17,987
2008	9,750	354	1,382	302	2,324	4,020	21	18,153
2009	9,760	350	1,414	359	2,330	3,856	38	18,107
2010	10,266	383	1,477	428	2,406	3,788	42	18,790
2011	10,316	357	1,471	432	2,378	3,655	41	18,650
2012	10,382	325	1,465	453	2,346	3,546	38	18,555
2013	10,266	322	1,491	380	2,320	3,437	36	18,252
2014	10,355	339	1,503	338	2,178	3,351	31	18,095
2015	10,598	354	1,579	323	2,051	3,154	34	18,093
2016	10,752	309	1,613	256	1,961	2,846	30	17,767
2017	10,810	268	1,571	231	1,901	2,385	39	17,205

Source: Inland Revenue Division.

3.4. Non-CO_2 Emissions

3.4.1. Methodology

Data was obtained from the Central Statistical Office (CSO), Government of the Commonwealth of Dominica, and trade import data for bitumen, personal care products, solvents and refrigeration and air conditioning products. Default IPCC emission factors based on import data were then used to estimate NMVOC emissions following the *2006 IPCC Guidelines*.

The *2006 IPCC Guideline* Tier 1 methodology was used to estimate the potential HFC emissions. The estimate was based on the number of different types of refrigeration and air conditioning products and equipment (e.g. household or larger commercial refrigerators and conditioning units). Data was obtained from customs and excise unit revised by contacting individually importers concerning quantity, type imported, and multiplied by quantity of HFC's content.

Data was available for 2014/2015/2017 from ECU (which manages an Ozone Depleting Substances Project) and extrapolated for the back years using import data for refrigeration and air conditioning units applying statistical adjustments for inconsistencies during some years. For fire protection, aerosols and other chemical use, import data was used with 2006 IPCC defaults factors to estimate the quantity of HFC's material in each product and potential losses.

Data for the quantity of road surface area paved or the amount of asphalt produced were not available. Hence, it was assumed that all the bitumen imported was used for road paving and that paving material contained 10% bitumen. The default emission factor for NMVOC emission for road paving was used.

Production data for brewery and alcoholic beverages products were obtained from the relevant companies, alcoholic production data was obtained from two main producers, and soap production from Dominica Coconut Products. Default emission factors offered under the IPCC workbooks were used in calculating the GHG emissions. Production data for bread and similar products were not available, therefore no emissions from bread making were estimated[4].

3.4.2. Energy Sector Non-CO_2 Emissions

Non-CO_2 emissions generated by the energy sector in Dominica include emissions of methane (CH_4), nitrous oxide (N_2O), non-methane volatile organic compounds (NMVOC), and sulphur dioxide (SO_2). The N_2O, SO_2 and HFC emissions (see Table 3.1.) are relatively small (less than 0.4 Gg) while the average annual CH_4, and NMVOC emissions were 1.32 Gg and 0.45 Gg respectively.

3.4.3. Industrial Sector Non-CO_2 Emissions

The Agro Processing Sector in Dominica is characterized by small to medium scale enterprises, which together employ an estimated 120 persons[5]. They, however, contribute significantly to forward and backward linkages within the economy with positive social and economic impacts particularly among farming communities in rural areas. Based on International Standard Industrial Classification of All Economic Activities (ISIC 3.1 Section D- ISIC), Code 154 (manufacture of other food products-bakery products) constitutes the largest component, Code 55 (manufacture of beverages and distilled spirits) and ISIC Code 242 (manufacture of other chemical products - paints and varnish) were the products mainly produced in Dominica.

The facilities that are sources of Non-CO_2 Emissions are bakeries, Dominica Brewery and Beverage Limited, paints, personal care products and asphalt paving which give rise to NMVOC emissions. HFC's are released from refrigeration and air conditioning, fire protection, aerosols, and other chemical use.

---

[4] Based on insufficient data, even after documentation reviews and expert opinions.

[5] Based on estimates carry out in 2015.

Table 3.8 Emissions from Industrial Processes (Gg)

	ANNUAL EMISSIONS (Gg)											
YEAR	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
NMVOCs	0.17	0.07	0.14	1.11	0.04	0.85	0.58	0.36	0.65	0.52	0.48	0.46
HFCs	0.042	0.056	0.060	0.049	0.046	0.045	0.053	0.046	0.051	0.049	0.049	0.046

Source: Research conducted using 2006 IPCC methodology

3.4.4. Solvent and Other Product Use

The use of solvents and certain products can result in emissions of NMVOCs. Nitrous oxide is released in certain medical applications (anesthetics), which is relative small and where there is insufficient data for analysis. These source categories are included in the Revised IPCC Guidelines, although there is no specific guidance in the IPCC manuals on how to estimate the emissions from these sources.

3.4.4.1. Methodology

Emissions from solvent and product use were calculated in the 2005 inventory. For this inventory, estimations of NMVOC emissions were estimated for products such as paints, varnishes, thinners, enamels and household product use. Estimates of the emissions from solvent and other product use are based on the amounts of products used and the percentage of NMVOC or N_2O that evaporates during use. Import data for paint products were obtained from the CSO and it was assumed that all imports were used in the same year. In addition, it was estimated that imported paints had the same solvent content limits as the US EPA solvent content limits. The emission factors represent the use of household products in the US and no data on the use of these products in Dominica (i.e., country-specific emission factors) were available. The emission factor was multiplied by the population in each year to give the NMVOC emissions from household product use in each year. Import data for paints categorized based on typical solvent content and the corresponding emission factors are summarized in Table 3.9.

Table 3.9. Emission Factor and Import Data for Paint

	Emission factor (g/Litre)	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015p	2016p	2017e
Enamels	450	38,305	36,697	25,804	13,159	12,867	7,498	10,096	22,194	88,983	26,316	26,391	28,319
Varnish	450	17,245	16,088	9,972	3,930	67,046	6,732	8,009	8,501	9,531	16,246	17,142	19,029
Water based	250	7,701	9,940	13,551	6,359	3,110	14,468	11,475	30,907	17,483	13,908	13,958	15,044
Polyester	250	-	-	-	-	-	-	-	-	-	-	-	-
Paints (Spray, automotive and other paints)	250	107,816	64,203	106,174	103216	58,831	70,163	90,583	68,487	74,299	81,679	89,907	80,092
Total Emissions (Gg)		**0.050**	**0.039**	**0.042**	**0.032**	**0.047**	**0.025**	**0.031**	**0.036**	**0.062**	**0.040**	**0.042**	**0.041**

3.4.4.2. NMVOC Emissions

Estimates of the total NMVOC emissions from Solvent and Other Product Use as shown in Table 3.10.

Table 3.10 NMVOC Emissions (Gg) from Solvent and Other Product Use

	ANNUAL EMISSIONS (Gg)											
Year	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Paints	0.050	0.039	0.042	0.032	0.047	0.025	0.031	0.036	0.062	0.040	0.042	0.041
Personal Care Products	0.184	0.299	0.269	0.309	0.467	0.439	0.339	0.242	0.322	0.336	0.354	0.358
Total	**0.23**	**0.34**	**0.31**	**0.34**	**0.51**	**0.46**	**0.37**	**0.28**	**0.38**	**0.38**	**0.40**	**0.40**

Source: Research conducted using 2006 IPCC methodology

3.5. Waste Sector

Emissions from the waste sector arise from the treatment and disposal of municipal or industrial solid waste and from the treatment and disposal wastewater from domestic and industrial sources. Solid waste treatment methods include disposal in landfills or burning waste in incinerators or in waste to energy plants. The main pollutants released during these processes are CH_4 and CO_2 from landfill sites and other pollutants from incineration. Wastewater treatment can release CH_4 in anaerobic systems and CO_2 in aerobic systems.

Dominica has two solid waste disposal sites one of which was closed in 2005. There is a sewage system in Roseau which is used to convey sewage from residencies and businesses in Roseau and surrounding communities to a primary treatment facility and then to a submarine outfall.

Domestic sewage in rural areas is treated in individual septic pits or latrines. There are no municipal or industrial wastewater treatment facilities.

3.5.1. Methodology

The IPCC methodology for estimating CH_4 emissions from SWDS is based on the First Order Decay (FOD) method. This method assumes that the degradable organic component (degradable organic carbon {DOC}) in waste decays slowly throughout a few decades, during which CH_4 and CO_2 are formed. If conditions are constant, the rate of CH_4 production depends solely on the amount of carbon remaining in the waste. As a result, emissions of CH_4 from waste deposited in a disposal site are highest in the first few years after deposition, then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

Tier 1: The estimations of the Tier 1 methods are based on the IPCC FOD method using mainly default activity data and default parameters.

Indirect N_2O emissions from human sludge were estimated from the nitrogen content of human sludge which was based on the per capita protein consumption of an average person in Dominica and then by applying a default IPCC emission factor (kg N_2O/kg human sludge N). A waste characterization study (DSWMC, 2006) conducted in 2002 provided country-specific estimates of the degradable organic carbon in waste. Data for waste received at the sanitary landfill during the months of 2012 were used to estimate the per capita waste generated. In addition, expert opinion from the landfill manager/s and it was estimated that the per capita waste generation in 2007 (21,000-25,000 kg annually) was the same in 2012- 2016. Population data obtained from the CSO and per capita solid waste disposal noted above were used to calculate total solid waste per year.

The 2006 IPCC methodology indicated much higher figures than 1996 methodology when using the IPCC Spreadsheet for estimating Methane Emissions from Solid Waste Disposal Sites (IPCC Waste Model). In addition, these changes may require countries to recalculate their results for previous years, so that the time series will be consistent. The new spreadsheet provided for the IPCC FOD method automatically calculates emissions for all past years. However, it is important to ensure that the data input into the model form a consistent time series. The FOD model requires historical data as far back as 1950, so this is a significant task. As such the model was not used and adjustments were made using 2006 guidelines.

3.5.2. CH_4 Emissions from Solid Waste Disposal Sites

Emissions of methane (CH_4) and nitrous oxide (N_2O) are shown in Tables 3.11 and 3.12 respectively. In 2000 there were a lot more solid waste disposal sites located all over the island as compared to the period 2006-2017. This explains the drop in CH_4 emissions from the year 2000 and the revise 2006 IPCC guidelines accounts for some changes

Table 3.11. CH_4 Emissions from Waste (Gg), Dominica, 2000, 2006-2017

CH_4 Emissions (Gg) 2000, 2006-20017													
Category	**2000**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Solid Waste Disposal on Land	0.47	0.41	0.42	0.46	0.42	0.42	0.44	0.46	0.46	0.47	0.47	0.47	0.64
Wastewater Handling	0.209	0.893	0.893	0.893	0.893	0.893	0.893	0.893	0.892	0.892	0.892	0.891	0.891
Waste Total	**0.679**	**1.31**	**1.31**	**1.35**	**1.31**	**1.31**	**1.34**	**1.36**	**1.36**	**1.36**	**1.36**	**1.37**	**1.53**

Table 3.12. N_2O Emissions from Waste (Gg), Dominica, 2000, 2006- 2017

N_2O Emissions (Gg) 2000, 2006-2017													
Category	**2000**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Solid Waste Disposal on Land	-	-	-	-	-	-	-	-	-	-	-	-	-
Wastewater Handling	0.0054	0.0054	0.0054	0.0055	0.0054	0.0054	0.0054	0.0054	0.0054	0.0053	0.0053	0.0053	0.0048
Waste Total	0.0054	0.0054	0.0054	0.0055	0.0054	0.0054	0.0054	0.0054	0.0054	0.0053	0.0053	0.0053	0.0048

3.6. Emissions from Agriculture

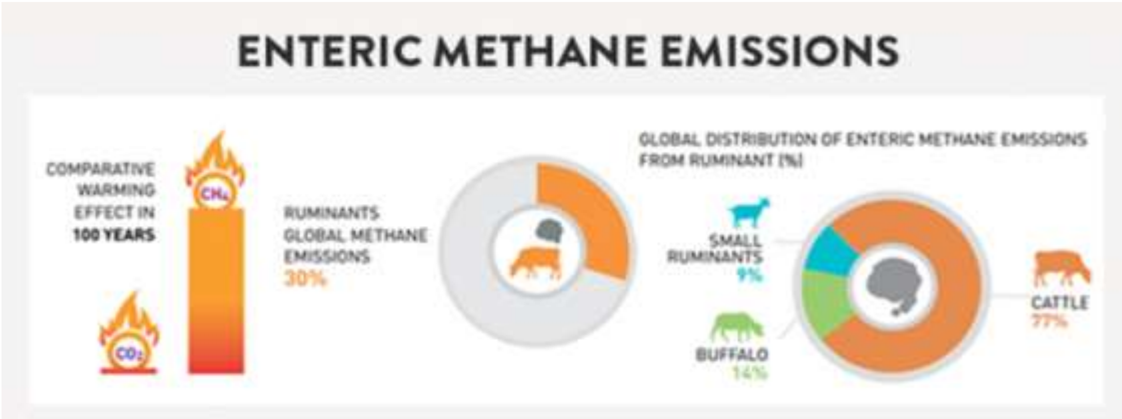
Dominica's agricultural sector is based on the cultivation of tree crop and root crops, including plantains, bananas, dasheen, avocados vegetables citrus and other fruits, mainly for export and for local consumption. Cultivation of bananas has declined dramatically over the past ten years largely due to change in export marketing arrangements. There is limited export of some root crops and citrus. Livestock (cattle, goats, sheep, pigs and poultry) are reared for local consumption.

Agricultural activities lead to emissions of CH_4 from enteric fermentation and CH_4 and N_2O emissions from fertilizer application to cultivated soils, excretion from grazing animals, atmospheric deposition of NH_3 and NO_x, and from leaching of agricultural soils.

Enteric fermentation is a natural part of the digestive process in ruminant animals such as cattle, sheep, goats, and buffalo. Microbes in the digestive tract, or rumen, decompose and ferment food, producing methane as a by-product. Enteric methane emissions from ruminant animals raised for their meat and milk account for as much as 30% of global anthropogenic methane emissions, and factors such as feed quality, animal size, and environmental temperature will increase the amount of methane an animal produces if left unchecked[6].

[6] http://www.ccacoalition.org/en/activity/enteric-fermentation

Figure 3.1 Enteric Methane Emissions (Global)



Source: http://www.ccacoalition.org/en/activity/enteric-fermentation

While Dominica has sufficient food supply overall, it is not self-sufficient in the production of high-protein foods like animal products (FAO Country Profile 2003). Commercial livestock ranching is also present on the island, including cattle, goats, pigs and chickens, however at low levels (FAO STAT 2014). Livestock is a minor but significant contributor to the sector. Laying hens, poultry, cattle, goats, sheep, and pork are grown primarily for local consumption. Animal products are largely imported to cover the food needs of the population.

Table 3.13. Distribution of Livestock

Livestock Type	N. of animals
Cattle	1,500
Pigs	3,000
Small ruminants	3,000
Broiler chicken	55,000
Laying chicken	28,000
Rabbits	12,000
Bee hives	900

Source: Ministry of Agriculture and Fisheries, 2016.

Considerable loss to livestock resulted from the devastation caused by Hurricane Maria in September 2017, which reduced the amount of greenhouse gases emitted. There was a total of 675 (45 percent) cattle, 1,950 (65 percent) pigs, 1,500 (50 percent) small ruminants, 49,500 (90 percent) broiler chicken, 25,200 (90 percent) laying hens, and 6000 (50 percent) rabbits killed in the storm together with 225 (25 percent) bee hives destroyed. In the case of the pork sector, drowning, heatstroke, lack of potable water and feed, as well as building collapse, all contributed to significant number of dead. For the poultry sector, and to a lesser extent rabbits, loss of animals was primarily due to building collapse and flooding. While for cattle and small ruminants, flash flooding, drowning and exposure to the natural elements, as well as flying debris, all contributed to the death of animals.

The nitrous oxide (N_2O) estimated in this section is the N_2O produced during the storage and treatment of manure before it is applied to land. The term ‘manure’ is used here collectively to include both dung and urine (i.e. the solids and the liquids) produced by livestock. The emission of N_2O from manure during storage and treatment depends on the nitrogen and carbon content of manure, and on the duration of the storage and type of treatment. The term ‘manure management’ is used as a collective noun for all types of storage and treatment of manure. Manure is a valuable resource when handled properly. It is an excellent source of nutrients and can improve soil fertility, tilth, structure and water-holding capacity. Manure has several advantages over commercial fertilizers, including on-farm availability, broad nutrient composition and ability to enhance soil organic matter. However, if manure is not properly managed, the risk of nutrient loss to water, soil and air increases. Nutrient losses can be costly and can negatively impact the environment.[7]

This section used international best practice for estimating N_2O emissions from manure management systems (MMS) using the method in the IPCC Guidelines

3.6.1. Methodology

The IPCC Tier 1 approach was used to calculate methane emissions from enteric fermentation and manure management emissions using regional default IPCC emission factors and the country-specific populations for each category of livestock (data obtained from the Food and Agriculture Organization-FAO website).

N_2O emissions from soils, animal production and from the application of fertilizers are estimated based on the amounts of nitrogen input from synthetic fertilizers, animal waste, nitrogen fixing crops and crop residues. Direct and indirect N_2O releases to the atmosphere were then estimated from these inputs using default IPCC emission factors.

Animal population data from 2006-2016 was obtained from FAO website, with 2017 estimated based on trends although the estimate for cattle appears high. The most recent agricultural census for Dominica was in 1995.

[7] http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw12912

Table 3.14. Livestock Populations, Dominica, 2006-2017.

Animal	2006-2017 FAOSTAT											
Year	2,006	2,007	2,008	2,009	2,010	2,011	2,012	2,013	2,014	2,015	2,016	2,017
Cattle	13,500	13,500	13,500	13,500	13,500	13,750	14,000	14,000	14,000	14,002	13,991	13,291
Pigs	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,005	5,068	4,561
Sheep	7,600	7,600	7,600	7,600	7,600	7,600	7,600	7,600	8,000	8,053	7,962	7,166
Goats	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,700	9,702	9,705	8,735
Rabbits	-	-	-	-	-	-	-	-	-	-	-	-
Poultry	190,000	190,000	190,000	190,000	190,000	190,000	200,000	200,000	200,000	200,000	199,000	169,150

Source: http://www.fao.org/faostat/en/#data/QA

Crop production data were obtained from FAO inclusive with some data from CSO. Annual import data from FAO and International Trade Center (Trade Maps) for synthetic fertilizer was used (Source: http://www.fao.org/faostat/en/#data/QA).

3.6.2. CO_2 Emissions

No CO_2 emissions were released from the agriculture sector.

3.6.3. Non-CO_2 Emissions

3.6.3.1. Methane

Total annual CH_4 emissions for the year 2016 (0.996 Gg) showed an increase over the year 2006 (0.031Gg), with 2012 showing the highest increase of 1.005. This is primarily a result of a larger number of cattle, animal size, and environmental temperature. Table 3.15. shows the agriculture sector CH_4 emissions for 2006 to 2017.

Table 3.15. Methane (CH_4) Emissions for the Agriculture Sector, Dominica, 2006-2017

Agricultural and Land Use Emissions (Gg)												
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017e
A Enteric Fermentation	0.956	0.962	0.962	0.962	0.974	0.987	1.005	0.996	0.996	0.997	0.996	0.936
B Manure Management	0.0251	0.0251	0.0251	0.0251	0.0251	0.254	0.0258	0.0258	0.0258	0.0259	0.0259	0.0253

Source: http://www.fao.org/faostat/en/#data/ES

An average of 0.977 Gg of methane was emitted due to enteric fermentation while 0.03 Gg was emitted because of animal manure management. There were slight upward trend in animal population between 2006 and 2016, with 2017 showing a slight decline based on the passage of Huricane Maria.

3.6.3.2. Nitrous Oxide

Nitrous oxide emissions from manure management are shown in Table 3.16. for the period under review the nitrous oxide emissions roughly 0.002 Gg annually.

Table 3.16. – Nitrous Oxide (N_2O) Emissions from Agriculture Sector, Dominica, 2006-2017

	N_2O Emissions (Gg)											
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Agriculture	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
A. Enteric Fermentation	-	-	-	-	-	-	-	-	-	-	-	-
B. Manure Management (Indirect and Direct management)	0.0022	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023	0.0023
C. Rice Cultivation	-	-	-	-	-	-	-	-	-	-	-	-

Source : http://www.fao.org/faostat/en/#data/GM

3.7. Data Gaps

Based on difficulties encountered in the process of document collection and storage, and the analysis, compiling and assessment of relevant data set, several inputs necessary for calculating emission factors or relevant data for computing GHG emissions were either unavailable or incomplete. Considering these data issues and the uncertainties identified, default values of emission factors proposed by the IPCC were used in many instances to compute GHG emissions. These did not capture the local realities, were not country specific, and should be treated as estimates and/or approximations.

3.7.1. Data Gaps by Sectors

The key data gaps by key areas for which additional information will be required are summarised below. This is in addition to the current data gaps and uncertainties identified and reported in the previous GHG inventory which have not been addressed.

3.7.1.1. Transport

a) The accuracy, consistency and validity of the data reference fuel imports should be addressed together with information in the following paragraphs which is required to compute emission factors. In addition, Dominica should consider using *higher tiers for future inventories to further improve the accuracy of the emission estimates*. However, in other to obtain this, *greater monitoring and recording of information such as the combustion technology and operating conditions for plants/machineries and weather conditions, road type and traffic type of vehicles need to be better established*.

b) In addition, given the expansion in transportation that has taken place in Dominica since 2006, current *levels of emissions must be higher* even with the indefinite moratorium on leaded gasoline. Moreover, *the use of diesel engines on most mass transit buses* may be a big contributor to GHG emission specifically CO_2. Specific information on bus engine size, year, country of manufacture, and fuel used needs to be gathered.

c) Dominica does not have facilitate for testing sulphur content in transport fuels and oils, although there is a laboratory with this capability in Antigua and Barbuda that can be accessed. However, every batch of fuel imported is accompanied with a certificate of quality, where a clear & bright test, a specific gravity test and a flashpoint procedure is conducted. This result is compared to the results on the certificate of quality. *However, there is no test for sulphur dioxide in gasoline and other products.* A more reliable and efficient procedure should be used to calculate, assess and record the above.

3.7.1.2. Energy Industries

The contribution from the Energy Industries comes from power plants using gas/diesel oil mainly to produce thermal electricity. Bitumen is also imported but used mainly in road pavement. This bitumen is partially combusted in preparation for use in road pavement and this contributes to CO_2 emission. *Data on tonnage of imported bitumen, or area of paved roads, are required to give a more accurate estimate of emissions of* CO_2 *and NMVOC. However, this information is recorded, for when a contract is signed with a contractor the quantity of road to be paved is included. However, no actually database and/or spreadsheet which are updated when contracts are signed and /or work conducted are kept on an annual basis.*

3.7.1.3. Solvents and Other Products Use

Data on consumption patterns and/or sales were not available and default factors were used. *Import data provides an indication, but is insufficient for higher tiers of calculation and to establish accurate emissions levels.* It is critical that such issues be addressed to effectively produce reliable and realistic emission calculations.

3.7.1.4. Waste Sector

Emission factors for solid waste must be developed and accurate volume of waste must be determined. The landfill has a scale, but it is not functional at present time (although reasonable estimates were given based on past trends). Wastes are not separated effectively before being emptied into the landfill. Different waste kinds will have differing levels and rates of Methane (CH_4) emission. An updated waste characterization should be conducted, not only for the assessment of GHG emissions, but also for the effective management of waste.

3.7.1.5. Agriculture Sector.

The Commonwealth of Dominica is fundamentally an agrarian-based economy. The agriculture sector, despite significant decline in economic performance, continues to play a dominant role in the socio-economic development of Dominica. Agricultural trade has been and continues to be a major factor determining food security outcomes in the Commonwealth of Dominica and a key driver of economic activity. However, there has been little by way of systematic record keeping over the years and consequently there is insufficient current data available concerning livestock numbers, land use and land use change to accurately estimate greenhouse gas emissions from the sector.

3.7.1.6. Recommendations

Recommendations are provided below for improving data and for reducing GHG emissions by sector, and are based on the use of 2006 IPCC Guidelines and difficulties encountered when conducting the GHG inventory.

3.7.1.6.1. Energy

a) Water-borne transport in Dominica coastal waters, ranging from recreational craft to large ocean-going cargo ships that are driven primarily by large, slow and medium speed diesel engines and occasionally by steam or gas turbines, should be adequately documented so that greenhouse gas emissions from such vessels can be calculated. However, insufficient data is available to include in this study. Hence, an independent study should be undertaken on a regional and/or international level based on shipping traffic/routes.

b) A policy should be introduced that all government vehicles, at the time of replacement, will be replaced by hybrid vehicles (or electric vehicles where appropriate) that are more energy efficient and produce less GHGs. Additionally, it is recommended that market-based mechanisms be introduced to encourage the private sector to purchase hybrid vehicles when replacing current vehicles. Additionally, lower import duties should apply to vehicles purchased that are 2014 model year and more recent. Tariffs and other incentives should be applied based on the age of vehicles and their CO_2 emission levels. Concurrently, data that is being maintained on vehicles should be further refined to capture low emission vehicles numbers being imported and used, together with manufacturer emission ratings for all registered vehicles.

c) Measures are being introduced to initiate sustainable energy programs for private residences, including solar PV and solar thermal, using innovative financing mechanisms to offset capital costs for home owners. However, there is no readily available data source to determine the number of renewable energy installations and their nett impact upon emissions from the energy sector. This deficiency should be addressed in the short term.

d) An Energy IT Specialist/Statistician should be attached to the Central Statistical Office and/or Environment Coordinating Unit to collate, verify and update energy statistics for fuel consumption (end use) and agriculture/forestry/fishing, in addition to information for international bunkers and electricity generation. Due to the frequent loss of data that has been experienced after recent extreme events, it is recommended that innovative data storage technologies be introduced, including cloud-based database which can provide data in real time regardless of system failures.

e) The development of data infrastructures and the promotion of networking for sharing data, information and knowledge on GHG inventories is a high priority to support future reporting. Addressing data and information deficiencies should be a priority under future GHG Inventory projects, including the preparation of Biennial Update Report (BUR) submissions.

3.7.1.7.2. Industrial Processes

Insufficient data is available on aerosols, fire protection and other HFC's consumption and/or sales, although there are import data for devices that contain HFCs (motor vehicle, refrigerators, and air conditioning systems). Such data should be compiled to improve the accuracy of HFC's emissions. This would require *compound-specific imports of HFCs to be recorded using appropriate HS Codes and/ or sales trend*. A weighted average of importers should be selected, monitored and assessed to obtain revised information and reduce misclassification based on HS Codes.

3.7.1.7.3. Waste Sector

The Dominica Solid Waste Management Corporation does not have a reliable waste stream data collection mechanism since their scale is not functional at present. Accordingly, it is recommended that a more technology-based system/scale be installed in the short term to facilitate continued and realtime data monitoring and verification. An updated waste characterization assessment is also required. Data is required to accurately calculate emission reductions from proposed waste management initiatives, including: (a) reduction of methane emissions from landfills through diverting organics from the waste stream that is currently deposited in the landfill; and (b) improved landfill management including waste to energy measures.

3.8. Uncertainties

Uncertainties in the inventory arise from both emission factors and the activity data. Since default emission factors were used, their uncertainties are those recognised in the 2006 IPCC guidelines. Uncertainties in the activity data were due mainly to the unavailability of some data either because records were not maintained or not compiled at all.

3.8.1. Energy

The accuracy, consistency and validity of fuel use and import data should be addressed. Source data was mainly used from the Customs and Excise Unit, with information made available from 2011-2017. End use consumption data for diesel, and to a lesser extent gasoline used in transportation, were not compiled. Hence assessment of fuel used for road transport and at marinas could not be reliably estimated. In the case of diesel fuel, data for the amount used in electricity production are available and accounted for over 35% of the total consumption. The remainder was allocated to road transportation since the amounts used at marinas and for other purposes (e.g. for boilers or standby diesel generators) were unknown but were assumed to be small.

3.8.2. Industrial Processes – Non-CO_2 Emissions

The factors below contribute to the uncertainties in estimating the NMVOC and HFC emissions:

a) No estimates were made since production data were not available from local bakeries;
b) Default factors were used for Personal Care Products and other NMVOC emissions, and accordingly more accurate information related to consumption and sales should be recorded.

3.9. Conclusions

Two methods are used to calculate the CO_2 emissions for the energy sector. These are the Reference Approach and the Sector Approach. The Energy Industries (35%) and Transportation (42%) subsectors are the main contributors, accounting for roughly 77% of total emissions from all sectors. These contributions are similar in the other years assessed and accounted for between 75% and 80% of the CO_2 emissions, while the Other Sectors (14%) comprising residential, commercial and forestry and fishing subsectors, and Manufacturing Industries & Construction Sector (9%) respectively accounted for the remainder.

The Transport Sector has the largest CO_2 emissions (from a low of 51.24 Gg in 2006 to a high of 71.33 Gg in 2016) and accounts for an estimated 40% of the emissions between 2006 and 2017. The Energy Sector registered a 27.3% increase in GHG emissions from 2006 to 2016, increasing from 42.70 Gg to 54.35 Gg. This sector also recorded a 50.55 Gg average over a 11 years period, with 2012 registering the highest increase. A rise of 39.20% from 2006-2016 in the Transport Subsector was recorded, with a slight drop of 6.0% from 2016-2017 mainly due to the passage of Hurricane Maria in September of 2017.

The use of Solvents and Other Products can result in emissions of NMVOC's. Estimates of the emissions are based on the amounts of products used and the percentage of NMVOC or N_2O that evaporates during use. During the period 2006-2017 NMVOC emissions ranged between 0.23 – 0.40 Gg. This was mainly attributed to emissions from personal care products and paints.

Emissions from the Waste Sector arise from the treatment and disposal of municipal or industrial solid waste and from the treatment and disposal wastewater from domestic and industrial sources. CH_4 emissions from the sector for the period 2006-2017 ranged from 0.905 to 0.907 Gg. Total N_2O emissions for the same period remained constant at 0.0054 Gg with 2017 declining to 0.0048 Gg due mainly to changes in wastewater handling.

The GHG inventory data for the years 2006-2017 have some uncertainties. Uncertainties in the activity data were due mainly to the unavailability of some data either because records were not maintained or not compiled at all. In such cases statistical analysis was conducted using *Table 3.1 Strategies for dealing with different causes of uncertainties, Volume 1: General Guidance and Reporting* and best estimates were used. This is the Third National Communication to the UNFCCC that has recorded the absence of data and the systematic failure to maintain records that are needed to determine greenhouse gas emissions from key sectors. This situation continues to undermine efforts to accurately calculate greenhouse gas emission for Dominica. Capacity assessments undertaken over the years consistently attest to the shortage of trained personnel, overburdened staff, and the absence of technical and financial resources as key reasons why complete and accurate data is not collected and maintained. This capacity constraint needs to be urgently addressed. Without current and accurate data, the Government of Dominica will continue to lack the information needed for informed decision making that is necessary to reduce green house gas emissions in keeping with Dominica's INDC and objectives of the Dominica ***Low Carbon Climate Resilient Development Strategy***.

Chapter 4 : National Inventory of Emissions from Land Use and Carbon Sinks

4.1. Introduction

This Section provide a national inventory of greenhouse gas (GHGs) emissions from land use and carbon sinks (forest and agriculture lands) by sources and removals by sinks of greenhouse gases from Dominica for the years 2014-2017. The categories of land used for this assessment were as provided in the IPCC *Good Practice Guidance for Land Use, Land Use Change and Forestry (LULUCF)*. These land use categories are provided in Table 4.1.

Table 4.1: IPCC LULUCF - Land Use Categories

Land Use	*Description*
Forest land	This category includes all land with woody vegetation consistent with thresholds used to define forest land in the national GHG inventory, sub-divided into managed and unmanaged, and also by ecosystem type as specified in the *IPCC Guidelines*. It also includes systems with vegetation that currently fall below, but are expected to exceed, the threshold of the forest land category.
Cropland	This category includes arable and tillage land, and agro-forestry systems where vegetation falls below the thresholds used for the forest land category, consistent with the selection of national definitions.
Grassland	This category includes rangelands and pasture land that is not considered as cropland. It also includes systems with vegetation that fall below the threshold used in the forest land category and are not expected to exceed, without human intervention, the threshold used in the forest land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastural systems, subdivided into managed and unmanaged consistent with national definitions.
Wetlands	This category includes land that is covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forest land, cropland, grassland or settlements categories. The category can be subdivided into managed and unmanaged according to national definitions. It includes reservoirs as a managed sub-division and natural rivers and lakes as unmanaged sub divisions.
Settlements	This category includes all developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories. This should be consistent with the selection of national definitions.
Other land	This category includes bare soil, rock, ice, and all unmanaged land areas that do not fall into any of the other five categories. It allows the total of identified land areas to match the national area, where data are available.

Anthropogenic activities play a major role in the emission of GHG (CO_2, CH_4, N_2O, CO and NMVOCs) as outlined in Chapter 3, whereas untouched forests acts as sinks.

4.2. Methodology

Applicable data for Dominica's forest is not available, with no recent census or forest inventory having been undertaken since 1987. This resulted in a default to the FAO Global Forest Resource Assessment data (FAO STAT). The *FAO Global Forest Resources Assessment of 2015 for Dominica* had five (5) descriptive categories that were unrelated to the six (6) descriptive IPCC categories described above. The data for the year 2000, though more descriptive and similar to the six (6) IPCC descriptive categories, could not be utilized. The calibrated values reported by FAO for 2000 were a product value of 0.9937 multiplied by the value observed for each category. Information on the justification for calibration was not provided and a direct request to FAO sub regional headquarters in Barbados yielded no results.

Table 4.2. below shows 2000 values for Dominica. Results for 2015 are shown in Table 4.3. In both 2000 and 2015 the total land for Dominica totaled 75,1000 Ha.

Table 4.2 : National data for each of the national forest classes for the year 2000

National Classes 2000	**2000 (1000 ha)**	**Calibrated 2000 (1000 ha)**
Montane Cloud Forest	0.25	0.25
Evergreen Montane Shrubland	1.07	1.06
Montane Rain Forest	3.04	3.02
Submontane Rain Forest	23.63	23.49
Disturbed Submontane Rain Forest	8.40	8.35
Lowland/Submontane Seasonal Evergreen Forest	5.68	5.65
Lowland Drought Deciduous Shrub/Semi-	5.55	5.51
Seasonally Flooded R.F./W.L./ G.L	0.25	0.25
Total forest	**47.88**	**47.58**
Fallow/Cleared Land	2.69	2.68
Active Agriculture	21.90	21.76
Urban/Residential/Bare Soil/ Rock	1.30	1.29
Short/Medium/Tall Grassland	1.68	1.67
Fumerole	0.02	0.02
Fumerole Sulphurous	0.00	0.00
Total other land	**27.59**	**27.42**
Total land area	**75.47**	**75.00**

Table 4.3. : FAO 2015 values for Dominica.

Categories		Area (000 hectares)				
		1990	2000	2005	2010	2015
	Forest	50	47.33	45.99	44.66	43.33
	Other wooded land	0.2	0.25	0.28	0.3	0.32
	Other land	24.8	27.42	28.73	30.04	31.35
	... of which with tree cover	N/A	N/A	N/A	N/A	N/A
	Inland water bodies	0	0	0	0	0
	TOTAL	75.00	75.00	75.00	75.00	75.00

The values from FAO STAT 2000, Table 4.2 could not be utilized to calculate the changes in acreages for the IPCC's six (6) assessment categories between the years 2000 and 2014, since these FAO's categories were different from that described in the IPCC guidelines. Given this information was the only complete land use data source information available for Dominica, it could not be treated as T_1 (or an initial time data). The current analysis therefore approached the categories as "beginning and ending an inventory in the same use" (IPCC 3.1.2) In other words, it was treated as a first-time analysis.

In 2014, Remote Sensing technology was used to obtain the acreages for the IPCC categories for Dominica. This imagery, was the most recently obtained within the Government of Dominica resources, and was the only imagery available. Details (obtained from imagery write-up) about the imagery is as follows:

> *"Pléiades imagery (2 images) recorded on 23 March 2014. These were bought via Geoserve, both as multispectral + panchromatic bundle (FCGC600186368 and FCGC600185648) and as pan-sharpened bundle (FCGC600186402 and FCGC600185649 respectively). License is for ITC, all ministries of the government of Dominica and the World Bank. These two images cover nearly the entire island, except for a small area around Salisbury."*

Three approaches are stated in the IPCC guidelines for representing land use areas:

- *Approach 1- identifies the total area for each individual land-use category, but does not provide detailed information on changes of area between categories and is not spatially explicit other than at the national or regional level.*

- *Approach 2 - introduces tracking of land-use changes between categories.*

- *Approach 3 - extends Approach 2 by allowing land-use changes to be tracked on a spatial basis".* (IPCC 2.3.1)

Approach 1 of the LULUCF was chosen as the best suited methodology for this analysis. This approach is most popular for assessing removals and emissions, without being dependent on spatial data notwithstanding its use in the current analysis. Approach 1 was chosen primarily because it does not require detailed information on land use changes - a major limiting factor as it relates to available data to enable its calculation nationally. Approaches 2 and 3 were not applicable based on the lack of data available. Although approaches 2 and 3 were not utilized this time, it is encouraged that systems be put in place to upgrade future analysis to extract maximum benefit from this activity. Approach 3 focuses on spatial distribution of land uses, and studies the changes using a grid system.

Information sources utilized to complete the calculations were obtained from various Government departments and international organizations via online media. All calculations were followed using IPCC *Good Practice Guidance for Land Use, Land Use Change and Forestry 2003 (LULUCF).* A listing of the sources utilized and the information sourced are included in Table 4.4. The authentication of the data sourced in most of the cases proved to be problematic. This most often was as a direct result of the lack of internal structures within the various departments to manage and report the available data to include complete methodology utilized to obtain the data in the first instance.

Table 4.4.: Information obtained and Sources

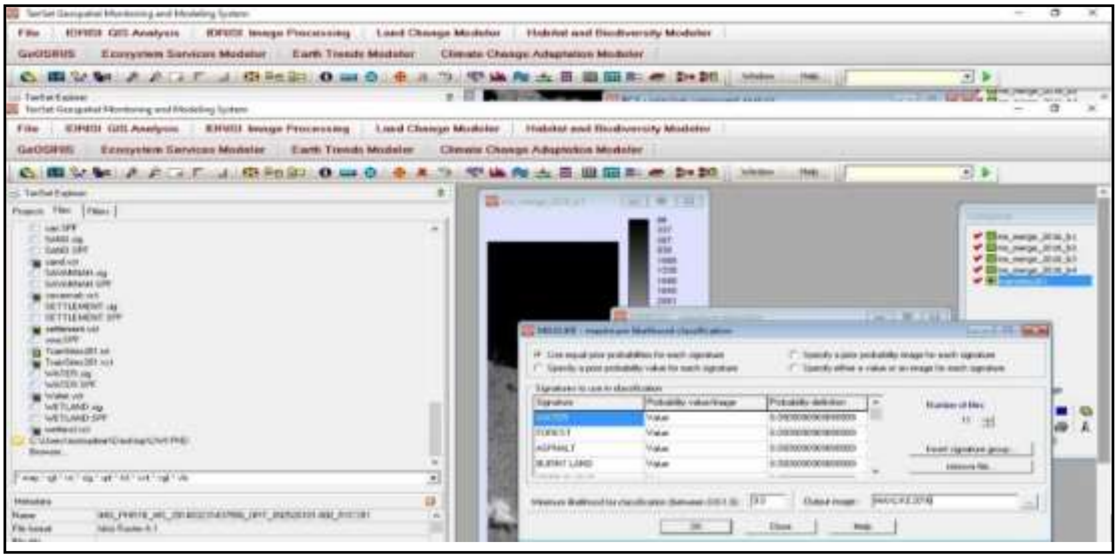
Data Obtained	Source
Livestock data	Livestock Division
Agri- Lime Data	Central Statistics Division
Species of Forest Trees	Forestry Division
2014 Satellite Imagery	Lands and Survey
Synthetic Fertilizer	http://www.fao.org/faostat/en/#data/RF
National Forest Data	*FAO Global Forest Resources Assessment of 2015 for Dominica*
Calculations and default values	IPCC *Good Practice Guidance for Land Use, Land Use Change and Forestry (LULUCF).*

2014 Satellite imagery was obtained from Government Resources, namely the Lands and Survey Department. Remote Sensing technology was used to obtain values for the 6 IPCC LULUCF categories. Clarks Lab TerrSet software was used to perform these calculations. Supervised classification tool was used, as it seemed to produce most accurate results. The tool ran on the imagery using the below parameters (also shown in Figure 4.1.):

1) A training site for each category was created within remote sensing software. A polygon was created around similar pixels that represent a specific land use and is named according to the land use which it represents. These sites are used later when running the classified analysis.
2) A signature file was created for each training site, again giving each the name of its corresponding land use type.
3) A supervised classification - Maximum Likelihood, was ran with equal probability for each category. "*Maximum likelihood classification assumes that the statistics for each class in each band are normally distributed and calculates the probability that a given*

*pixel belongs to a specific class. Unless you select a probability threshold, all pixels are classified. Each pixel is assigned to the class that has the highest probability (that is, the maximum likelihood). If the highest probability is smaller than a threshold you specify, the pixel remains unclassified". (*Richards, 1999.) Figure 4.1 shows the MAXLIKE window used. The Minimum likelihood for a classification was changed using values: 0, 0.5 and 1. The best data was obtained from 0 results.

Figure 4.1: MAXLIKE window



4) MINDIST raw and normalized were also run to compare results.
5) Areas of know land use on the imagery were compared against the results, and the best matched categories were kept. MAXLIKE yielded the most favorable results.

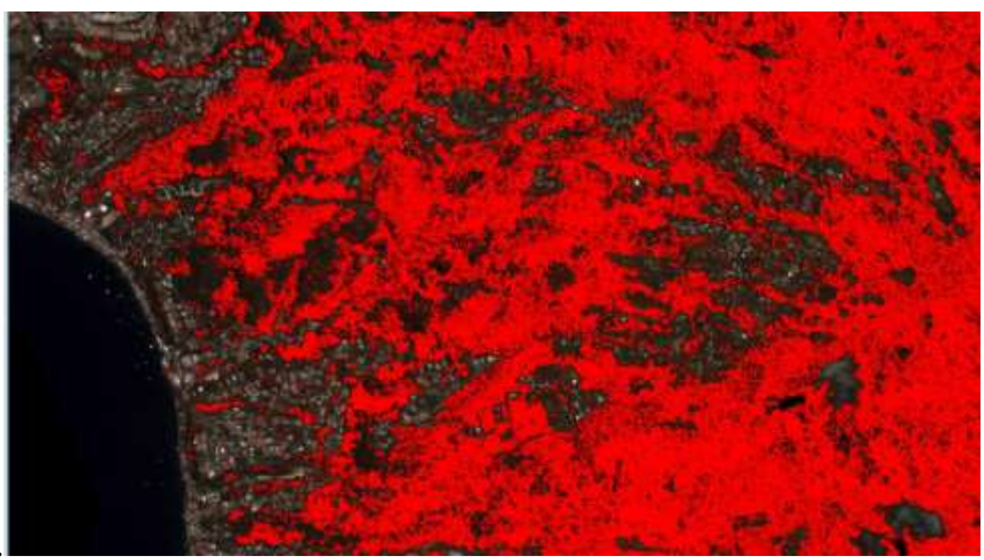

.

Figure 4.2: Sample Results of Forest Classification from Remote Sensing Analysis

6) The area for each category was calculated in hectares.
7) Ground truth random samples of results.

The values for each category is shown in Table 4.5. Clearings and burnt land were obtained in addition to the six categories, because their values were needed in later calculations.

Table 4.5.: Values obtained from Remote Sensing.

Categories	Total area (ha)
Forest	44,860.00
Grasslands	638.00
Croplands	14,300.00
Wetlands	27.00
Settlements	9,610.00
Burnt	242.00
Clearings	3,210.00
Other	2,113.00
Total	75,000.00

After step one (outlined in Chapter 2 of the IPCC LULUCF Guide), that is an estimation of land use areas was completed, the next step was the selection of an appropriate Tier.

The decision tree from the IPCC Guide, Chapter 3, was used to select the Tier level. Following the steps for Forest remaining as forest (FF), the following questions were answered (See Figure 3):

Step 1: Does Managed Forest Exist? Yes

Step 2: Is FF a key category? Yes

Step 3: Is this subcategory significant? Yes

Step 4: Is country specific data available? No

Suggested Tier #1 use country specific data. "***Tier 1:*** *Tier 1 applies to countries in which either the subcategory (forest land remaining forest land or biomass carbon pool) is not a key category* *or little or no country-specific activity data and emission/removal factors exist nor can be obtained."*

Dominica falls into the category of having little or no country specific data available and thus Tier 1 was followed. Tier 1 advices the use of default values where necessary when undertaking the calculations of sinks or sources.

The same procedures were followed for the other 5 categories.

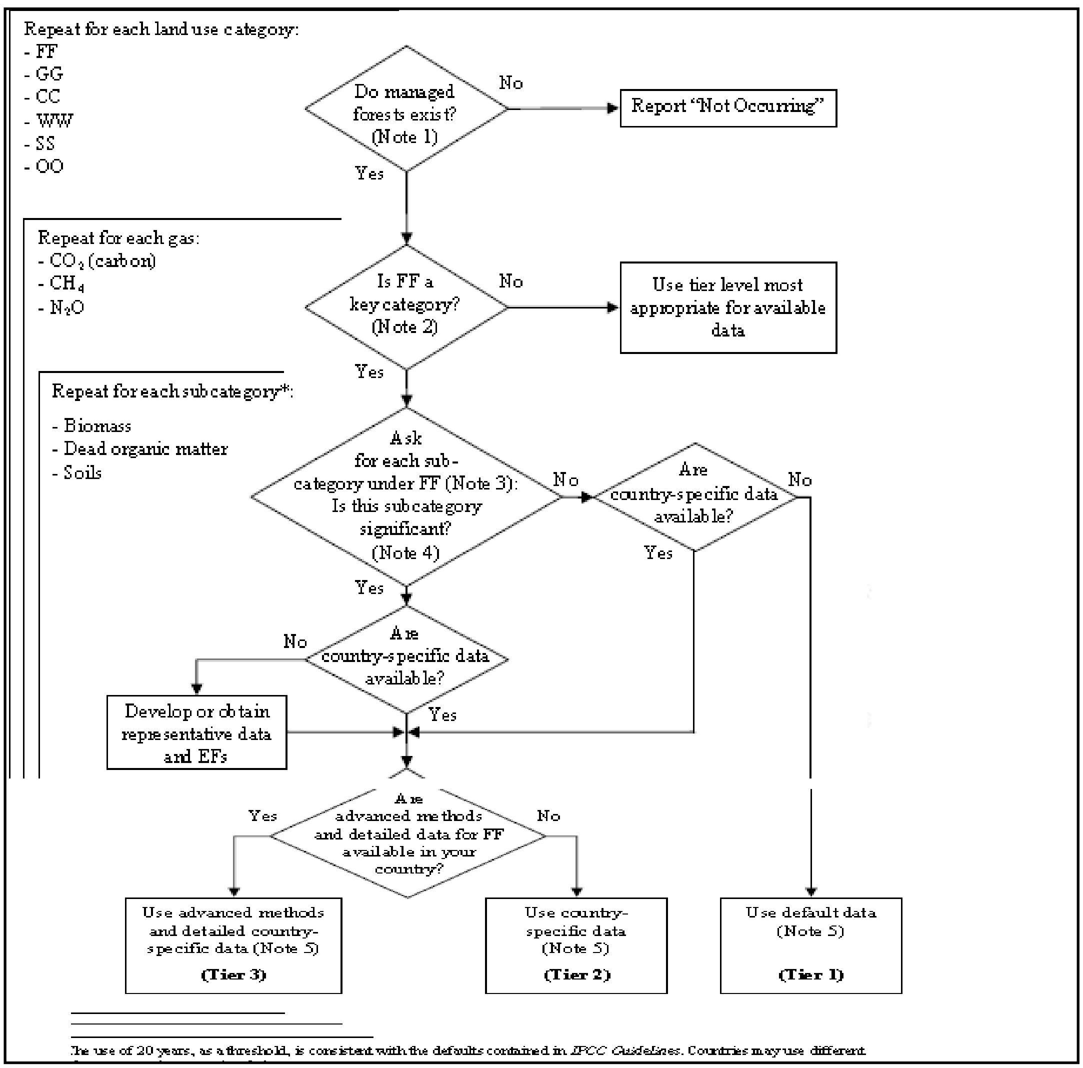


Figure 4.3: Decision Tree used in Tier selection for land remaining in the same land use category

4.3. Calculations and Results

4.3.1. Forest Land Remaining as Forest - Change in Carbon Stocks

In future calculations, the selected Tier may be different, since data from this year's project can be used as Time 1. However as previously discussed, this project is being treated as an initial project, with no "time 1" and "time 2" to be compared.

In this section, the methodology for calculating "carbon stock changes and greenhouse gas emissions and removals associated with changes in biomass and soil organic carbon on the forest lands" was to be determined. It also takes into account managed forests and not natural and undisturbed forests. According to the IPCC LULUCF a manage forest/forest management is:

> *Forest management is the process of planning and implementing practices for stewardship and use of the forest aimed at fulfilling relevant ecological, economic and social functions of the forest...A managed forest is a forest subject to forest management.*

Subsequently, any forest, whether for commercial felling or any planning or management for non-commercial purposes will be construed to be a managed forest. For the purposes of this analysis, all of Dominica's forest is therefore considered to be a managed forest.

In calculating Forest Remaining Forest greenhouse gas inventory, emission of non-CO_2 gases and estimations of carbon stock changes of the following 5 carbon pools are required: below ground biomass, dead wood litter, aboveground biomass and soil organic matter, and litter. Equation 3.2.1 below, gives in respect to changes in the above 5 carbon pools, the calculation of the annual emissions or removal from Forest remaining Forest (FF) (IPCC LULUCF Guide pg. 3.24). This Equation is a summary of several other Equations that are required.

EQUATION 3.2.1

ANNUAL EMISSIONS OR REMOVALS FROM FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF} = (\Delta C_{FF_{LB}} + \Delta C_{FF_{DOM}} + \Delta C_{FF_{Soils}})$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual emissions or removals of carbon from forest land remaining forest land for 2014 (based on Equation 3.2.1) is: **-3,680,606.16 tonnes C yr^{-1}**

4.3.2. Forest Remaining as Forest - Nitrogen Emissions

Figure 4.4. (shown below) from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories was used to determine the Tier Method to use. The steps followed are highlighted in yellow, and led to the decision that Tier 1 should be used, since there is no/very little country specific data, and it cannot be obtained.

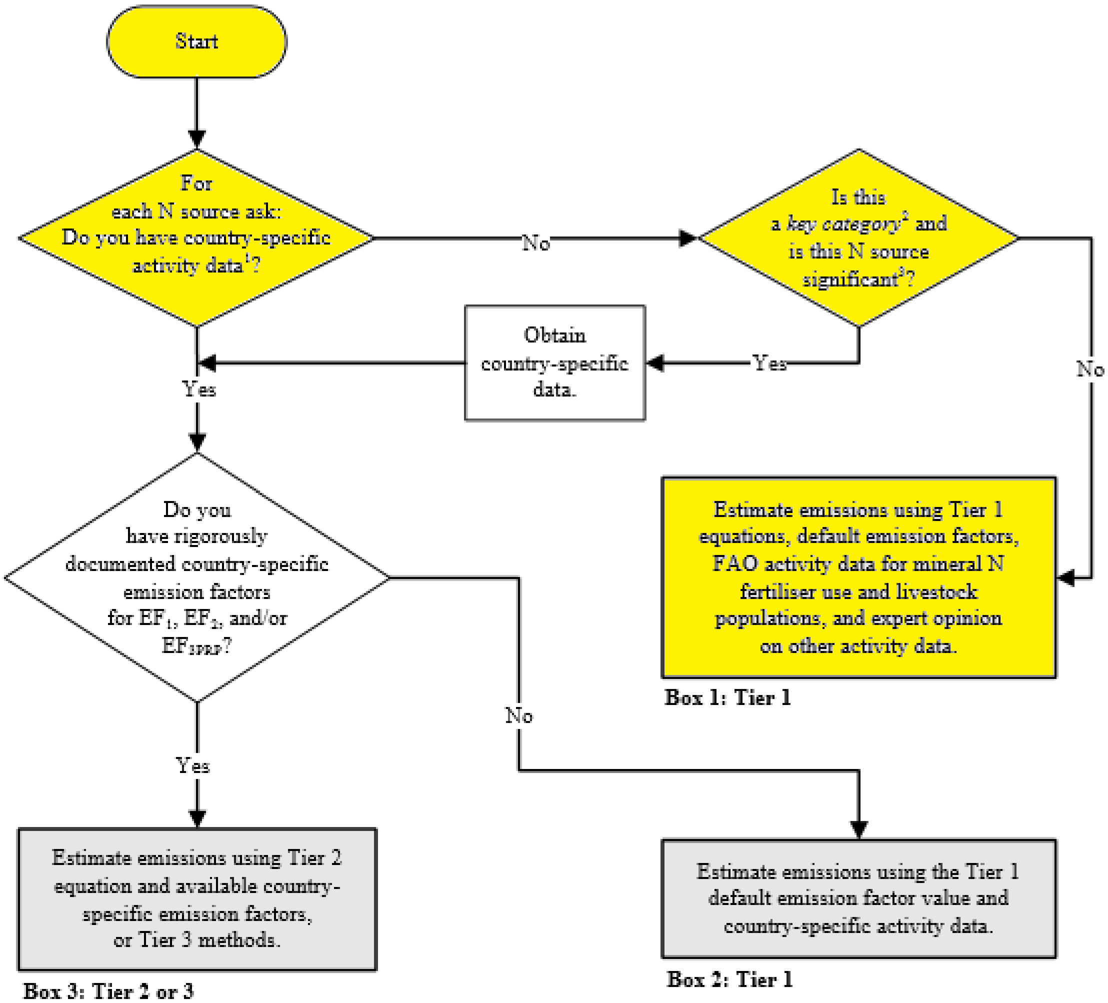


Figure 4.4: Decision Tree for Direct N_2O Emissions

To determine the amount of N_2O emissions from the forest fertilization, Equation 3.2.18 from the IPCC Guidelines was used. Amount of synthetic fertilizer used in Dominica was obtained online from FAO's http://www.fao.org/faostat/en/#data/RF website. Organic manure was estimated using number of livestock on the island values obtained from the Livestock Department of the Ministry of Agriculture. The mass of organic manure was then determined by the relationship: - # of a group of animals*365 days*avg. Kilograms of feces known for that group. Table 4.6. details the estimated mass of organic manure for the various livestock species.

Table 4.6.: Organic Manure totals based on Animals.

Animal	Total Yearly feces (Gg yr^{-1})	Daily weight of feces (Gg)	No. of animals
Goats	0.25	0.000000454	1500
Pigs	6.46	0.000005897	3000
Sheep	0.99	0.000001814	1500
Cattles	11.18	0.000020412	1500
Rabbits	0.04	0.00000006	2000
Layers	2.72	0.000000095	78500
Total Organic Manure	**21.64**		

EQUATION 3.2.18
DIRECT N_2O EMISSIONS FROM FOREST FERTILISATION

$$N_2O\ direct\text{-}N_{fertiliser} = (F_{SN} + F_{ON}) \bullet EF_1)$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual Nitrogen Emissions from Forest Remaining Forest during 2014 is: **0.63 Gg N.**

4.3.3. Forest Remaining as Forest - Other Green House Gasses Emissions

Calculating Other Green House Gases released directly during fires are calculated using Equation 3.2.20 from the applicable IPCC Guide as shown below. Using Tier 1, this Equation and corresponding values were chosen.

EQUATION 3.2.20
ESTIMATION OF GHGS DIRECTLY RELEASED IN FIRES

$$L_{fire} = A \bullet B \bullet C \bullet D \bullet 10^{-6}$$

Where:

L_{fire} = quantity of GHG released due to fire, tonnes of GHG

A = area burnt, ha

B = mass of 'available' fuel, kg d.m. ha^{-1}

C = combustion efficiency (or fraction of the biomass combusted), dimensionless. (See Table 3A.1.12)

D = emission factor, g (kg d.m.)$^{-1}$

The area of burnt land (A) was calculated from Remote Sensing, and would represent the occurrence during a set period. Given that the largest burnt area usually occurs on the west coast within the dry scrub forest, the optimal period for undertaken this imagery would be at the end of the dry season – July – August.

The total burnt area assessed was 242.00 ha and was not limited to only Forest land use but included all other land use types in Dominica. No, local data was available for B- mass of available fuel and C- combustion efficiency, therefore Table 3.A.1.13 was used, where the value for Primary Moist Forest was 160.4 T/ha. This gives a product of the two (B*C). Emission factor (D), for each gas was used - shown in Table 4.7. below.

Table 2.7. : GHGs and Corresponding Emission Factors

Emission Factors fuel combusted	
GHGs	G/KG
CO_2	1403
CO	67
CH_3	4
NO_x	0.5
N_2O	0.01

The values for each factor from Equation 3.2.20 was is listed in Table 4.8. below, together with the value of the amount of GHG that was released (L) from 242 hectares of burnt land during the period of review (2014).

Table 4.8.: Calculation for L for each GHG.

A *	B * C *	D *	0.000001	GHGs	**L (GHGs Released in Tonnes) =**
242	160.4	1403	0.000001	CO_2	**54.45**
242	160.4	67	0.000001	CO	**2.60**
242	160.4	4	0.000001	CH_3	**0.16**
242	160.4	0.5	0.000001	NO_x	**0.019**
242	160.4	0.01	0.000001	N_2O	**0.00038**

4.3.4. Cropland Remaining as Cropland - Change in Carbon Stocks Emissions

The approach for calculating the change in carbon stock for this category, cropland remaining cropland is similar to that utilized for the Forest section. Equation 3.3.1 of the IPCCC Guide was however followed. Using Remote Sensing, a total area of 14,300.00 ha was calculated as the area under cropland land use.

EQUATION 3.3.1
ANNUAL CHANGE IN CARBON STOCKS IN CROPLAND REMAINING CROPLAND

$$\Delta C_{CC} = \Delta C_{CC_{LB}} + \Delta C_{CC_{Soils}}$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual emissions or removals of carbon from cropland remaining as cropland for 2014 (based on Equation 3.2.1) = **- 497,504.0015 tonnes C yr^{-1}**

4.3.5. Cropland Remaining as Cropland - Other Green House Gasses Emissions

This section was incorporated into Section 4.3.3. (Forest Remaining Forest - Other Greenhouse Gases Emissions), since the burnt area used was the estimate of all burnt land use in Dominica.

4.3.6. Grasslands Remaining Grasslands - Change in Carbon Stocks Emissions

The total area Calculated as Grasslands in Dominica, using Remote Sensing analysis, was 638.00 ha. Carbon stock within grassland category is affected by several anthropogenic activities as well as natural occurrences including: wild fires and harvesting of woody biomass. Equation 3.4.1 below from the IPCC Guidelines summarizes the calculation for the annual change in the carbon stock for grasslands remaining grasslands. This includes calculating carbon stock change in living biomass and in soils.

EQUATION 3.4.1
ANNUAL CHANGE IN CARBON STOCKS IN GRASSLAND REMAINING GRASSLAND

$$\Delta C_{GG} = \Delta C_{GG_{LB}} + \Delta C_{GG_{Soils}}$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual removal of **3,194 tonnes C yr^{-1}** from Grasslands remaining Grasslands in Dominica (2014).

4.3.7. Grasslands Remaining Grasslands - Other Green House Gasses Emissions

This section was incorporated into section 4.3.6.

4.3.8. Wetlands Remaining Wetlands - Changes in Carbon Stocks Emissions

The default method for this section focuses on wetlands drained for peat extraction. Such an activity is not done in Dominica and therefore no data on land drained or amount of peat extracted is available.

CO_2 for flooded land are calculated using Equation 3a.3.8. from the IPCC Guide (see below). The E $(CO_2)_{diff}$ was obtained from Table 3a.3.5 for tropical wet climate as 0.64 kg ha^{-1} d^{-1} converted to Gg is 0.0000604 Gg CO_2 ha^{-1} day^{-1}. Area obtained from Remote Sensing is 27 ha.

EQUATION 3a.3.8
CO_2 EMISSIONS FROM FLOODED LANDS (TIER 1)

$$CO_2\ emissions_{WW flood} = P \bullet E(CO_2)_{diff} \bullet A_{flood,total\ surface}$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual emissions from wetlands = **0.595242Gg CO_2 yr^{-1}**

4.3.9. Wetlands Remaining Wetlands - N_2O Emissions

Calculation for N_2O emissions from flooded lands using the Tier 1 method was obtained using Equation 3a.3.10 from the IPCC Guide – see below.

EQUATION 3a.3.10
N_2O EMISSIONS FROM FLOODED LANDS (TIER 1)

$$N_2O\ emissions_{ww flood} = P \bullet E(N_2O)_{diff} \bullet A_{flood,total\ surface}$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual emissions from wetlands = **0.00000493 Gg N_2O $year^{-1}$**

4.3.10. Wetlands Remaining Wetlands - Other Greenhouse Gases Emissions

Calculating the CH_4 emissions is done using Equation 3a.3.9 from the IPCC Guide – see below.

EQUATION 3a.3.9
CH_4 EMISSIONS FROM FLOODED LANDS (TIER 1)

$$CH_4\ emissions_{WW flood} = P \bullet E(CH_4)_{diff} \bullet A_{flood,total\ surface} + P \bullet E(CH_4)_{bubble} \bullet A_{flood,total\ surface}$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2. Based on these calculation, the annual emissions of methane in 2014 from wetlands = **0.03419685 Gg CH_4 yr^{-1}**

4.3.11. Settlement Remaining Settlement

The change in carbon stocks for settlement remaining settlement, is based on the trees within settlement areas along the streets, within parks in gardens etc. Total areas of trees by type within settlement areas in Dominica are not available. However, the trees in these areas were captured as part of the area for forest remaining forests.

4.4. Summary

Total GHG emissions and removal of GHGs from land use and forests in Dominica is presented in Table 4.9.

Table 4.9. GHG Emissions and removal of GHGs by Land Use and Forestry (Ggs in 2017)

Emissions and Removals of GHGs	CO_2	CO	CH_3	CH_4	N_2O	NO_x	N
Forest Land Remaining as Forest – removal as sinks	-3,680						
Forest Remaining as Forest - nitrogen emissions							0.63
Forest Remaining as Forest - other GHG emissions	0.054	0.0026	0.00016		0.00000038	0.000019	
Croplands Remaining as Croplands		-497.504					
Grasslands Remaining as Grasslands		3.194					
Wetland Remaining as Wetland	0.595242			0.03419685	0.00000493		
Totals:	**-3,679.40**	**-494.31**	**+ 0000.16**	**+ 0.034**	**+ 0.00000531**	**+ 0.000019**	**+ 0.63**

4.5. Impact on Carbon Sinks after Hurricane Maria

Prior to Hurricane Maria, Dominica was considered a carbon sink because of its thousands of hectares of lush green forest, grasslands and agricultural lands. It was one of the countries in the world with the lowest carbon emission value. Table 4.10. provides a summary of greenhouse gas emissions and removals by sinks for Dominica during the reporting period.

Year	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NMVOC	SO_2	HFCs
2000	106.00	-138 (est.)	1.57	0.118	1.64	0.177	0.0046
2005	119.00	-128 (est.)	1.56	0.097	2.30	0.218	0.003
2006	122.01	No data available	1.32	0.0054	0.172	0.250	0.042
2007	128.46	"	1.32	0.0054	0.074	0.274	0.056
2008	122.46	"	1.37	0.0055	0.142	0.248	0.060
2009	133.78	"	1.33	0.0054	1.110	0.282	0.049
2010	141.56	"	1.33	0.0054	0.043	0.299	0.046
2011	149.80	"	1.35	0.0054	0.850	0.316	0.045
2012	158.91	"	1.37	0.0054	0.583	0.335	0.053
2013	161.02	"	1.37	0.0054	0.358	0.339	0.046
2014	167.23	-3,680.61	1.38	0.0053	0.645	0.355	0.051
2015	170.14	" (est.)	1.38	0.0053	0.524	0.362	0.049
2016	169.83	" (est.)	1.38	0.0053	0.481	0.356	0.049
2017	156.20	-2,760.45 (January to September : Pre-Hurricane Maria) (est.) 0 (October to December : Post-Hurricane Maria) (est.)	1.55	0.0048	0.455	0.305	0.046

Table 4.10. – Summary of greenhouse gas emissions (all sources) and removals by sinks (Ggs)

The calculations undertaken for 2014 used the IPCC *Good Practice Guidance for Land Use, Land Use Change and Forestry (LULUCF)*, and determined that the total removals of carbon dioxide by Dominica's forests and land use for the year was 3,680.61 Gigagrams (Ggs), ***which is in excess of twenty times the amount of carbon dioxide emissions from all sources for the same year***. Due to limited available data, it has not been possible to calculate the total removals of carbon dioxide by Dominica's forests and land use for the years 2015-2017. However, until Hurricane Maria in September 2017, there was no substantial changes in forestry cover, forestry management, or land use and therefore is can be estimated that the amount of total removals of carbon dioxide by Dominica's forests and land use for the years 2015 and 2016 and for the first 9 months of the year remained at the same levels. After the devastation caused by Hurricane Maria, which effectively stripped all vegetation and cover from Dominica's forests and stripped bare all agricultural lands, it has been estimated that the amount of total removals of carbon dioxide by Dominica's forests and land use for the last three months of 2017 was zero.

A summary of emissions and removal of GHGs by category for 2017 is provided in Table 4.11.

Table 4.11. Summary of emissions and removal of GHGs by Category in 2017 (in Ggs)

Greenhouse gas source and sink categories	CO_2 emissions	CO_2 eq removals	CH_4	N_2O	CO	NOx	NMVOCs	SOx
Total national emissions and removals	**444.158**	**-3,261.148 ****	**2.687**	**0.907**	**-491.704**	**0.019**	**0.86**	**X**
1. Energy	156.20	X	X	X	X	X	X	X
A. Fuel combustion (sectoral approach)	156.20	X	X	X	X	X	X	X
1. Energy industries	46.86	X	X	X	X	X	X	X
2. Manufacturing industries and construction	4.08	X	X	X	X	X	X	X
3. Transport	67.17	X	X	X	X	X	X	X
4. Other sectors	38.09	X	X	X	X	X	X	X
5. Other	X	X	X	X	X	X	X	X
B. Fugitive emissions from fuels	X	X	X	X	X	X	X	X
1. Solid fuels	X	X	X	X	X	X	X	X
2. Oil and natural gas	X	X	X	X	X	X	X	X
2. Industrial processes	X	X	X	X	X	X	**0.46**	X
A. Mineral products	X	X	X	X	X	X	X	X
B. Chemical industry	X	X	X	X	X	X	X	X
C. Metal production	X	X	X	X	X	X	X	X
D. Other production	X	X	X	X	X	X	X	X
E. Production of halocarbons and sulphur hexafluoride	X	X	X	X	X	X	X	X
F. Consumption of halocarbons and sulphur hexafluoride	X	X	X	X	X	X	X	X
G. Other	X	X	X	X	X	X	0.46	X
3. Solvent and other product use	**0.08**	X	X	X	X	X	**0.4**	X
A. Paints	0.08	X	X	X	X	X	0.4	X
4. Agriculture	**286.00**	**-497.504**	**0.962**	**0.002**	**X**	**X**	**X**	**X**

A. Enteric fermentation	X	X	0.936	X	X	X	X	X
B. Manure management	X	X	0.026	0.0023	X	X	X	X
C. Rice cultivation	X	X	X	X	X	X	X	X
D. Agricultural soils	286.00	-497.504	X	X	X	X	X	X
E. Prescribed burning of savannahs	X	X	X	X	X	X	X	X
F. Field burning of agricultural residues	X	X	X	X	X	X	X	X
5. Land-use change and forestry	**1.298**	**-2763.644**	**0.194**	**0.900**	**-491.704**	**0.019**	X	X
A. Changes in forest and other woody biomass stocks	0.649	-2760.45	X	0.630	2.60	0.019	X	X
B. Forest and grassland conversion	X	X	X	X	X	X	X	X
C. Abandonment of managed lands	X	X	X	X	X	X	X	X
D. CO_2 emissions and removals from soil	X		0.16	X	X	X	X	X
E. Other (Grasslands & Wetlands Remaining)	X	-3.194	0.034	X	-494.307	X	X	X
F. Other (emission from Forest fertilization.)	X	X	X	0.27	X	X	X	X
G. Other burnt land	0.054	X	X	X	0.003	X	X	X
Other (flooded land	0.595	X	X	X	X	X	X	X
6. Waste	**0.58**	X	**1.531**	**0.0051**	X	X	X	X
A. Solid waste disposal on land	X	X	0.64	X	X	X	X	X
B. Waste-water handling	X	X	0.891	0.0048	X	X	X	X
C. Waste incineration	0.58	X	X	0.0003	X	X	X	X

** Based on the determination that during the period from 2014 to late 2017 there was little to no change in land use practices and areas under forestry management, it is estimated that GHG emissions and removals by sinks were of similar magnitude for 2015, 2016 and for the first 8 months in 2017.

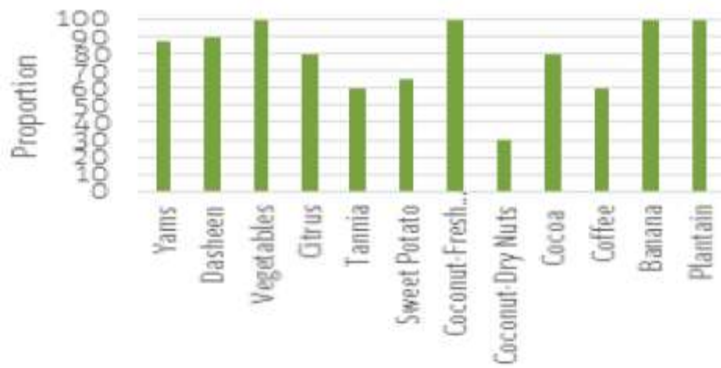
However, these statistics changed within hours on the 18th September 2017 when Hurricane Maria ravaged through the island from coast to coast. The hurricane made landfall on Dominica as a Category 5 hurricane, the worst of its kind to hit Dominica, with maximum sustained winds of 165 mph (265 km/h), leaving Dominica bare with about 100 percent of the forest, grasslands and crops destroyed. Hurricane winds and intense rainfall produced widespread damage to the forest system. Much of the forest was stripped of leaves and damaged and downed trees were widespread throughout the island. Forest undercover and soils were removed by the high winds.

The strong winds and the salty sea blast resulted in an almost complete defoliation of all trees. In addition to the loss of leaves, most trees lost all their fine twigs and/or part of the tree crown. Only in protected valleys or on the leeward side of slopes did a small number of trees retained their foliage.

Post Hurricane Maria Images from Dominica

Damage and losses in the agriculture sector were extensive, affecting all aspects of agricultural production including crops, infrastructure, equipment and croplands. Crop losses were high, particularly with respect to basic foodstuffs such as root crops, vegetables, banana and plantain, and tree crops (including mango, avocado, citrus, and bay) where destruction ranged from 80 to 100 percent. It has been estimated that 65 percent of coconut, 80 percent of cocoa and 80 percent of citrus trees have been damaged. 100 percent of banana trees and vegetable crops have been affected.

Figure 4.5. : Percentage of Agricultural Loss by Crop from Hurricane Maria



It would be fair to conclude, after Hurricane Maria, that forest lands, grasslands and croplands, all of which contributed to the carbon sink would all be decreased to near zero, if not to 0 ha. On the other hand, the amount of land being bare or submerged under water would have increased and so would the emissions from such lands. The annual removal of carbon from Dominica's forest land remaining forest was calculated to be -3,680,606.16 tonnes C yr-1 based on 44,860 hectares of forest land. With now an almost 0 hectors of forest, this emission value would also be close to 0 tonnes C yr^{-1}

It is therefore of utmost importance now to focus on reforestation and replanting croplands and grasslands at an accelerated rate. With the decrease of these land cover types, not only did Dominica's carbon footprint get bigger, the country is now at a very high risk to landslides, food shortages, decrease in food security and higher importation costs due to efforts to feed the population. 224% of the GPD based on 2016 data has been lost as a result of Hurricane Maria and so there is an urgent need for external assistance, regional and international to assist Dominica in rebuilding and becoming once again a carbon sink.

REDD+ (Reducing emissions from deforestation and forest degradation) and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries that were the innovative concepts introduced by UNFCCC COP13 and crystallized as an implementation mechanism by the *Paris Agreement*, are considered to be one of the pillars of the so-called low-carbon development strategies, especially in rainforest nations such as Dominica, where the forestry sector is one of the building blocks of the national economy. The examples provided by the climate compatible development plans prepared by the Dominican Republic and Papua New Guinea show that an approach based on integrating climate change, sound ecosystem management and economic development is possible and can place developing countries in the best position to grow in a sustainable manner and in line with national priorities and circumstances.

The new climate change regime defined in Paris by COP21 recognizes both low-carbon development and the fight against deforestation and forest degradation through the REDD+ mechanisms as two key mechanisms to combat climate change. With agreement reached on all the methodological and technical rules on REDD+ under the UNFCCC and the explicit recognition of this mechanism in the *Paris Agreement*, rainforest nations are now ready to start implementation on the ground.

To make REDD+ a successful reality, adequate and predictable financial and technological support should flow as soon as possible to rainforest nations like Dominica. However, for Dominica, access to REDD+ still requires the completion of the following steps:

1) proper channeling of funds at the national level by ensuring that REDD+ activities are designed and implemented in compliance with the UNFCCC requirements, including robust Monitoring, Reporting and Verification (MRV) systems and the fulfillment of the Green Climate Fund access criteria;

2) define the adequate national environment with the view to deliver high quality results-based reduction of greenhouse gas emissions in the forestry sector.

Dominica's first REDD+ implementation strategy has been prepared to respond to the two points above and in particular with the view to assisting the Forestry, Wildlife and Parks Division of Dominica in streamlining and coordinating the various past and present efforts on REDD+ currently being implemented at different levels in Dominica.

4.6. Recommendations

Undertaking the assessment provided in this Chapter was particularly challenging. It was recognized that the quality of the results obtained were directly linked to the availability and quality of required data. It was discovered that a significant volume of data was available nationally, but access to such information was not always straight forward as the repositories were diverse and scattered throughout many governmental ministries and departments. The management of data within some of these entities did not always allow for ease of access or use. Too often during this assessment process, it appeared that access to critical data seemed to be the purview of particular individuals rather than the responsible government agency.

Ultimately, the immediate objective should be to establish the mechanism whereby a Tier 3 assessment can be successfully concluded. Remote Sensing has been utilized during this assessment as it provides the most efficient method for obtaining land use areas. The supportive or complimentary structures to supply the other required data is however significantly deficient. There is the urgent need to conduct an audit of all data needed to undertake a high-quality assessment and systematically determine how to establish or enhance various existing data management mechanisms in order to provide what is required. It is anticipated that this process will be resource intensive and so adequate planning will be critical.

A lot more work is required to classify trees by species in expectation of utilizing the grid system as proposed by Tier 3 in the IPCC Guidelines. In light of this, it is indeed commendable that plans to conduct a national forest inventory are at an advance stage. It is recommended that intervention should be made early to ensure that this exercise captures data in a form that will be appropriate to utilizing a Tier 3 approach. Also, it would also be desirous that this process be associated with higher resolution imagery (2 cm). Obviously two sets of imagery are needed to do a Time 1 and Time 2 analysis where needed. Also, information on atmospheric conditions on the day and time of the imagery is required, so as to aide in carrying out atmospheric corrections on the images that are obtained.

Some data that is required to be collected includes:

- Total acreages of types of crops;
- Total amount of organic manure used annually;
- Total acreages of different types and age of trees in the forests;
- Types of trees within settlements and their total acreages;
- Amount of vegetation from each land use type that is burnt annually;
- Amount of forest felled yearly and for what reasons, round wood values, fuel wood values;
- Tracking of landuse change types and acreages;
- Annual Biomass;
- Annual Dead Organic Matter;
- Annual amount of synthetic fertilizer nitrogen applied;
- Annual amount of organic fertilizer nitrogen applied;
- Amount of lime applied;
- Area of grassland covered with perennial woody biomass;
- Annual Biomass loss of grasslands.

Finally, it is highly recommended that there is a designated person, preferably within the Environmental Coordinating Unit, who would be solely responsible for the yearly collection, research, and storing of all the data needed for carrying out this inventory. The data should also be available online for ease of access to others. The collection and realtime management of this data should be a priority under the Biennual Update Report (BUR) project that is shortly to commence in Dominica.

Chapter 5: Greenhouse Gas Mitigation Assessment

5.1. Introduction

This chapter provides the greenhouse gas mitigation assessment for Dominica by analyzing the impacts of various practices and technologies on the island's greenhouse gas emissions, and evaluating national schemes and approaches to reduce or eliminate these emissions. The assessment covers the period from the date of the Second National Communications up to December 2017.

The assessment provides policy makers and other stakeholders and interested parties with an evaluation of the practices and technologies in Dominica that can:

- affect GHG emissions;
- support the adoption of policies and programs that could reduce emissions from greenhouse gases; and
- contribute to national development objectives.

In keeping with commitments under Dominica`s *Intended Nationally Determined Contributions* (INDC), the scope of this assessment covers projections of GHGs for the period up to 2030 and uses historical data for the period 2006 to 2017 in order to calibrate where feasible, the bases for the projections.

5.2. Situation with Regards to Renewable Energy and Energy Efficiency

Despite several efforts in recent years to promote renewable energy technologies (RETs), Dominica is still largely dependent on fossil fuel as its main source of energy for power generation and other applications. Currently, the country imports in the range of 900 - 1,000 barrels of oil daily for energy generation and other applications. Power generation represents the main use of imported fossil fuels (50%), followed by transport (33%). Dominica's current electricity power generation comes from diesel generators fuelled by imported oil (71%), and hydropower (27.4%) with marginal generation from wind power (0.95%) and solar (0.25%). Dominica does not have any domestic sources of fossil fuels, and therefore the fluctuations in the import price of oil have posed challenges for Dominica, notably when oil reached a high of US$145 per barrel in 2008. In 2011, Dominica spent US$ 41 million on oil imports, representing 20% of its GDP.

The price of electricity (tariff structure) in Dominica is approximately US$0.38 kWh for residential consumers and between US$0.38 and US$0.41 kWh for businesses, including fuel surcharge, VAT and a service charge per kilowatt of customer-installed capacity. The cost of electricity in Dominica has increased significantly in recent years as it is subject to world oil prices. The country has the highest electricity tariffs within the Organization of Eastern Caribbean States (OECS). In addition, the country experiences significant power losses of 8.2 per cent due to lack of maintenance and obsolescence of electricity distribution lines, which increases operational costs between 8 and 14 per cent that are passed on to consumers. Since electricity prices are not subsidised in Dominica, the widespread use of energy efficiency and renewable energy technologies could have positive social effects through reduced tariffs.

Dominica Electricity Services Ltd. (DOMLEC) is the only electricity utility company in the country. It is owned by Light and Power Holdings (subsidiary of Emera Corporation) (52.8 per cent); the Dominica Social Security (20 per cent); with employees, local corporations and private citizens own the remaining 27 per cent. DOMLEC's license had been exclusive until the enactment of the new *Electricity Supply Act* in 2006, which opened the way for the Independent Regulatory Commission (IRC) to license other service providers. DOMLEC has been granted two licenses from the IRC. The first is a non-exclusive generation license, and the second as an exclusive license to transmit, distribute and supply electricity within Dominica (IRC, 2013). Both licenses became effective on the 1st January 2014. In 2009, DOMLEC installed 26,000 smart meters as part of the implementation of Advanced Metering Infrastructure (AMI). The company's efforts have contributed to a reduction in losses from 17 per cent in 2005 to less than 9 per cent in 2015.

Ever since the first oil shock of 1973, oil dependence has become a heavy burden on Dominica`s economy. The Government faces considerable fiscal constraints due to high fossil fuel import bills. High electricity prices both hinder economic growth, and a high public sector energy bill drains public resources that could be used to provide more social services. As presented in Table 5.1. oil imports as a percentage of Gross Domestic Product (GDP) exceeded 7% in 2012. Limited borrowing capacity as implied by the Debt-to-GDP ratios averaging 86% limits the governments' ability to invest in RE technologies, thus perpetuating dependency on imported fossil fuels and its tightening effect on fiscal space.

Table 5.1. Key Information on Energy Sector in Dominica

Average Fuel Cost (US$/kWh sold) (2014)	Oil Imports as a % of GDP	Fossil Fuel Imports (US$ Million)	Debt to GDP ratio	Fossil fuel used for electricity generation
0.18	7% (2012)	41.5 (2012)	73.7% (2013)	75%

Utility	Govern. Ownership (%)	Peak Demand (MW)	Installed Capacity (MW)	Energy generated (MWh/a)	Generation from Fuel Oil/ Diesel (%)	GHG emissions (tCO2/a)	Tariff (US$/kWh)	
							2013	2014
DOMLEC	21%	16.8	26.7	103,018	75	76,320	0.41	

Source: Green Climate Fund

Growth in the Solar PV market is currently limited by a DOMLEC-driven limit to intermittent renewable energy (IRE) inputs into the national grid at 10% of peak annual demand or equivalent to 2.5 MW of installed renewable energy (RE) capacity. The most recent information indicates that there is only one renewable energy independent power producer (IPP) with a 225 kW wind turbine at Rosalie Bay. However, the resort operating this wind turbine closed after sustaining damage during Hurricane Maria.

DOMLEC has a total installed electricity capacity of 23.8 MW with peak demand of 17.2 MW. There are two operating diesel plants (Fond Cole and Sugar Loaf {Portsmouth}) with a combined capacity of 20.0 MW. The three hydropower facilities (Laudat, Trafalgar and Padu) account for 6.72 MW of installed capacity, although these hydropower units are not currently operating at full capacity. Average system losses for DOMLEC are in the order of 9.5% of net generation.

With the exception of an expanding hydro power industry, and political preference for investment in geothermal energy, the growth and diversification of Dominica's RE and EE sectors have been limited to the following:

- Solar technologies accounting for approximately 0.25% of the energy generation mix and comprising of 190 kW of solar PV in Roseau with a private entity and another 100 kW at the Rosalie Bay Resort (which was closed after sustaining damage during Huricane Maria). While there is high interest amongst Dominicans for additional solar PV installations on residential and commercial properties as a means to reduce electricity costs, there are regulatory barriers to adoption of these technologies that constrain the markets potential.

- Energy efficiency (EE) measures have been marginal with no formalized energy codes or standards for buildings, and no energy efficiency appliance standard in legislation or policy to encourage its import, sale and installation. The GoCD has waived VAT on a number of selected EE appliances, and in 2009, DOMLEC installed 26,000 smart meters as part of its Automated Meter Infrastructure (AMI) project. This project continues to provide the utility company with real-time data about power consumption, and allow customers to make informed choices about energy usage based on the price at the time of use. This monitoring system does have potential benefit in measuring the financial savings associated with future RE and EE technology deployment. 2015 electricity rates are $0.39 per kilowatt-hour (kWh), and forecasted to potentially reach $0.45 per kilowatt-hour (kWh) by 2030. This rate is higher than the Caribbean regional average of $0.33/kWh.

- In the lighting sector, compact fluorescent lightbulbs (CFL's) have been in use through an extensive distribution program introduced in 2007 to all residences. In 2014, the Government of China donated 2,500 LED street lights to be powered by solar PV. By late 2014, an estimated one hundred 50W LED street lights were installed with an approximate lifetime $C0_2$ reduction of 200 tCO_2e. However, almost all of these were destroyed during Hurricane Maria.

Dominica has implemented several energy efficiency and renewable energy projects to date, including:

- 2007: A program sponsored by Cuba replaced 280,000 incandescent light bulbs with compact fluorescent bulbs in Dominican households;
- 2008: Rosalie Bay Resort installed a 225-kilowatt (kW) wind turbine that produces 596 megawatt-hours (MWh) annually. This was the first renewable energy project to be interconnected to the DOMLEC grid. An additional 1kW turbine is in operation, but is not connected to the grid.
- 2013 and 2014: A government-led initiative installed a number of LED streetlights, including at the main airport;

- 2015 – 2017: Solar energy was installed by the Community High School and by private businessman Carl Nassief at the KFC, Auto Trade, and Save-a-Lot premises.

Dominica has high solar potential with a solar resource of 5.6 kWh per square meter per day and also has approximately 30MW of wind power potential, some of which is under development. After nine wind studies, it has been determined that Crompton Point, located in Saint Andrew, has a potential of 10MW of wind power and that an additional 20MW of potential wind power is available elsewhere in the country.

The $C0_2$ emissions reductions associated with solar RE and EE projects in Dominica have therefore been marginal with current $C0_2$ reductions for the existing Solar PV generation at 184.28 tCO_2e, and no current measure of the contribution from the energy-efficient lighting programs. At this rate, it is unlikely that the RE and EE market will develop without intervention. Therefore, the ability of the market to offset the approximate 35,949 tCO_2e emissions produced by the current installed diesel generation in Dominica is undermined. Without planned interventions for catalyzing low carbon development in Dominica, the GoCD will continue along its development of geothermal energy without any certainty of its development dates, and with continued uncertainty over the development of alternative sources of indigenous energy generation that would result in lower electricity prices. Moreover, the absence of support for RE and EE financing and the absence of supportive institutional mechanisms increase the risk of insufficient numbers of interested proponents making the switch to RE or EE installations on their premises, and therefore poor progress on mainstreaming low carbon adoption in Dominica.

5.3. Geothermal Development

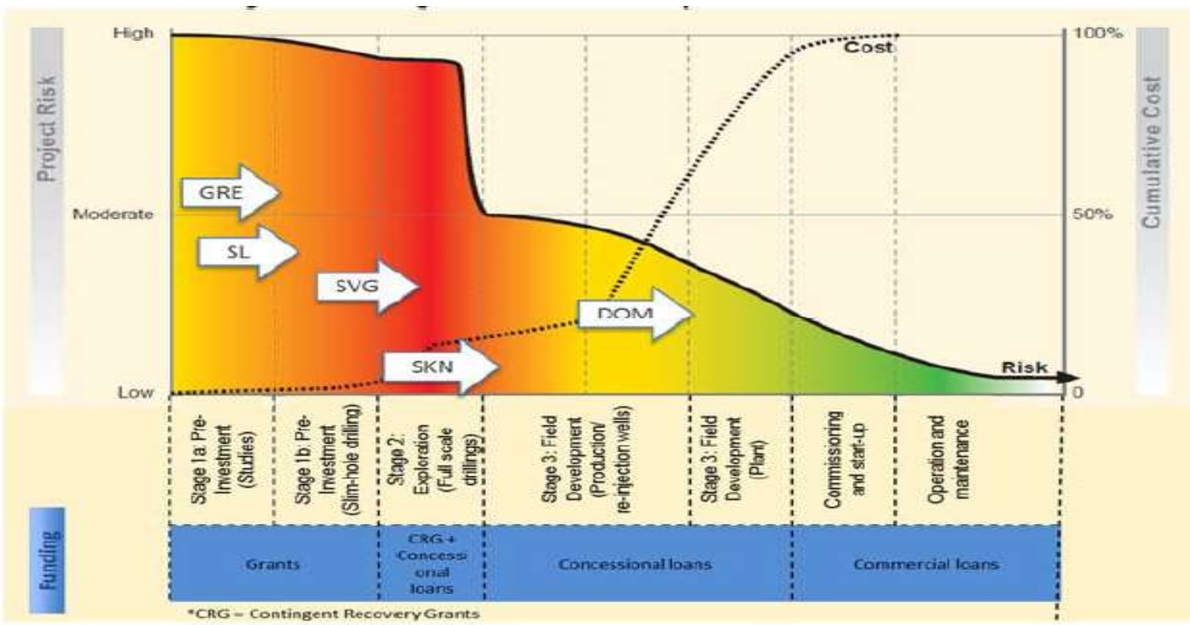
Dominica, being a volcanic island has tremendous potential for geothermal energy, with estimates ranging from 300 MW to 1,390 MW. Site assessments, and feasibility studies have been carried out that indicate that the energy capacity in the Roseau Valley Geothermal Resource area is at least 300 MW, The current production capacity based on wells already drilled is approximately 11 MW. Further generation capacity can be added with the drilling of additional production wells as assessed and necessary.

In Dominica, the Government has advanced considerably in developing its geothermal resources compared to other countries in the region (see Figure 5.1.). It confirmed the geothermal resource potential of the Wotten Waven-Trafalgar-Laudat geothermal field through exploratory and production well drilling and has drilled a commercial production well with generation capacity of 11MW. The cost of exploratory drilling alone was US$11.7 million, and was financed by the Government (44 percent), Agence Francaise de Developpement (AFD) (40 percent), and the European Union (17 percent).

In September 2016, Dominica joined with other Eastern Caribbean SIDS and secured financing from the Green Climate Fund (GCF) to advance geothermal development. The *Sustainable Energy Facility for the Eastern Caribbean* regional programme approved by GCF aims to address the financial, technical and institutional barriers which geothermal development encounters in Dominica and neighbouring volcanic countries (Grenada, St. Kitts and Nevis, Saint

Lucia, St. Vincent and the Grenadines) and to provide institutional strengthening and capacity building to the governments of these Small Island States and to the Caribbean Development Bank (CDB) to develop geothermal energy (GE).

Figure 5.1. Status of Geothermal Energy (GE) Development in Eastern Caribbean States



The GCF regional programme will be part of the Inter-American Development Bank`s (IDB's) Sustainable Energy Facility (SEF) for the Eastern Caribbean approved in October, 2015. IDB-SEF aims to address barriers for energy efficiency (EE) and RE, including GE, in the six Eastern Caribbean countries (ECC) (including Antigua and Barbuda which does not have GE potential). The regional programme for the GCF includes the following two components:

Component 1: GeoSmart Initiative: This initiative, initiated by the CDB, is a partnership for supporting geothermal energy development. Given the inherent risk at each stage of GE development, the programme will offer timely and tailored financial instruments to enable sub-projects to advance step-by-step, through plant construction. CDB will mobilize appropriate financial resources (price and other terms) such as grants, contingent grants and concessional loan resources to Governments and Special Purpose Vehicles, established as Public Private Partnerships, for the purpose of addressing the specific challenges that GE development faces.

Component 2: Regulatory framework, institutional strengthening and capacity building: Technical assistance for strengthening capacity building will be provided to the CDB. Support to improve regulatory frameworks and institutional capacity will also be provided to the five participating countries, including to ministries responsible for energy and electric utilities.

The programme anticipates the following five main impacts in the participating countries:

1. 60MW of Geothermal power generation capacity installed in projects facilitated or financed at some stage;
2. GHG Emission Reductions of 313,421 TCO_2e/year and 9,402,621 TCO_2e during the lifetime of the programme;
3. Reduction of 722 thousand barrels of oil imported for electricity generation;
4. US$ 50 million reduced spending on oil imports (at a fuel price of US$70 per barrel);
5. Reduction of the average electricity generation cost and, if generation cost reductions are passed on to customers, leading to an average decrease in tariffs from US$0.35/kWh in 2015 (at a fuel price of US$70 per barrel) to US$0.28/kWh.

In Dominica as in neighbouring Eastern Caribbean countries, GE development is hindered by: (i) high capital costs; (ii) lack of access to credit at appropriate terms (e.g. affordable rates); (iii) inadequate regulatory and policy frameworks; (iv) limited fiscal space for governments to acquire new public debt; (v) lack of economies of scale; (vi) high resource risk in early exploration phases for GE; and (vii) insufficient specialized technical skills required in such areas as structuring public private partnerships (PPPs), negotiating PPP structures with private sector counterparts, project financing, financial modelling and analysis, and managing and coordinating the implementation of GE projects.

These barriers will be addressed by the GCF Programme through: (i) contingent grants for drilling exploration which will help reducing early exploration risk and unlocking investments in the subsequent stages of production drilling, field development and plant construction; (ii) concessional loans which will help to reduce funding costs and lower overall capital costs so as to reduce the cost of energy for final users; (iii) the implementation of GE projects through public private partnership (PPP) structures which will help limit new public debt and bring in the private sector; and (iv) technical assistance to improve the regulatory framework and capacity building will provide the necessary base for successful implementation of GE projects.

Under this project, Dominica will receive US$46.9 million to finance the capital costs of the first phase of domestic geothermal energy production, principally plant construction. Technical assistance under the project is expected to support:

- training to strengthen the Ministry of Public Works, Energy, and Ports, and in particular its Geothermal Project Management Unit's ability to execute GE projects;
- training to strengthen the IRC's capacity to develop regulations for GE;
- the hiring of a full time staff member to support the Geothermal Project Management Unit.

5.4. Policies to Support Low Carbon Development

Over recent years, the Government has formulated several policies aimed at reducing energy prices, increasing environmental sustainability, and reducing fossil fuel use. Most notably, the ***Low Carbon Climate Resilient Development Strategy***, adopted by Cabinet in 2012, sets out many of the Government's objectives for the energy sector, envisioning a "low-carbon, climate-resilient" development path for the country. Specifically, it identifies the objectives of developing renewable energy projects and promoting energy efficiency and energy conservation programs.

The ***Low Carbon Climate Resilient Development Strategy*** 2012-2020 (LCCRDS) considers climate change mitigation measures (CCM) as a priority. The LCCRDS provides the rationale and outlines strategies towards the development of a low carbon development path including the promotion of energy conservation and RE development to address rising energy costs that affect the cost of living and quality of life, the high costs of manufacturing and services, and the challenges of remaining competitive. CCM is a priority with the understanding that CCM will generate energy savings and funds that can be availed through a sustainable financing mechanism for Dominica to invest into urgent climate change adaptation measures.

The LCCRDS identifies the pathway for low carbon development including:

- Development and commercialization of geothermal resources with the aim of financing the design and construction of a grid-connected 12 MW geothermal plant;
- Development of solar energy that includes training for solar energy conversions and related technologies, incentives for conversions of solar heating in homes and public buildings, feed-in tariffs for solar producers, design and construction of pilot grid-connected solar power facilities, and soft financing for communities and small-scale private solar power conversions;
- Development of wind energy and hydropower that includes training on wind and hydropower technologies, development of wind and small run-of-river hydropower resource inventories for Dominica, feed-in tariffs for wind and hydropower producers, financing of the design and construction of grid-connected wind farms and hydropower projects, and soft financing for community and small-scale private wind and hydropower power conversions;
- Promotion of green communities including training on energy conservation, GHG auditing and low carbon technologies, financing and commissioning of energy and GHG audits of cities, public buildings and other public energy expenditures, establishment of soft financing of energy conversions and conservation to renewable energy that includes solar powered LED lights, and conversion of public building infrastructure to low carbon technologies in Portsmouth;
- Sustainable financing for low carbon technologies and energy conservation that will include the provision of training on climate change financing for the private sector, assessment of viable options to finance low carbon technologies using market based instruments (e.g. carbon levies);
- Design and establishment of the Climate Change Trust Fund (CCTF) architecture to finance conversions to low carbon technologies, and the legal establishment of the CCTF; and
- Development of low carbon management services and technologies including training programs on energy and GHG auditing, establishment of standards and certification programs for low energy applications and equipment, energy metering and auditing, and promoting the professional certification of low carbon management services and technology providers.

In 2014 the Government of Dominica developed the *National Energy Policy (NEP) for Dominica, 2014* and the supporting *National Sustainable Energy Plan (NSEP).* The Policy objective is to promote the utilization of indigenous sources of energy to produce and supply electricity at the lowest possible cost. The Policy provides, amongst other issues, conditions to facilitate the exploitation and development of cheaper energy through using RE technologies, encouragement on the installation of solar PV technology (where economically viable) on all new public sector buildings, commercial buildings, and residences, particularly for buildings that could benefit from those systems in the event of service outages, and measures to promote energy efficiency in all electricity consuming sectors, as well as in production of electricity.

Final drafts for the *National Energy Policy* (NEP) and the *National Sustainable Energy Plan* (NSEP) were developed with support of the Caribbean Sustainable Energy Project (CSEP). These drafts are however still awaiting Cabinet approval. The overarching theme of the national energy policy is the pursuit of a sustainable approach to energy development that ensures the availability of energy that is reliable, affordable, clean and efficient. Additionally, the NEP seeks to increase private sector participation through large-scale electricity generation from renewable energy sources, as well as in distribution in order to eliminate monopolies.

5.5. Legal and Institutional Structure Governing the Energy Sector

The *Electricity Supply Act* (ESA) No. 21 of 1996 establishes: (a) the institutional framework for the electricity sector as well as the rights and duties of the different bodies in the electricity sector; and (b) the procedures for licensing and monitoring electrical utilities. The ESA creates the Independent Regulatory Commission (IRC) which is responsible for setting tariffs, licensing service providers, and setting service standards. In addition, the ESA also specifies that renewable resources must be included in Dominica's electricity generation expansion plans.

The IRC was designed to govern electricity supply in Dominica and to facilitate a competitive electricity market while protecting the interest of consumers of electricity on the island. The Act requires the IRC to be independent and not be subject to the direction and control of the Government or of any person, corporation or authority, except that the Commission shall have due regard to the public interest and overall Government policy as embodied in the legislation. The stated functions of the IRC are as follows:

- Encouraging wider availability of electricity supply throughout Dominica;
- Ensuring that all reasonable demands for electricity are met;
- Promoting efficiency in the generation, transmission, distribution, supply and use of electricity;
- Establishing technical standards applicable to providing electricity service or equipment installed on customer's premises;
- Protecting the interests of consumers;
- Facilitating competition in the electricity sector;
- Enabling the financial viability of efficient licensees;
- Issuing, monitoring and amending licenses and collecting license and other fees;
- Establishing and monitoring standards by which the efficiency of the service provision can be evaluated;
- Inspecting and testing electrical plant and equipment owned by licensees as well as consumers;
- Protecting the health and safety of all persons affected by the operations of the sector;
- Protecting the national environment;
- Advising the Minister on all issues relevant to the electricity sector; and
- Promoting wider regional cooperation in the regulation and operation of the electricity sector.

The regulation and governance of the sector is further developed through decisions made by the IRC. The IRC has issued several decisions that further develop the legal framework governing the sector. The most important decision issued by the IRC is the *Regulatory Policy and Procedure—Licensing Procedure* that sets out the license application process. It also provides DOMLEC an exclusive license for transmission and distribution, and states that there will be a single distribution license granted for the island.

Under the provisions of the ESA, Dominica previously operated under a single licence issued to one electrical utility company which was solely responsible for the electrification of the country through generation, transmission and distribution, and supply. Subsequently, the IRC issued two new licences, a Generation Licence and a separate Transmission, Distribution and Supply Licence, to Dominica Electricity Services Ltd (DOMLEC), both which became effective on the 1st January 2014. These two licences, which completed the process for aligning the regulatory framework for DOMLEC with the principles and intent of the Electricity Supply Act (revised in 2006), established a regime of separate licensing for each of the business sectors of the public electricity supply undertaking – generation, and transmission distribution and supply.

Another important decision is the IRC's *Tariff Regime for Dominica Electricity Services Ltd. 2009/004/D* ('the Tariff Regime') which establishes the tariff setting mechanism. The Tariff Regime sets a formula for determining tariffs that allows for DOMLEC to recover costs associated with generation from renewable energy and electricity purchased from Independent Power Producers (IPPs).

A *Geothermal Resources Development Bill* (2013) was first developed in 2012 and has undergone a process of revisions since that time. The Geothermal Resources Development Bill is currently in the final stages of review before it is ready to present to Parliament. The Geothermal Resources Development Bill "provides for the regulation of geothermal resources with the objective of ensuring the sustainable development of the resource, and ensuring its allocation to the uses that are most economically beneficial to Dominica". In particular, the Geothermal Resources Development Bill:

- establishes procedures for allocating geothermal resources in Dominica, including a 'competitive track' under which the Government tenders out a concession and awards it to the best bidder presenting the best option, and a 'negotiated track' for cases where there is not sufficient information for competition to be viable;
- creates a statutory board to advise the Minister responsible for energy (who in turn advises the Cabinet) on geothermal resource development;
- establishes an approach for securing approvals to develop geothermal projects.

Energy issues in Dominica are managed by the Energy Unit of the Ministry of Public Works and Ports, which sets policy on electricity generation and distribution. The Unit also coordinates Dominica's Renewable Energy Programme, and is responsible for coordinating activities related to the development and expansion of electricity generation and distribution, including the development of renewable energy sources such as geothermal, solar, wind and hydro energy. The Unit also coordinates matters related to the supply of public lighting.

5.6. Constraints to Low Carbon Development

Despite the high level of interest in low carbon development from a number of Dominican Parliamentarians and Dominican-based and foreign investors, the opportunities for developing renewable energy and energy efficiency initiatives in Dominica are threatened by:

- The pre-occupation of the Government's energy experts on developing geothermal resources as a means of lowering the carbon footprint of Dominica's energy sector. One of the primary concerning issues includes the uncertainty of when geothermal power will be developed. Given the complexities of the geothermal development related to design and financing, the dates for commissioning of the geothermal power resource range from 3 to 10 years or more. As such, the Government is unwilling to provide appropriate attention to alternate medium-term solutions to high electricity costs. Moreover, the IRC that regulates electricity tariffs in Dominica cannot guarantee that geothermal power will reduce electricity costs to Dominican customers[8], as they do not have the capacity to evaluate such plans;
- DOMLEC's indications of the limits of intermittent renewable energy (IRE) into the Dominican grid which have been presented in their March 2015 *Integrated Resource Plan* (IRP) as 10% of peak annual demand[9]. This assumes that the current grid can only take another 2.5 MW of new RE power into the grid without further investments into grid stability measures that would allow for a higher rate of IRE. With DOMLEC's IRP already proposing a 1.5 MW utility-scale solar PV plant in 2017 and 2018, and more than 400 kW of IRE capacity already installed, there is less than 600 kW of IRE available under DOMLEC's IRE ceiling. As such, there is no incentive for DOMLEC to encourage additional RE installations in Dominica.

These threats were somewhat scaled-back due to the loss of most of the country's hydropower generation capacity by damage sustained during Tropical Storm Erica in August 2015. This led to DOMLEC announcing the need for large electricity consumers to "self-generate" that would make up for the loss of approximately 6.2 MW of hydropower. Notwithstanding this recent development, there are other barriers to low carbon development, which are summarised in Table 5.2.

---

[8] While a fuel surcharge on tariffs may be reduced, the cost of upgrading transmission lines from geothermal plants to customers to cater to voltage drops and fluctuations, especially the upgrading of an 11 kV line to Portsmouth area to the north to 33 kV, will be costly and likely be reflected in new DOMLEC tariffs.

[9] Available on http://www.ircdominica.org/files/downloads/2015/03/DOMLEC_IRP-Investment_Plan-v2.pdf. It is surmised that geothermal power is not counted against the IRE ceiling of 10%.

Table 5.2. – Barriers to Low Carbon Development in Dominica

Barrier type	Barrier Descriptions
Regulatory Policy / Legal	No detailed action plans for the development of RE sources and EE appliances, lack of standards for the importation of RE and EE equipment and its installation using best practices; a utility-driven cap on RE development (2.5 MW) that does not address potential for higher intermittent renewable energy (IRE) penetration to the national grid; and no policy on feed-in tariff to safeguard cost recovery of IPPs feeding into the national grid.
Institutional / Technical	No "energy champions" solely dedicated to the promotion of low carbon development in Dominica. Key institutions include the Ministry of Trade, Energy and Employment (MoTEE) whose energy-related personnel are being driven primarily by geothermal development, and Ministry of Health and Environment (MoHE) under which it's Environmental Coordination Unit is driving a broad but important climate resilience agenda that includes energy-related climate change actions, which is not considered a core discipline within this ministry. This lack of government capacity to provide focused development of low carbon for relief from high energy costs for commercial and residential sectors, are being led by the privately-owned DOMLEC.
Awareness/ Knowledge	This ranges from politicians and policymakers with insufficient exposure to these issues, to the financial sector, energy designers and architects in Dominica, technicians with the vocational skills to install RE and retrofitting equipment for EE benefits, and general public who are aware of the high cost of electricity but not aware of the means of reducing these costs.
Market / Financial	Barriers that restrain the public sector from making investments in RE and EE include investments in RE or EE not being factored into public sector capital expenditure or operating budgets; high upfront cost of RE and EE investments that do not have immediate or highly visible benefits; RE and EE being outside of the core expertise area of most public sector entities; and the lack of testing of alternate public sector financing vehicles for RE and EE, such as Energy Performance Contracting and Third Party Ownership models.

The Government of Dominica is planning re-structuring of institutional arrangements to implement the LCCRDS. While the Environmental Coordination Unit (ECU) is the current government agency tasked with oversight of Dominica's LCCRDS, a strengthened institutional arrangement was proposed under the ***Strategic Program for Climate Resilience*** (SPCR) (see Chapter 6). In an effort to maximize the country's potential to develop low carbon energy sources, a "Department of Environment, Climate Change, and Development" (DECCD) is being proposed under the *Climate Change, Environment and Natural Resource Management Bill* to develop a "Low Carbon Climate Resilient Policy and Action Plan". Passage of the new legislation through Parliament is expected in 2018. The new legislation will be addressing:

- how funds can be used for catalyzing the setup of pilot RE and EE projects;
- the architecture of a Climate Change Trust Fund (CCTF) that will facilitate direct access to international climate change financing for priority climate change mitigation and adaptation initiatives;
- possible sources of CCTF capitalization including fuel surcharges, license fees, fines and donor support.

Key features to the architecture outlined in the proposed legislation include additional positions to the existing organizational structure of the (former) MoHE. Under a Permanent Secretary of MoHE and Director of the DECCD (that would replace the ECU), additional positions would include:

- A Legal Policy Advisor (LPA) reporting to the Director of the DECCD to affect policy, lead formulation of a "Green Building Code" and setup a system for permits for energy efficiency and renewable energy;
- An Environmental Enforcement Officer (EEO) also reporting to the Director of the DECCD would provide "low carbon" policy guidance and enforcement instruments to Environmental Officers of other line agencies;
- An EIA/Certificate of Environmental Clearance (CEC) Officer reporting to the EEO and tasked with issuance of Certificate of Environmental Clearance for low carbon projects;
- Lead Administrator for the CCTF;
- A CCTF Projects Manager reporting to both the Lead Administrator and the Director who is tasked with oversight of CC projects approved for funding under the CCTF;
- A Public Awareness Officer;
- Project Officers who screen and provide recommendations to the CCTF Projects Manager for approvals.

Under a Global Environment Facility (GEF) project, approved in 2015, entitled *Low Carbon Development Path: Promoting energy efficient applications and solar photovoltaic technologies in streets, outdoor areas and public buildings in island communities nationwide (LCDP)*, funding will be provided to support new positions within the new DECCD including the LPA, the EEO and the EIA/CEC Officer. This GEF-supported Project seeks to catalyse low carbon development through the removal of the aforementioned policy, institutional, awareness and knowledge, financial and market barriers to energy-efficient applications and solar PV technologies in Dominica's streets, outdoor areas and public buildings nationwide. The Project will target up to 5 communities including Dubic, Boetica, Roseau, Portsmouth, for further scale up.

5.7. Implementation of Mitigation Measures

Dominica`s *Intended Nationally Determined Contributions* (INDC) (September 2015) defines priority mitigation measures that are to be established to achieve specified GHG emissions reduction targets. As stated earlier, under the INDC, Dominica commits to progressively reduce total gross greenhouse gas (GHG) emissions below 2014 levels (164.5 Ggs est.) at the following reduction rates:

17.9% by 2020; 39.2% by 2025; and 44.7% by 2030.

By 2030, total emission reductions per sector will be as follows:

- Energy industries – 98.6% (principally from harnessing of geothermal resources);
- Transport – 16.9%;
- Manufacturing and construction – 8.8%;
- Commercial/institutional, residential, agriculture, forestry, fishing – 8.1%;
- Solid waste – 78.6%.

Benefiting from sound management practices, it was foreseen that Dominica forests would continue to sequester 100 Ggs of national GHG emissions on an annual basis during the period

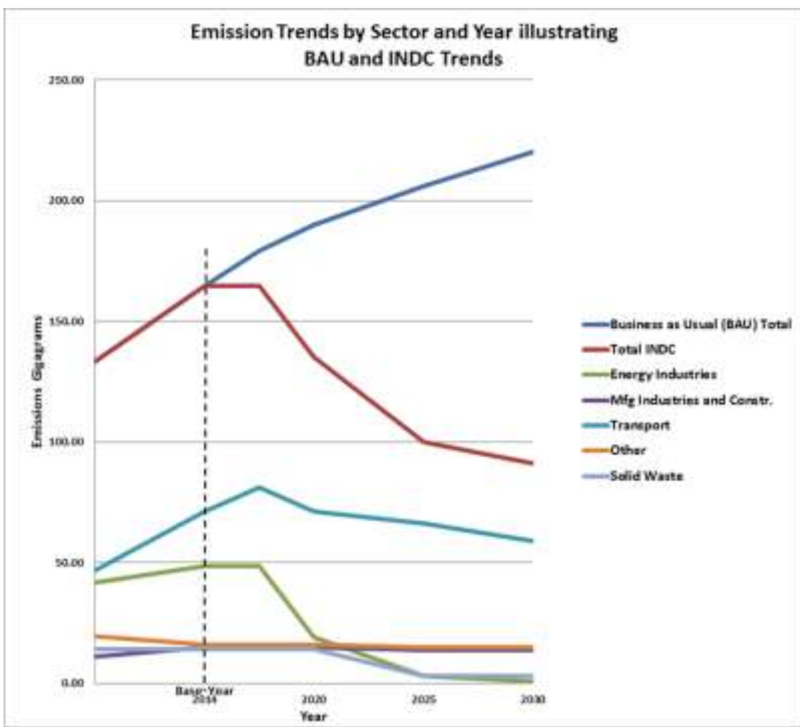
2020 to 2030. However, with the devastation caused by Hurricane Maria, the achievement of this target will depend upon how quickly Dominica`s forests recover.

It is anticipated that the commercial development and continued harnessing of Dominica's geothermal resources will, from 2025 onwards, enable the country to export significant amounts of renewable energy (estimated to exceed 200 Mw annually) to the nearby French Territories of Martinique and Guadeloupe, thereby contributing to global efforts to reduce GHG emissions.

This contribution is conditional upon receiving timely access to international climate change financing, technology development and transfer, and capacity building support for priority adaptation and mitigation measures.

The Graph below which was provided in Dominica`s INDC depicts:
• The Business as Usual (BAU) case from 2005 to 2030;
• The total emissions from 2005 to 2030;
• The emissions trends by Sector and year from 2005 to 2030.

The BAU case used Table 2.6 from Dominica's *Second National Communication* (SNC), which provides emission changes from 2000 to 2005, as its starting point. It provides emissions data on four of the five sectors. The data for the fifth sector, solid waste, was also obtained from the SNC. The projections for emissions post 2014 for each sector were derived from the application of the energy intensity value for each of the mitigation measures analyzed and by further breaking down this data by reporting year. The total emissions for each year were the total of the sector emissions for that year.



In order to achieve the GHG targets contained in the INDC, Dominica intends to implement the following measures to enhance resilience while promoting low-carbon development, which amounts to approximately US$99 million in costs.

1. New Geothermal Generation Plants.

It is the intention of the Government of Dominica to develop, with concessionary climate change financing provided under the Green Climate Fund, a geothermal generation plant to provide electricity to the domestic market. The first phase of this plant will comprise two 3.5MW electricity generation units, with the physical plant designed to accommodate another 3.5MW generator in the future. The first, two x 3.5MW plant is planned for operation in the early 2020`s, with the third 3.5MW coming in stream shortly thereafter. The Government of Dominica seeks to harness geothermal resources in manner and at a cost that will ensure that electricity charges to consumers do not increase. Forecasted Emission Reductions from this initiative is 39.3Gg, with a Capital Cost estimate of US$75,000,000 (inclusive of loan repayment costs for the exploration wells).

2. Energy Efficiency (EE) Programme

This EE program will be country wide, and will include the Manufacturing, Commercial and Institutional sectors. Such programmes carried out in other jurisdictions in the Latin America and Caribbean Region have resulted in energy savings in the order of 15 to 20% of total energy usage, and should achieve similar results in Dominica. Market based mechanisms are to be introduced to enhance the uptake of these programmes. The EE programme for Dominica will be designed and implemented to address the specific issues of the country and shall focus on retrofitting of energy efficient lighting, air-conditioning, appliances, and a vigorous education and awareness drive. Estimated installation costs have been based on the results of the audits of similar facilities in the LAC Region. Forecasted Emissions Reductions are 5.2 Gg. Costs estimates are US$2,300,000.

3. Solar Photovoltaic (PV) conversion program for Hotel Sector

This sector includes hotels and guesthouses. There are approximately 29 such facilities in Dominica, but there is insufficient detail provided to determine size and individual energy usage. Estimates have been made to derive the quantity of systems that may be involved and anticipated GHG reductions based on lessons learned from similar conversions undertaken in the region. The solar PV programme will comprise the installation of solar PV panels and related equipment on the roofs (and in some cases, the grounds) of buildings in this sector. Forecasted Emissions Reductions are 0.24Gg. Capital Cost estimates are US$1,000,000.

4. Solar Photovoltaic (PV) conversion program for Commercial, Institutional and Manufacturing Facilities

This program will include: schools, universities, hospitals, commercial buildings, manufacturing plants, government buildings, municipal facilities, etc. Estimates have been made to derive anticipated GHG reductions based on lessons learned from similar conversions undertaken in the region. Forecasted Emission Reductions are 0.86Gg. Capital Cost Estimates are US$2,700,000.

5. Off-Grid Hybrid Micro-Hydro, Wind, Solar PV, DG Back-up for Ross University

Prior to Hurricane Maria, Ross University was the single largest electricity user in Dominica, using 2MW of power resulting in significant annual electricity charges. In order to compute possible emission reductions and estimate costs, 200kW of in-stream micro-hydro, 100kW of solar PV and 500kW of wind (assuming a site is available and a reasonable wind regime is available), and 500kW of back-up diesel generation (DG), connected as a hybrid power plant in an off-grid mini-grid configuration were calculated as being required to meet average projected power demand at the University. Forecasted Emission Reductions were 1.71Gg and Capital Cost Estimate were US$3,300,000. However, with the University relocating after Hurricane Maria, it is uncertain whether this initiative will proceed.

6. Replace Streetlights in Portsmouth with Off-grid Light Emitting Diode (LED) Fixtures.

At present, there are some 368, 100W High Pressure Sodium (HPS) streetlights in Portsmouth which is the second largest city in Dominica. This initiative comprises the replacement of these HPS streetlights with smaller, off-grid LED streetlights. Forecasted Emission Reductions are 0.36Gg, with an installation cost estimate of US$1,200,000.

7. Transport Sector Emissions

11,167 vehicles were imported into the country between 2005 and 2014. During that same period, 6,624 older vehicles were retired, for a net increase of 4,543 vehicles over this period. The largest percentage of these new vehicles were sport utility vehicles (SUVs), with an increase of 2,950 of such vehicles during this period. Accordingly, GHG emissions during this period increased from 46.8Gg in 2005 to 71Gg in 2014. This is a very serious problem, which if not arrested, will prevent Dominica from adequately reducing GHG emissions in the future. Currently, import duties and charges amount to approximately 140% on motor vehicles imported into Dominica. Additionally, there is an environmental tax added on imported vehicles, which ranges from 1% of the total value (including freight charges) on vehicles that are less than 5 years of age, to EC$3,000 on vehicles older than 5 years. Two priority steps are proposed, starting as soon as practically possible:

(i) Introduce a policy that all government vehicles, at their time of replacement, will be replaced by hybrids vehicles;

(ii) Introduce market based mechanisms to motivate the private sector to purchase hybrid vehicles when replacing current vehicles.

It is expected that these actions will be implemented before 2020, and will continue to the end of the INDC reporting period, 2030, and beyond. The Forecasted Emission Reductions are 12Gg.

8. Reduce Methane Emissions from Landfill

Dominica’s existing landfill commenced operation in 2005. It is a modern, engineered landfill, with a liner, leachate collection, and capping. Methane collection vents were installed from the start, and have been venting the methane produced from the organic waste decomposition process ever since. This project will abate most of this methane by: (a) diverting organics from the waste stream that is currently deposited in the landfill; and (b) suitably preparing the landfill, and installing a flaring system. In addition, the present landfill needs to be expanded if it is expected to receive more waste within the next 5 years. The previous dumpsites that were closed also need to be considered for methane collection and flaring systems. These are the Point Ronde and Stockfarm dumpsites which were closed when the new site was commissioned. In order to further reduce methane emissions and reach INDC targets, the present volume of organic waste brought into the landfill (40% of all waste) needs to be reduced. This can be done by implementing a fully integrated solid waste management program that involves the following:

(i) public awareness and extension program throughout the island;
(ii) curbside pickup of organic waste (separation from source with revised collection system);
(iii) curbside pickup of individual types of non-organic waste (separation from source with revised collection system);
(iv) material recovery facilities and composting facilities in selected regions on the island.

Upgrading only the landfill will not solve the problem of methane gas emissions unless what is actually brought to the landfill is managed systematically. In order to achieve this goal, upgrades and equipment will be required to the amount of US$4.5 million. Forecasted Emission Reductions are to exceed 11Gg.

9. Capacity Building

The following are other high priority INDC measures that will commence during the 2016-2020 period, as part of the energy efficiency program:

- launching an education and awareness program, at school level, as well as an awareness building program for the general public;
- making energy efficient appliances more readily available, include their importance in the programs above;
- institutional strengthening at the government level, and capacity building for the private sector (e.g. contractors, maintenance personnel, and other personnel);
- developing and implementing a climate resilient energy efficient building code (Green Building Code) including a training and capacity building program;
- launching Sustainable Energy Programs for private residences, including solar PV and solar thermal, using innovative financing mechanisms to offset capital costs for home owners;
- introducing measures to reduce GHG emissions from the Agriculture Sector including through the harnessing of biomass.

10. Off-Grid Hybrid Wind, Solar, Biodiesel Generator Back-up in Off-grid Mini-Grid Configuration for South-East and East Coast of Dominica (three separate projects)

Based on lessons learned from Tropical Storm Erika and other recent extreme events, the east coast region of Dominica is particularly vulnerable to storm damage with the power systems in this area being highly vulnerable to damage rendering communities without electricity. Since the amount of remaining availability of grid connected intermittent renewable energy (IRE) systems is very limited, in order to increase power system reliability and reduce energy costs for the residents in these locations, off-grid mini-grids, powered with hybrid wind and solar PV power plants (and hydro if available), with bio-diesel generator back-up, are proposed as a possible viable alternative. Three separate mini-grids, estimated at 500kW each, comprising 500kW of wind energy and 200kW of PV, with bio-diesel generator back-up for each, are proposed. Forecasted Emission Reductions are 2.92Gg. Capital Cost estimates are US$9,000,000. After the devastation to the DOMLEC transmission and distribution (T&D) system from Hurricane Maria, this initiative has been given priority. The *DOMLEC Post Maria Recovery Plan* (December 2017) indicated that 100% of the T&D system was affected by the hurricane, with initial assessments revealing that a significant amount of equipment on the distribution system was recoverable and not requiring complete replacement. The total transmission and distribution (T&D) system comprises 17,000 poles, 1,400 km of wires and more than 1,500 pole-mounted transformers. DOMLEC estimated that 35% of the system remained standing and requires repairs, 40% was down but recoverable, and 25% required replacement. DOMLEC also estimated that at least 50% of the pole-mounted transformers in rural communities were damaged and not recoverable. None of the T&D system was insured. DOMLEC's Recovery Plan is to build back a national electricity system that is more reliable, more efficient, contains more renewable sources, and above all, is more resilient in the face of climate change. A key component of the Recovery Plan involves micro-grid and off-grid renewable energy initiatives.

It is DOMLEC's intention to adopt the micro-grid approach in the restoration of the transmission and distribution system, to create communities where "Planned Islanding" can be achieved in the event of major operational issues, or a natural disaster such as Hurricane Maria. Through planned islanding, the grid is designed and constructed in such a way that there are smaller distributed generation grids in selected areas which are normally connected and fed from the main grid, but will have their own energy sources and therefore capable of operating for long periods independent of the main grid.

In this way, remote but reasonably well populated communities rendered inaccessible for long periods, or those facing a long waiting time for the return of power will be able to be re-energized in whole or partially until power from the main system has been restored to the area. This suggested approach also supports the securing of energy supplies to critical services such as hospitals, health centers, fire, police, ambulance, airports and shipping ports etc., where the service from the source of generation can be undertaken in a manner (underground/secure overhead) where it is much more resistant to external impacts.

The electricity grid for the Commonwealth of Dominica (the Grid) can be viewed as comprising of the following main sections:

1. The Roseau Main Energy Grid;
2. The Northern Energy Grid;
3. The Rest of the Island.

Areas 1 and 2 account for over 65% of the load of the country, and are already established grid networks with planned islanding capability. Further discussions are required with respect to addressing the current limitations of the connection between the two hubs as it relates to:

a. resilience and possible scope for undergrounding/overhead T & D systems to secure the grid;
b. future inclusion of the load in the northern grid into the sphere of the geothermal operation.

The rest of the island, based on the sparseness of the population generally and the remote nature of some of the communities, would also be best suited for the implementation of the micro-grid based planned islanding approach.

Following extensive consultation with industry-leading renewable energy storage design and manufacturing companies, the options for rapid deployment distributed generation (solar +

energy storage, backed up with small diesel or propane generators) have been reviewed by DOMLEC for possible deployment in the south and east of the country. The initial opportunities for planned islanding infrastructure deployment are:

<u>1. Roseau Micro-grid</u>
At the end of 2017, as power is being restored in the areas of Roseau, Fond Cole and Canefield, DOMLEC will continue to build out the “Roseau Micro-grid” to Mahaut in the west and Pointe Michel in the southeast. This region encompasses around 25,000 residents and comprises the majority of DOMLEC’s commercial customers, with the required generation is well supported by the existing Fond Cole and hydro generating assets. The continuation and expansion of the Roseau undergrounding programme and the replacement of pole-top transformers with ground-mounted units will further enhance storm resilience. DOMLEC intends to work with strategic storage partner, Tesla Inc., on making available cost-effective and flexible bulk energy storage for use with solar PV, together with their Powerwall2 © product for home and small business energy storage, further increasing the resilience of the power delivery system. Emera companies are already deploying Tesla Inc. storage products in Barbados, Grand Bahama and Nova Scotia (Canada) for similar purposes.

<u>2. Northern Microgrid</u>
As power is being restored in the area of Portsmouth, DOMLEC will continue to build out the “Northern Microgrid”. Depending on the condition of the Roseau-to-Portsmouth feeder (PMF), this line may or may not be rebuilt. The load in areas north and west would be supplied by the existing Sugar Loaf generation assets. As in Roseau, DOMLEC will look for opportunities for underground distribution, bringing transformers to ground level and deploying energy storage assets. DOMLEC intends to continue to push forward with renewable energy options to gradually reduce reliance on Sugar Loaf generation as detailed in the next section.

<u>3. Distributed Microgrids</u>
DOMLEC reviewed the options of rapid deployment microgrids in the south and east of the country. The initial conclusions are:

(A) *Soufriere - Scotts Head Microgrid* - 300kW Solar/Diesel/Storage rapid deployment microgrid.

(B) *Grand Bay - Fond St. Jean Microgrid* - 500kW Solar/Diesel/Storage rapid deployment microgrid.

(C) *Delices – La Plaine Microgrid* - 200kW Solar/Diesel/Storage rapid deployment microgrid.

(D) *Rosalie – Petite Soufriere Microgrid* - 80kW Solar/Diesel/Storage rapid deployment microgrid.

(E) and (F) - *Castle Bruce - Salybia and Airport North Microgrid*

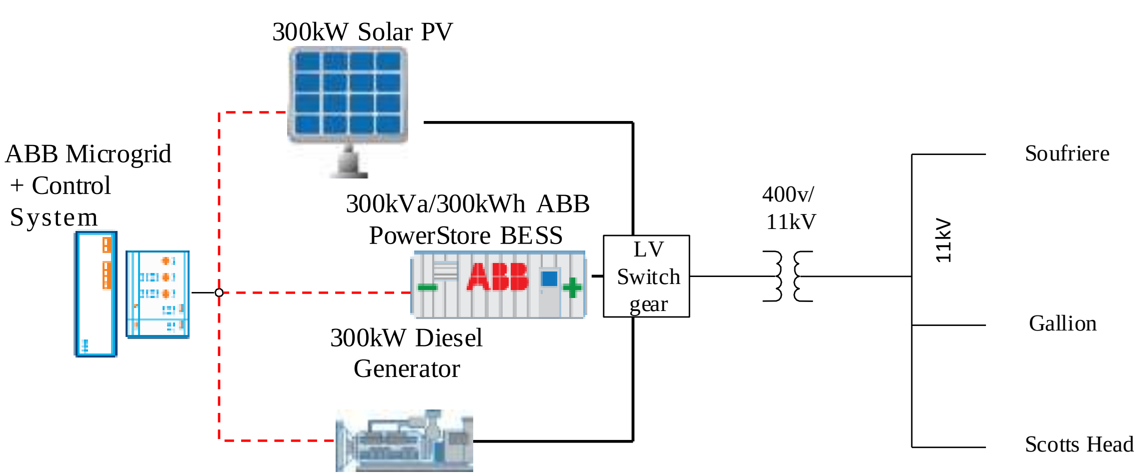
Due to the continuous distribution of small load centres from the north of the island through to Castle Bruce, this area will likely remain connected to the 11kV line from Portsmouth (via the Sugarloaf East Feeder - SEF), supplemented by local distributed generation in the Marigot and Castle Bruce areas. This equipment would initially be diesel or propane powered, but would be superseded by solar PV, biomass and battery storage over time. Emera and DOMLEC are currently (December 2017) undertaking a more detailed review of this area to develop a firm resilience plan.

4. Rural Load Clusters

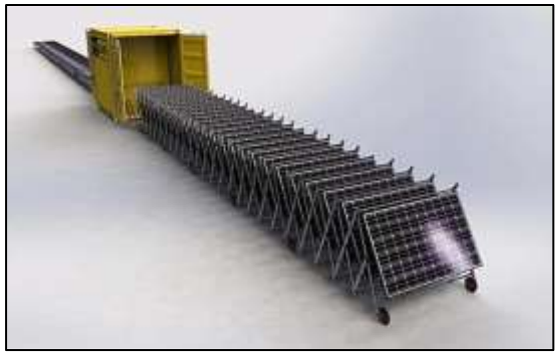
Most scattered pockets of small loads (10-30 kW) will be served by the new microgrid systems, but further opportunities will exist to employ smaller microgrids where it makes sense to do so (a few homes at the end of a long spur line). This arrangement would comprise home solar, home storage, and backup by a small propane generator owned and maintained by DOMLEC as part of rate base.

The six Dominican Microgrids, plus the Portsmouth and Roseau Microgrids are shown on the map below:

The larger (80 – 500kW) microgrids will generally be in the format below (Soufriere – Scotts Head shown):



The rapid deployment technology is modular and comprises the following features for resiliency:



- The Solar PV systems are retractable and can be quickly and safely redeployed back into its container as hurricanes and storms approach.
- The microgrid system is pre-engineered and modularized so only takes a day to install at site. Land availability is yet to be determined, but no significant land preparation is required.
- The batteries are stored in dedicated weatherproof containers, and are pre-engineered to be connected directly to the backup generator and solar PV inverters.

The deployment plan would be to install temporary diesel or propane generation onto the remote microgrid customers immediately and start restoring customers.

The microgrid systems would then be deployed over the next 3-6 months (early 2018) to provide the resiliency required, and move the diesel/propane generation to a backup role.

Emera and DOMLEC are also working to deploy small-scale biomass (woody residues) conversion equipment. These would be in the range of 20-40kW installations, and used to convert the large amounts of waste wood yielded by Hurricane Maria to electricity and hot water (if required). This technology is proven, small scale, transportable and will provide a means to dispose of the significant quantity of scrap wood, while providing a valuable infeed to the distributed microgrid systems. Meaningful employment would be created in running the equipment and harvesting and preparing the wood supplies.

Total cost estimates for the above microgrid options are provided in Table 5.3.

Table 5.3. Cost Estimates (December 2017) for Microgrid Installations (source – DOMLEC)

	Electrical Capacity (kVA)	OEM Microgrid Cost Est. ($USD)	Local Costs ($USD)	Total Costs ($USD)
a. Soufriere–Scott's Head	300 kVA	$1,300,000	$40,000	**$1,340,000**
b. Grand Bay - Fond St. Jean	500 kVA	$1,900,000	$65,000	**$1,965,000**
c. Delices - La Plaine	200 kVA	$1,100,000	$40,000	**$1,140,000**
d. Rosalie - Petite Soufriere	100 kVA	$600,000	$35,000	**$635,000**
e. Castle Bruce m- Salybia	200 kVA	$920,000	$40,000	**$960,000**
f. Airport – Wesley *	600 kVA	$2,300,000	$1,570,000	**$3,770,000**
		Total		**$9,810,000**

5.8. Mitigation Opportunities in Electricity Generation, Transmission and Distribution

Dominica Electricity Services Limited (DOMLEC) is a privately owned company. Its majority shareholder is Barbados Light & Power Corp (a subsidiary Emera Inc.). Dominica Social Security and others are minority shareholders. DOMLEC is the sole electric utility with an installed electrical generating capacity of 23.8 megawatts (MW) with a peak demand of 17.2 MW. Dominica is not as reliant on imported fossil fuels as other islands in the region thanks to three hydroelectric plants on the Roseau River that produce 27.4% of the electricity supply. In the 1960s, hydropower supplied 90% of Dominica's electricity. As population and electricity demand grew, diesel generator use increased due to the then cheap price of fuel, and hydropower share thereby diminished. The electric utility company operates three hydro-electric power stations (Laudat, Trafalgar and Padu) and two diesel power stations (Fond Cole and Sugar Loaf). The country's three operational hydroelectric plants have capacities of 1.3 MW, 1.8 MW, and 3.5 MW with an additional 17 MW potentially available. In 2016 Dominica's baseload was 11MW and peak load at 17.8MW.

All generation sources are linked via 11 kV inter-connectors and, in some instances, via 11 kV distribution feeders. The secondary distribution voltage is 230/400V. The transmission and distribution (T&D) network, comprising 368 km of 11 kV and 922 km of low voltage overhead lines, serves about 98% of the island's population pre Hurricane Maria. With the requirement for constant tree trimming and other insulation issues, line losses have been a serious challenge in transmission and distribution as the utility have been trying to keep losses at or below 8%. In an effort to further reduce line losses, there has been consideration of plans to distribute at 33,000 Volts on certain lines. The promotion of off-grid and micro-grid renewable energy systems could significantly reduce the high T&D costs that are currently passed on to DOMLEC customers.

DOMLEC operates under a Transmission and Distribution (T&D) license, and a production license that is being phased out. The T&D license gives DOMLEC sole responsibility for the transmission, distribution, and supply of electric power to the public. The phased out of the DOMLEC production license is expected to lead to an open production landscape by IPPs in the near future. However, the fuel surcharge levied by DOMLEC on electricity, which was introduced to offset volatility in the international petroleum markets, is perceived to be a disincentive to the increased use of hydro-electricity by DOMLEC which is unable to levy the fuel surcharge on renewable energy. The utility uses the fuel surcharge mechanism based on the fluctuation in the diesel price to compensate for increases in the price of diesel. The fuel surcharge needs to be regulated by the IRC in a more proactive manner as it could incentivize the use of hydro and other renewables instead of diesel.

Current terms for electrical generating licenses are regressive and provide a disincentive since independent power producers do not benefit from net metering or feed-in tariffs so their excess generation is either not stored or is sold to the grid at much lower rates than those charged to customers by DOMLEC. Climate change mitigation in generation can be achieved through using renewable energy over fossil fuel energy wherever possible, and though energy saving measures. The overall grid power requirements for base and peak load are being reduced by partial grid defection after Hurricane Maria, with some consumers installing solar PV to guard against total blackouts as occurred in storm situations while simultaneously reducing their electric bills. There is also the continued migration to solar hot water heating. Additionally, the utility's largest private customer, Ross University School of Medicine, has been closed since Hurricane Maria. It is anticipated that this closure will increase the cost of grid electricity as negative economies of scale force prices upwards, thereby creating pressure for further grid defections.

The introduction of the DOMLEC “pay as you go” meters allows residential customers to receive more targeted information about their energy use. However, further customer savings could be achieved though measures that would encourage the introduction of household energy conservation and energy efficiency measures.

Currently there is no guidance on compensation for private standalone energy producers to the grid. DOMLEC buys electricity from private producers at very concessionary rates and sells back at its regular rate which is over three times its buying rate. As generation and distribution inch closer to smart micro grids, the need for a rate/purchasing system like Net Metering, or Feed-in Tariffs becomes more acute.

This laissez-faire approach to regulating DOMLEC by the IRC may unwittingly advance grid defection leading to sub-optimal outcomes for customers and the utility alike. Customers will invest in systems that best suit their needs and interests. For most customers, this means reducing their electricity bills, and improving the quality and resilience of their electric service. The absence of a planned transition could lead to grid defection for customers that are able, and a fragmented, higher-cost grid for everyone else.

5.9. Mitigation in Electricity Consumption

5.9.1. Buildings

The energy performance of buildings takes into account the building envelope, the external walls’ material/fabric/texture, paint colour and finish, natural ventilation, natural lighting, and the efficiency of its installations and appliances with the objective of achieving net zero in new and renovated buildings. Net-Zero buildings with energy efficiency certification like Leadership in Energy and Environmental Design (LEED) Platinum certification and Passive House certification need to be introduced.

5.9.1.1. Roofs and Walls in Buildings

Electricity consumption could be reduced if various energy efficiency measures were implemented. Most importantly, energy efficiency begins with the design, orientation, and nesting of structures in the municipality. Natural ventilation and lighting help reduce the need for artificial cooling and lighting. Most new office buildings require artificial lighting during the day. Physical Planning Department design guidelines for new and retrofit buildings should minimize the need for artificial cooling and lighting energy.

The proliferation of concrete roofs, which are resilient to Category 5 storms, are left bare where the concrete mass absorbs hours of solar energy transforming top floors and sun facing rooms into concrete ovens. Green roofs and appropriate overhangs and vegetation can negate this warming effect.

5.9.1.2. Natural Ventilation and Cooling

In recent times the use of natural ventilation in buildings has receded and artificial ventilation and cooling have become commonplace with the ubiquitous use of fans and air conditioners. Appropriate windows that do not restrict the maximum air flow are generally overlooked in most contemporary buildings. Additionally, windows that also serve as overhangs are seldom deployed.

Air conditioners are now standard in most contemporary buildings. Energy efficient and renewable energy augmented air conditioning units are hardly considered. Geo-exchange air conditioners, which are quite feasible in most locations, have never been deployed in the cooling cycle.

5.9.1.3. H_2O Heating

Dominica at one point led the Caribbean (per capita) in solar water heaters which were manufactured locally by Marinor Enterprises. This zeal has subsided a bit but penetration is still significant, led by Solar Dynamics from Barbados. The fervor should be rekindled to reduce the need for the use of electricity in buildings' hot water systems.

5.9.1.4. Lighting: Lamps

Lighting consumes a significant percentage of the electricity consumed in Dominica. Currently LED lamps are increasingly penetrating the market, with new installations being mostly LED fixtures. However, electromagnetic ballasted fluorescent fixtures are still the dominant lighting fixture, while the lower costs of incandescent bulbs still keep them in the market. Energy efficiency awareness and energy audits are still not commonplace, so most consumers do not know the financial savings that comes with installing LED lamps. Further, energy use, the promotion of energy efficiency and associated links to impacts such as climate change still remains far from the public consciousness in Dominica. Public awareness on this front needs to be augmented.

5.9.1.5. Lighting: Photo Cells, Motion Sensors, Automatic Light Level Controllers

In Dominica, too many lights stay on all night, all weekend, and often well into daylight hours due to the reliance on human intervention to do the switching. This can be avoided and reductions in power consumption by at least 80% can be achieved if these lights were fitted with photocells and motion sensors. The increased installation costs would be covered by savings in electricity charges in a short term. Light level controllers would help maintain consistent light levels and intensify or dim corresponding to ambient light levels.

5.9.1.6. Appliances

Appliances are not regulated by any energy efficiency ordinance, tax incentives, or rating standards like Energy Star or Energy Label. Importation of appliances is not influenced by import duties or other concessions. Introducing appliance energy efficiency standards and labelling could reduce emissions and provide significant savings over time.

5.9.2. Food Preparation

Currently most cooking and baking undertaken on the island uses Liquefied Petroleum Gas (LPG), a mixture of propane (C_3H_8) and butane (C_4H_{10}), both derived from fossil fuel sources. Charcoal is still widely used for bar-b-ques and outdoor cooking at picnics. A few households are using LPG in outdoor grills. Wood is used mostly in rural areas, although infrequently. With the proliferation of renewable energy in Dominica, a corresponding change should be encouraged to migrate to renewable energy electric powered stoves and ovens (ranges). Also energy conservation food preparation practices should be encouraged through a public awareness campaign, for example the promotion of the practice of reducing cooking heat once water and other liquids have reached their boiling point which would save energy and electricity costs.

5.9.3. Attire

Dominicans should dress appropriately befitting its tropical clime. Non-tropical attire is standard in most offices, which when combined with inappropriate office ventilation, results in the use of air conditioning to attain a minimum level of comfort. Most office workers dress code is inappropriate for the tropics. Lawyers for instance wear black synthetic suits and gowns. So in addition to the multi-layers of clothing, the garment colour absorbs the more heat. By contrast, in India, the legal dress code is white and the fabric is usually breathable cotton. So courts, banks, parliament, and most offices are air conditioned but at lower temperatures. Indeed air conditioned offices also seem to bear an element of status.

5.9.4. Street Lighting

Street lights in municipalities are all LED lamps connected to the grid. Currently solar PV powered LED lamps are being installed on the major roadways connecting municipalities. These lights would be better deployed lighting playgrounds and improving the level of current street lights while eliminating the emissions of municipality street lights.

5.9.5. Playground Lighting

Pre Hurricane Maria lighted playground fixtures were halogen or metal halide. LED fixtures are replacing these lamps. There is some effort to power some of these fixtures with solar PV.

5.9.6. Solid Waste

Waste discharge to the central landfill continues to rise. In 2009, some 14,000 tons were discharged, rising to 22,000 tons in 2012. The major waste producers were residential waste, commercial business, construction, and manufacturing. Significant improvements in waste management, particularly backyard and municipal composting, separation at source, and reduction and recycling of plastics will sharply reduce the amount of waste transported to the landfill. Too much organic waste ends up in the landfill, sometimes transported miles, while alternatively, backyard or municipal composting could transform the waste to compost and collectable methane thus eliminating greenhouse gasses that are generated by the decomposition and transportation of biodegradable waste. The problem of reducing waste production nevertheless remains a priority issue.

5.9.7. Mobility - Transportation

Transportation is the single largest source of greenhouse gas emissions in Dominica. Dominica can make a great leap forward, and bypass incremental steps, by aggressively moving into green transportation, focusing on electric vehicles and possibly fuel cell vehicles. Currently, vehicles in Dominica run on fossil fuel, gasoline, diesel, and a few on liquid gas. There is one electric vehicle and a few owners complement their diesel with biofuel. Most imported vehicles are older pre-owned vehicles from Japan which do not meet more recent international emissions standards.

Most vehicles in Dominica run less than 150 miles a day, so for electric vehicles a single charge would suffice for a day. With the abundance of rivers across the island, and with good wind resources on the east coast and solar radiation everywhere, a few rapid charging stations can be setup around the island powered by hydro or wind to provide the daily charging requirement, with solar PV reserved for top-up at bus stops and parking garages. The transition could begin with passenger buses which would have the added benefit of lowering passenger fares. Currently electric vehicles are cheaper to own and operate over four years than fossil fueled vehicles.

Diesel vehicles in Dominica are especially polluting. Most diesel vehicles' mufflers invariably can be seen visibly emitting dirty exhaust fumes. Particulate matter pollution from diesel vehicles contributes to the high incidence of juvenile asthma. Diesel vehicles should be phased out. An immediate ban on the importation of small diesel vehicles should be effected. Additionally, the introduction of clean biodiesel should be encouraged.

Daily traffic rush hour delays, roadway bottlenecks, indiscriminate parking, and the lack of storage on most roadways, extends the duration of trips by several minutes with the corresponding increase in avoidable emissions. Comparatively inexpensive roadway design could reduce trip time (and GHG emissions) by 30% or more.

The motorisation rate in Dominica is one car for every 3 inhabitants, with 24,600 vehicles registered in 2014 for 71,000 people, which is excessive. On average, each car covers 18,500 km/year. This phenomenon is driven to a large extent by inadequate public transportation. With an improvement in public transportation, a corresponding decline in motorization rate, and concurrent reduction in GHG emissions, should result.

5.9.8. Mobility - Walking, Cycling and Habits

Many Dominicans in the urban areas drive when walking would avoid emissions and save time. A combination of improved public transportation, enhanced pedestrian walkways, routes and sidewalks, and public awareness on the cross benefit of exercise could reverse that trend.

Over the years, cycling as given way to motorized transportation. Most Dominicans do not ride bicycles anymore. A newly formed cycling association could help reverse this situation, but so far its focus has been on competitions and not more public use of cycling. A improvement in the availability of cycle paths along major coastal roads could foster greater interest and use of this healthy alternative to vehicles, and expand the range of tourist outings on offer.

5.9.9. Mitigation in Agriculture

There are several areas where GHGs mitigation and carbon sequestration in agriculture can be achieved. By enhancing the soil organic carbon, reducing soil erosion, mitigating Nitrous Oxide (N_xO) emissions, eliminating Short-Lived Climate Pollutants (SLCPs), introducing manure management, continuing no tillage, and replacing fossil fuel farm energy with biofuels and other renewable energy (RE), climate friendly agriculture can be achieved. GHG mitigation is an innovative approach which enhances the farmer's livelihood rather than being another regulation to be defied when possible. Significant reduction of GHGs will be attainable through this transformational approach.

In bananas production, the nation's premier agriculture crop, the high application of synthetic fertilizers on the undulating landscape combined with the heavy rainfall induces elevated nitrous oxide (N_xO) emissions, while the required meticulous field sanitation results in scant topsoil cover and depletion of the soil organic carbon. The use of such fertilizers also inhibits attempts to promote organic agriculture as a niche market opportunity for farmers.

GHG emissions can be further reduced by the reduction/elimination of the slash and burn practice used for clearing land, the disposal of cuttings through burning, the burning of grass or fibre by workers to repel biting insects, and the burning of shrubs and weeds.

The Division of Agriculture recognizes that in addition to mitigating climate change, systems that increase Soil Organic Carbon (SOC) are also more productive, more profitable and more sustainable. Therefore it behoves the Division to implement soil carbon sequestration. The sector should actively encourage enhancing Soil Organic Carbon, the reduction of soil erosion, the elimination of SLCPs especially black carbon, the reduction of nitrous oxide and methane, while promoting crop residue management and no tillage methodology as sound farming practices. The sector should replace fossil fuel energy with renewable energy where possible and reduce carbon footprints by substituting imported inputs with local inputs (e.g. replace synthetic fertilizers with compost). 50% reduction is a realistic target for 2030.

The Agriculture Division supports the concept of "Organic Dominica" that is being championed by the Dominica Organic Agriculture Movement (DOAM). The transition to Organic Dominica will sequestrate carbon in the soil thus improving its Soil Organic Carbon. Organic methodologies will significantly mitigate GHG emission in agriculture.

With the right approach, GHG mitigation is quite compatible and economical friendly. For example, the over use of synthetic fertilizers and its full or partial replacement by organic compost can sustain good healthy crops while reducing N_2O emissions and fertilization cost. It also reduces production costs and emissions associated with organic waste disposal, and the carbon footprint associated with imported synthetic fertilizers.

5.9.10. Wetlands and Mangroves

Wetland and mangroves provide multiple environmental services and are important carbon sinks that need active protection. The Indian River wetlands and Cabrits National Park wetlands serve as flood protection areas and a refuge for migrating birds. The active conservation and protection of such areas needs to be encouraged.

5.9.11. Forests

Dominica's forests and terrestrial national parks, covering 63% of the land area, are well established and will continue to be a carbon sink once they have recovered from the devastation caused by Hurricane Maria. These areas are protected by law, but improved enforcement is needed to protect buffer zones. Additionally, with the devastation caused by Hurricane Maria, efforts need to be made to: (a) support forest regeneration where necessary; (b) replace lost soil and ground cover to restore moisture balance and soil fertility; and (c) remove invasive species which stifle forest re-generation.

5.9.12. Marine and Air Transport

Dominica does not own or operate any airline and has little influence on the fuel used by airplanes. However, Dominica Air and Sea Port Authority (DASPA) has embarked on a program to augment their airport and sea port facilities with off-grid electricity using solar PV and possible hydro. Over the next three years the Douglas Charles Airport, the Roseau Ferry Terminal, Woodridge Bay Port, Longhouse Port, and the Cabrits Cruise Ship Berth will all be fitted with solar PV systems. Fishing boats, cargo trawlers, and cargo vessel all use fossil fuel. Currently, there is no significant program to transit to renewable energy powered vessels, or to introduce bio-fuels which can be produced from fish waste.

5.9.13. Energy Audits

Energy audits need to be part of the energy efficiency toolkit for homeowners and commercial building operators. Energy audits are still rarely used, and should be actively promoted by DOMLEC. Light levels are hardly ever checked, and light meters should form part of the energy efficiency toolkit.

5.9.14. Fiscal and Other Incentives, and Environmental Awareness

Dominica, "the Nature Island", should embark on a comprehensive program of aligning its development to the environment. Building a climate resilient country means not only addressing risks from climate change, but also reducing risks from the loss of electricity supply which frequently results from extreme events, and seriously undermines productivity and competitiveness. Mitigation, biodiversity, health and wellness are critical components of this alignment. Fiscal and other incentives must be part of the environmental transformation toolkit. So too are education and awareness programs at all levels. The appropriate administrative structures and systems should be installed to govern and coordinate this undertaking. The relevant laws should be enacted to support compliance. Ultimately, a spirit of environmental awareness must pervade the nation.

The Government of Dominica and the Environmental Coordinating Unit understand the importance of education and public awareness in the fight against global warming. Various methods are being deployed to raise public consciousness and mitigation action. However, there are no specific climate change lessons in most schools. Some elementary aspect are covered in geography classes at secondary schools, but geography is not a compulsory subject and less than 30% of students nationally include geography in their subject choices. Given the ubiquitous nature of climate change, education policy should be adjusted to expose all students to climate change information across a range of subjects. There is an emerging movement to include environmental studies as part of the nascent STEM programs, but that has not fully taken hold and is still in its infancy. Environmental clubs are also popping-up in a number of schools. There is also need to improve climate data management and monitoring capabilities.

5.9.15. Ongoing Initiatives

The Ministry of Public Utilities, Energy and Ports, is providing support to restore, and possibly expand the hydro electricity generation stations that will have the capacity to increase the generation from 1.8 to 3 megawatts of electricity at one particular plant. Dominica has already installed hydro electricity capacity of 7.6 MW. The Ministry also encourages other investments for the expansion of hydro electric capacity, and the installation of photovoltaic (solar) electric systems for domestic, commercial, and institutional use.

Initiatives have identified some 7 to 9 wind sites on the island with the view for further development of wind farms. However there is need to collect the requisite wind data from the target sites, which is costly and time consuming. Dominica participates in the OAS/GTZ GeoCaraibe initiative which is looking at quantifying the resources and development of geothermal energy in St. Kitts and Nevis, Dominica, and St. Lucia. At present Dominica is actively undertaking a project supported by the GCF that will seek to exploit its geothermal resources for generating cleaner and lower cost electricity. This will build upon the support provided by the Government of France and the European Union, through the Regional Council of Guadeloupe, that launched a 3 year geothermal resource development programme in Dominica.

This programme determined and characterized Dominica's geothermal resource and set the stage for investments in geothermal energy generation plants or commercialization of the resource.

The project plans to generate 20 MW of electricity for local consumption and export of at least 40 MW of electricity to each of the French departments of Guadeloupe and Martinique via submarine cables (see Figure 5.2), bringing in much needed foreign exchange to assist with the economic recovery after Hurricane Maria.

Figure 5.2. Routes for Proposed Sub-sea Cables to Export Geothermal Energy

Chapter 6: Vulnerability, Risk and Adaptation Assessment

6.1. Introduction

This Chapter provides a summary of climate change vulnerability and risks facing Dominica, and an overview of the capacity at the national and local levels to adapt to such vulnerability and risks. Much of the information for this Chapter is drawn from the extensive evaluation and risk assessment work undertaken to develop the Dominica ***Strategic Program for Climate Resilience*** (SPCR) and ***Low Carbon Climate Resilient Development Strategy*** in 2012 by a large group of dedicated stakeholders.

This Chapter has also been informed by work undertaken under the US$35 million Disaster Vulnerability Reduction Project (DVRP) which was officially launched in September 2014 to implement some components of the Dominica ***Strategic Program for Climate Resilience***.

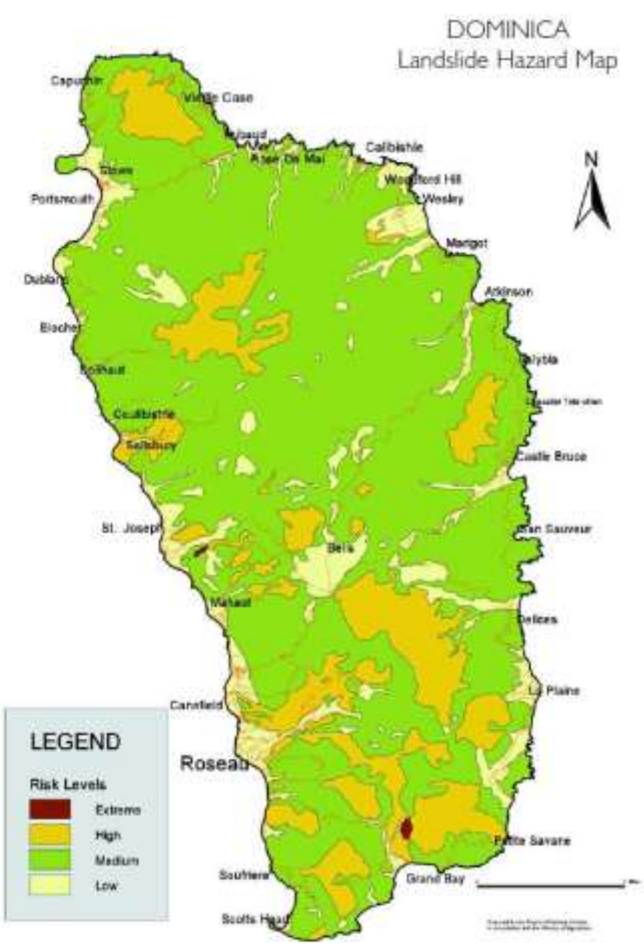
6.2. Vulnerability Context

Dominica, by its very nature is vulnerable, given its susceptibility to natural disasters and its ecological and economic fragility. Vulnerability to climate change in Dominica, like many developing countries, is aggravated by external pressures affecting its resilience and adaptive capacity such as terms of trade, impacts of globalisation (both positive and negative), financial crises, international conflicts, external debt, and internal local conditions such as minimal population growth, incidence of poverty, political instability, unemployment, reduced social cohesion, and a widening gap between poor and rich, together with the interactions between them. It is widely acknowledged that climate change can exacerbate natural disasters with enormous human and economic costs. The people of the Caribbean region are among the most vulnerable to climate change and related risks and disasters. The impacts of climate change are being seen, yet, an environmentally sustainable approach still remains to be fully mainstreamed into development policy in many countries.

6.3. Land Use, Protecting Carbon Sinks, and Enhancing the Resilience of Natural Ecosystems

Dominica is characterized by a very youthful and fragile forest landscape, which makes it very susceptible to the effects of land degradation. However, historically Dominica has a strong tradition of conserving its land resource base. These traditions date back to pre-Columbian times when the forms of land use employed by the indigenous peoples (Kalinago) had very little negative impact on Dominica's physical environment and the land in particular. However, the introduction of plantations and the associated large-scale land clearings by Europeans caused an increased level of soil erosion, especially along the west coast. In the post-World War II period, the banana industry developed, leading to the introduction of heavy machinery to build infrastructure (e.g. roads) together with increased housing needs related to the expanding economy. Thus, significant pressures were brought to bear on the fragile resource base with increasing levels of land degradation and desertification that is now being compounded by impacts from climate change.

The general pattern of land use in Dominica has been dictated by topographic limitations. The highest, most rugged elevations in the interior have remained inaccessible and therefore forest cover - which constitutes Dominica's largest carbon sink - predominates, although there has been gradual loss of forest cover in the lower elevations. The Food and Agriculture Organisation's (FAO) *Country Profiles on Forests, Grasslands and Dry Lands* cites a percentage reduction in forest cover relative to land mass area of 65% to 61% over the period 1990 to 2000, with much of the recorded forest loss being through the sale of State lands and subsequent conversion out of forest cover. Most of these lands were converted to agriculture production and ultimately into housing.



The narrow flat floodplains of the major rivers in the country have seen the most intensive land utilization, predominantly agriculture, with hillside cultivation extending into the mid-elevation areas along road access routes. Banana and temporary (vegetable and root) crops, coconut and citrus dominate commercial agricultural production in Dominica. Urbanization has been largely confined to the narrow coastal fringe, although newer settlements have been expanding into the interior along the rural road network.

The latter half of the 1990s saw a downturn in the agricultural sector as the banana industry contracted due to the gradual loss of preferential market access to the United Kingdom (driven by World Trade Organization rulings) for Windward Island fruit. Although there has not been a comprehensive national agricultural census since 1995, the Ministry of Agriculture estimates a decrease in the number of farm holdings under active agriculture. Much of the lands that were formerly under banana cultivation are now under short-term cropping systems. Some of the former agricultural lands are now under ***urban development with the threat of accelerated degradation*** due to the high degree of land disturbance, lack of soil and water conservation measures, and increasingly from climate change impacts.

Historically, the majority of the land area in Dominica was parceled into large estates owned by the Crown (mainly unutilized lands in the interior) and private owners (major agricultural estates). As agricultural output from these large estates declined over time the land was subdivided and sold as smaller agricultural parcels and housing lots. From the late 1970's to the mid 1980's, in a major land settlement scheme, the Government acquired 11 private estates totaling 2,368 hectares which were then sub-divided and sold for housing.

The Dominica Agricultural Census of 1995 reported an increase in the number of land parcels classified as farms (from 9,101 to 10,100 from 1961 to 1995), but a decrease in the total acreage under farming systems over that period (from 30,850 hectares in 1961 down to 21,134 hectares in 1995). This trend was due to the transition from large estate agricultural production systems, as these estates were cut up and sold, to more intensive agricultural production on smaller acreages. The expansion in the number of holdings under cultivation corresponded to the rise of the banana industry in Dominica (although on a lesser scale than on the other Windward Islands) from the 1970's into 1990s.

According to the agricultural census (1995) in 1961, at least 95% of private lands in Dominica were categorized as single-owner free-hold. By 1995 this had fallen to just over 65% with an increase in the percentage of lands categorized as "family ownership" to just under 11%. The census also noted the increase in the quantum of lands classified as "leased", "communal" and "squatter". By 1995 just over 12% of non-state lands fell under these categories. There are no definitive recent statistics to update the situation from the 1995 assessment.

By extension, the transition from larger-scale agriculture to small farms has also had implications for implementation of land conservation measures and efforts to enhance the resilience of natural ecosystems to address climate change concerns. As holdings become smaller, farmers tend to cultivate the full acreage within the holding in short-term crops to maximize financial returns. ***Trees that would otherwise maintain the soil and serve as carbon sinks are often removed resulting in accelerated land degradation in fragile environments***. A compounding factor is that small farmers tend to be resource-poor, with low capacity to invest in soil and water conservation measures. In cases where lands are converted to housing and other forms of urban development, land degradation is driven by similar factors particularly where ***settlements are unplanned and developed without infrastructure to control pollution, runoff, erosion and landslides***. In Dominica, land and water resources degradation has been historically driven mainly by indiscriminate clearing of forests in environmentally fragile areas (steep slopes underlain by erodible soils within high rainfall zones) and subsequent replacement by intensive agricultural cultivation. Installation of poorly constructed farm access roads in these areas in many instances contributes to land degradation and landslides. Other activities such as poorly managed mining and quarrying operations and expansion of settlement areas in erosion-prone and landslide-prone areas compounds the country's vulnerability to impacts from climate change. Climate change has both on-site and off-site effects on land. On-site effects include the lowering of the productive capacity of the land, causing either reduced outputs (crop yields,

livestock yields) and/or the need for increased inputs. Off-site effects include changes in water regime, such as decline in water quality and sedimentation of river beds and reservoirs, with increased sedimentation rates in rivers being expected in Dominica due to climate change.

These issues translate to a situation in which land that may be otherwise productive, remain under sub-optimal production, with the farmers remaining in a poor subsistence state. In all instances, the resilience of natural ecosystems is undermined, making them increasingly vulnerable to impacts from climate change and natural disasters. Landslides are a constant threat and present a significant impediment to development.

The Government and people of Dominica have for a long time recognised the need to protect the island's fragile ecosystems. By the 1950's the first *Forest Ordinance* was enacted which authorised the establishment of forest reserves on Crown Lands and protected forests on private land for purposes of soil and water conservation. Since then, a series of laws have been enacted to regulate the use of fragile land resources. These include *inter alia:* the *Town and Country Planning Act*; the *Land Management Authority Act*; the *Forest Reserve Rules*; the *Forestry and Wildlife Act*; the *National Parks and Protected Areas Acts* (over 20% of the island's land mass is under legislated protection); the *Beach Control Act*; the *Water and Sewerage Act* and the *Pesticide Control Act*. Currently, under Cabinet directive issued in August 2011, a comprehensive *Climate Change, Environment and Natural Resource Management Bill* is being developed through broad-based consultation, which will address key deficiencies in the existing legal and institutional framework, and establish an effective framework for managing anthropogenic threats to vulnerable ecosystems.

6.4. Agriculture, Fisheries and Food Security

The Agricultural Sector is a significant contributor to the economy of Dominica. Agricultural contributes approximately 17%, or US$93.4M to the country's GDP. The agriculture sector is a major source of employment in Dominica. Of the estimated 32,000 persons actively seeking employment, an estimated 7,000 are employed in agriculture. This represents 21% of the active work force. In terms of arable land (including permanent crops) Dominica has approximately 24,000 ha available based on 2012 estimates.

The vulnerability of Dominica's agricultural sector – which together with tourism is the mainstay of the country's economy - is manifested in the risks presented by natural disasters and climate extremes, as well as in the sector's vulnerability to climate variability and external economic shocks. The World Bank points out that Dominica's real agricultural sector product and agriculture's share of GDP has fallen consistently with each major natural disaster, with the sector failing to recover to previous levels of relative importance. Most of this decline is attributable to the crop sector, and within that sector, to the decline in banana production. Otherwise there has been significant growth only within the small livestock sub-sector. The World Bank indicate that "the post disaster shift out of agriculture seems to be explained by a combination of a further reduction in larger scale production (failure to invest fully in replacement), a shift of small shareholders into employment in other sectors, and also off-island migration".

The performance of the crops sub-sector was severely affected by the extended drought in 2010. Agriculture's decline has been particularly marked since Hurricane Hugo. Crop sector product in real terms in the late 1990s was 20% below the 1988 peak caused primarily by the decline of the banana industry, which has maintained this pattern during the 2000s.

Dominica witnessed significant impacts to the agriculture sector during Tropical Storm Erika and Hurricane Maria. During Tropical Storm Erika, lowland flooding and landslide were the principal causes of loss and damage in the agricultural sector. Apart from crop loss and damage, some important agriculture based operations were completely destroyed. Among these were the destruction of two rum factories and the partial damage of a third as well as the destruction of the bay oil distillery and the bay leaf crop in Petite Savanne. Other severe impacts were realized with erosion and landslides blocking interior farm-to-market roads. As such, numerous farmers were either denied access to their fields and livestock or were denied access to markets. Finally, arable lands have been destroyed either through landslide, erosion or rock and debris deposition. The impacts of this were most severe where individual landowners have lost a significant portion of their arable plot requiring them to purchase new lands or abandon agriculture. The total damages and losses to the Agriculture sector were estimated to be EC$122,832,078 (US$40,789,110).

The direct effect of Hurricane Maria to the local agricultural economy can be categorized as the following, but not limited to:

(a) physical/environmental impact (loss of bio-diversity, loss of a critical ecosystem services, dislocation of lands, transport and sedimentation of soil material, loss of crop canopy, feeder and farm access roads, damage to government infrastructures, etc.,);
(b) economic impact (loss of foreign exchange, loss of market share, loss of income, increase in food import, increase production cost, impact on revenue, etc.,);
(c) socio-economic impact (loss of farm employment and related agricultural activities, exit from sector, migration, urbanization and changing agrarian structure, etc.,).

After Hurricane Maria, it was estimated that 65 percent of coconut, 80 percent of cocoa and 80 percent of citrus trees have been damaged. 100 percent of banana trees and vegetable crops have been affected. In general, farming crop production has been severely affected. There was a total of 675 (45 percent) dead cattle, 1,950 (65 percent) pigs, 1500 (50 percent) small ruminants, and 49,500 (90 percent) broiler chicken, 25,200 (90 percent) laying hens, 6000 (50 percent) rabbits, and 225 (25 percent) bee hives destroyed. In the case of the pork sector, drowning, heatstroke, lack of potable water and feed, as well as building collapse, all contributed to significant number of dead animals. For the poultry sector, and to a lesser extent rabbits, loss of animals was primarily due to building collapse and flooding. While for cattle and small ruminants, flash flooding, drowning and exposure to the

natural elements, as well as flying debris, all contributed to the death of animals. The most affected sub-sector within the livestock industry will be that of poultry, particularly egg production. Dominica has been self-sufficient in eggs for over 40 years. The entire sector, valued at EC$5 million (US$1.9 million), was lost. Implications would be the loss of income for farmers, and threat from external market importations. The total damages and losses for the poultry sector is estimated at EC$16.5 million (US$6.1 million). The pork sub-sector is the second main contributor of the livestock sector, valued approximately at EC$3 million (US$1.1 million). Fifty-six pork farmers providing fresh pork on a weekly basis to the market, and live animals to the abattoir have been severely impacted. The total damages and losses for this sub-sector is estimated to EC$3.6 million (US$1.3 million). Small ruminants play an important role in import substitution, the protein base and incomes for rural farm families and households. About 83 full time small ruminant farmers and associated families are active in this sector. The damages and losses in this sub-sector amount to EC$1.8 million (US$0.7 million).

These extreme events also resulted in considerable social impacts. The impacts on poor rural families relates to access to food, the decrease in job opportunities and lower wages and an increasing food and nutrition insecurity. The impact on Dominica's ability to contribute to Sustainable Development Goal 1 has been severely compromised by several years, due to changes in social and family cohesiveness, increased cost of health, migration, increased production costs, reduced investments in the sector, and reduction in the purchasing power of farm families.

With the rapid decline in the major cash crop (bananas), many farmers began moving into the fishing sector, which in 2000 employed 2843 registered fishermen (40% full-time). There is a much greater demand for fish at the present time as a major source of protein. Dominica's fishery resources are relatively diverse including near-shore demersal and pelagic species as well as deep-water pelagics and various crustaceans and other marine species.

The Fisheries Subsector in Dominica is largely artisanal in nature and primarily serves the local population. Fisher folk typically sell their catch in their local communities and the export of fish is not a significant contribution to their revenue. About 88% of the catch is used for personal gain, either sold or consumed directly. Approximately 12% of the catch is given away. Fishing is accomplished primarily using nets or fish traps. Boats used are typically canoe or keeled wood construction types with approximately 86% of the fleet using outboard motor propulsion (with backup oars) and approximately 6% powered by oars only.

There are about 52 communities along the coast that support fishing activities. The Department of Fisheries monitors fishing activities through 15 fisheries' enumeration districts. Based on the 2011 fisheries census, there are approximately 749 persons identified as fishermen with approximately 72% (539) registered with the fisheries department. Fishers and their families are generally dependent on the subsector for their livelihood. According to the census, approximately 2,074 fisher family dependents rely on fishing for their livelihood. There is still a large number of fishing activities involving the use of fish traps which target demersal species. Lobsters are caught for the hotel and tourism industry, while beach seine activities target coastal pelagic species such as sardines and jacks. Gill nets are commonly used to capture schooling species, such as mackerel, ballyhoo and small tunas. There is a closed season for lobster. The only inland fishery presently being practiced is the fresh water prawn (Macrobrachium rosenbergii) culture industry. There are six farmers on the island involved in this industry, which supplies the local market.

The artisanal and local nature of fisheries in Dominica introduces significant vulnerabilities to the subsector. The catch is vulnerable to spoilage, boats are small and generally of wood construction, and sales are generally restricted to the community of residence for each of the fishers. While sales and cost data are not available, fishing is not a major income generator. It is very likely that the livelihoods of the majority of fisher folk are susceptible to poverty given some kind of shock. During storm events, the practice is generally to place boats and fishing gear in protected bays, most of which are the mouth of a river.

Tropical Storm Erika and Hurricane Maria also resulted in significant damage to the fisheries sector. In the case of Tropical Storm Erika, extreme flooding carried large volumes of debris and flood water which resulted in the destruction of fishing craft and gear. Additionally, flood debris has created navigation hazards, and damaged fishing gear where rocks and sediments were washed out to sea. Fishing grounds in these areas had been covered in sediments which altered the ecology of some fishing areas. The total damage and losses to the fisheries sector from Tropical Storm Erika were estimated to be EC$2,949,324 (US$1,096,403). Owing to the nature of the subsector, losses and damage were catastrophic to livelihoods and families involved, including lost income and lost opportunities due to equipment damage and changes in the fishery habitats. Additionally, long-term losses will be incurred due to potential reductions in catch from the effect of irretrievable fishing pots or “Ghost Pots”.

Hurricane Maria caused significant damage and losses to the fisheries sector in Dominica. The first assessment indicated approximately 128 vessels and 126 engines have suffered damage or are lost. Fisheries cooperatives have lost their ice-making machines, fuel pumps and supplies for market vendors. Fishers have lost a large percentage of their fishing gear. The Fisheries Division in Roseau has lost its roof and all furniture and office equipment. Most of the destruction took place on the east coast, whereas the west coast was less affected.

The destruction has affected the food security and livelihoods of fisher folk and those in associated sectors (e.g., market vendors, gutters, mechanics, boat builders). Vessel and engine repair and replacement is urgently needed, as well as repair of ice-making machines and replacement of coolers to store fish. In addition, the infrastructure of Fisheries Division and eight fishing cooperatives needs to be urgently addressed. Based on current assessments, total damage amount to EC$6.52 million (US$2.41 million) and losses amount to EC$1.35 million (US$0.5 million). Total cost for the recovery need is estimated at EC$6.87 million (US$2.54 million).

These extreme events, which are increasing in frequency in keeping with climate change projections by the scientific community, have a devastating impact on the viability of the food production sector in Dominica, further undermine efforts to achieve food security. Reinstating livelihoods to farmers and fisherfolk will have spill-over effects to the entire coastal communities by means of supporting mechanics, boat builders, small and medium sized business as well as all household dependents. This will support the livelihoods and food security of thousands of people in Dominica fostering social cohesion and resilience.

For a country that could be self-sufficient and provide food to neighbouring countries, Dominica's food imports constitute an increasing burden on the economy, and threaten food security. Impacts from climate change, affecting agricultural productivity, continue to aggravate this vulnerability.

The fishing industry has been faced with considerable challenges, due to the rugged terrain of the Dominican coast, the limited foreshore space, the unsheltered bays and the impact of high-energy waves on the east coast. Development of climate-resilient fisheries infrastructure has therefore been one of the Fisheries Division's greatest priorities. The two proposed fisheries complexes at Marigot and Portsmouth will serve as regional facilities to accommodate fishermen from the various neighbouring landing sites, and will also serve as hurricane shelters/dry docking facilities for fisher folk. The fisheries sector, due to its vulnerability to hurricanes, is continuously trying to recover from the damage caused by these storms. The Division intends to establish a disaster relief fund with funding provided under the *Pilot Program for Climate Resilience* (PPCR) to which fishermen will contribute and which would help support recovery costs.

Already fishery resources face considerable stresses from a number of land based sources of pollution. Existing climate stresses especially hurricane/tropical storm systems and warming oceans present important challenges for the health and sustainability of the ecosystems that sustain the islands fisheries. Climate change, including increasing ocean acidification and changes in sea temperatures, are affecting fishery resources and migration patterns with consequent impacts on the sustainability of Dominica’s fishery sector, livelihoods, human health and prospects for food security. Climate change impacts on Dominica’s vibrant diving and whale-watching industry are yet to be determined.

6.5. Enhancing the Resilience of Water Resources

The vulnerability of water resources is a major concern. A number of challenges already face development and management of water resources in Dominica, which depends on its abundance of rivers for its water supply and to sustain agricultural productivity. Freshwater resources are already under stress as a result of pollution from land-based activities such as agriculture and industry, combined with seasonal changes in flow from climate variability. The development of the water sector is capital intensive with the supply of water being regarded as an essential social service rather than as a profit centre. Additionally, topographical constraints, limited finances, and other limitations have resulted in small, individualized water storage systems which are costly to manage and maintain. Additionally, small population centers separated by extremely rugged terrain in Dominica results in high water distribution costs.

Risks attributable to climate change include seasonal drought-like conditions, floods, and landslides particularly in the high rainfall areas, as well as hurricane and storm activities. Substantial human and economic losses are attributable to these events. Climate change continues to significantly accentuate these impacts and alter existing patterns of water availability and use.

The Dominica Water and Sewage Company (DOWASCO) service system comprises 42 service areas supported by 44 abstraction points, the majority of which are stream extraction systems. DOWASCO supplies 98.5% of the population with treated piped water. System production is approximately 10 million gal/day. Surface water and springs are the main sources of water, and water supply is provided in 41 water areas to approximately 70,739 people (two areas were decommissioned after Tropical Storm Erika). The intake basins, production and distribution pipelines and systems in most of the water areas are in need of upgrading. Annual water supply income was EC$19.5 million and expenditure EC$11.5 million in 2016.

Sewage is largely managed on an individual basis with homeowners and businesses providing septic systems. There are a few wastewater treatment plants but the majority of collected wastewater is directly discharged. Combined, the system supports over 12,349 service connections and 595 standpipes. The vast majority of the services areas are serviced by a single intake system. The two exceptions are WA1, the Roseau area, which is serviced by 3 sources and WA30, Grand Bay which accesses 2 intakes. Raw water quality is generally excellent and owing to the emphasis on maintaining forest resources, Dominica is regionally recognized for the quality of its water resources.

During recent extreme events, water supply and water resources were severely impacted. Damage in the water sector from Tropical Storm Erika were significant and widespread with most of the damage occurring to transmission and abstraction infrastructure. Abstraction facilities are located in streams at various elevations throughout the country and depending on the location with respect to the upper watershed, suffered varying levels of damage. Damage to sewer systems were to transmission lines (3) and outfalls (2). During the storm, flash flood damage to transmission infrastructure were largely concentrated at bridge crossings. Much of the transmission system is underground although at river crossings is typically attached on the external side of the bridge beam. This practice makes the transmission lines particularly vulnerable to damage by flood debris even if a bridge remains intact. As water transmission generally follows transportation routes, the majority of bridges in Dominica have water transmission lines attached. Immediately after the storm, 100% of the network was off line due to damage to intakes and transmission line damage. DOWASCO responded quickly, giving priority to intakes and transmission systems serving large populations. Additionally, DOMLEC, the electric company depends on DOWASCO water services to cool generating facilities. Intakes were cleaned out and stabilized. Where damage occurred, temporary measures were taken to put intakes back into service. This involved using sand bags, tarpaulin, geotextile and the installation of temporary piping to extract water. The total damage and losses to the water sector from Tropical Storm Erika were estimated to be EC$45,221,590 (US$16,811,000).

During Hurricane Maria, the 41 water supply areas were damaged by strong winds, flooding, landslides, falling trees and power outage. 16 were heavily damaged and 21 moderately damaged. Damage from the hurricane disabled water intakes, distribution pipelines and treatment plants in 43 water areas, the three wastewater treatment facilities and landfill facilities. Production and distribution pipelines were damaged or washed away, intake systems were blocked with sand and debris, and storage tanks, pumps, physical structures and access roads were damaged. Losses included reduced revenues and higher operating costs, and private costs of obtaining water, with an estimated cost of EC$53.6 million (US$20 million).

The disruption of water and sanitation services from recent extreme events has impacted livelihoods and disrupted production, manufacturing and tourism activities. The limited access to water supply has changed habits and consumption patterns among the affected population. The worst impacts were offset by substantial international response in providing potable water, portable treatment systems and desalination plants, but residents have also incurred costs purchasing and transporting fresh water. The health impact could be high given increased vulnerability of affected communities and the risk of water, sanitation and vector borne related diseases, such as cholera, diarrhea and malaria.

6.6. Human Health

To a large extent, public health depends on the availability of safe drinking water, adequate food and nutrition, secure shelter, functioning waste management services, and good social conditions. For Dominica, climate change continues to affect all of these conditions, with the likelihood of increased incidents of water-borne and vector-borne diseases, and rising concerns over food security. The real effects of climate change on human health in Dominica will likely be dependent on the vulnerabilities resulting from economic, environmental, social, and health related impacts that will determine the populaces' ability to ability to react and adapt.

The country's natural resource base as well as its commitment to provision of health care has resulted in significant achievements in population health indicators. Emerging concerns increasingly involve chromic non-communicable diseases including many, such as cardiac diseases and diabetes, which will be affected by projected changes in climatic parameters such as heat as well as by indirect impacts on food and nutrition. Other existing problems such as solid and liquid waste disposal also reduce resilience in the natural ecosystem and in the population of the country, thereby increasing vulnerability to health risks from a changing climate.

Recent extreme events has highlighted unexpected vulnerability of the health sector from damage to health infrastructure and disruption to health service delivery. Environmental health services include a broad range of activities critical to ensuring the health and well-being of the population of Dominica. Activities and services include solid waste collection and disposal, management of special wastes (e.g. medical, chemical), vector control and monitoring, food services inspection (food vendors, meat and poultry inspections etc.), maintenance and management of public sanitation facilities and inspection of private facilities, as well as monitoring for vector and water borne disease. The Environmental Health Department maintains equipment and facilities notably for solid waste collection and disposal including collection vehicles, the national sanitary landfill, waste incinerator and associated treatment equipment including a metal compactor, tire shredder, and waste collection vehicles. All these services and functions were seriously disrupted during Hurricane Maria. The general post flooding environment after Tropical Storm Erika created conditions favorable for the widespread propagation of pests and vectors, particularly associated with the accumulation of solid waste and standing water.

Government health care services are delivered through a network of 50 primary health care facilities and one secondary health care facility – the Princess Margaret Hospital, based in the capital, Roseau. Through these facilities the entire population gains access to basic health care services such as immunization, pre-natal and childcare as well as management of non-communicable diseases. Public health services, such as water quality monitoring and the monitoring of solid and liquid waste in the community, are also delivered through the Type 3 facilities which serve as the administrative centres for the seven health districts. When Tropical Storm Erika impacted Dominica in the early hours of the 27th August 2015, several health care facilities were affected either directly through flooding or as a result of being isolated from the rest of the country through road blocks from landslides, roadways being damaged or bridges being washed away.

Nine of the primary health care facilities were impacted by flooding and as a result were not operational for at least two days. Two of the facilities that were flooded also suffered minor damage to structure and damage to fencing. Some equipment loss was recorded including weighing equipment, step down transformers, etc. A number of the facilities were not accessible from the outside by roads. In the immediate aftermath several patients were airlifted to the Princess Margaret Hospital since access was not possible by road. Fractures were the most common type of injury and other conditions included acute abdomen trauma, eye trauma, psychological trauma & pregnancy. This event highlighted the fact that some health facilities are vulnerable to flooding, which means that at the time of an extreme event when they are most needed they are not operational.

During Hurricane Maria, all health facilities were damaged. The main Princess Margaret Hospital in Roseau sustained severe damage with 15 percent of its buildings totally destroyed and 53 percent able to function. During the event it was necessary to relocate several wards. The generator failed and the oxygen generator malfunctioned. Central medical stores lost the majority of medical supplies due to water damage but most medications were spared. Capacity decreased by 95 beds. Electricity was restored within three days. Fluoroscopy, portable x-ray and all blood bank equipment were lost. Five weeks post-Maria no elective surgery was being done and services had to be contracted out. La Plaine Type 3 centre and a third of all Type 1 facilities (17/48) were severely damaged. Marigot Type 3 centre (a rented facility) and a further 25 percent (12/49) of Type 1 facilities were moderately damaged. There was an immediate increase in persons seeking care and an increased need for visits to homes and shelters. Five weeks after the hurricane, primary health services continued to be offered in buildings with only emergency repairs or in alternate premises.

The Environmental Health Office sustained damage and some equipment was compromised. The airport Port Health building was destroyed. Water quality laboratory equipment was lost. The HIV program office sustained damage, however most supplies and drugs were available and patients continued to access the nutrition program.

The cost to continue health operations was significant. Initial air evacuation of critical patients and neonates, and their ongoing care in hospitals in other countries, were major expenses. Lost diagnostic services had to be met in private facilities or abroad, creating an additional financial burden to the government and general population. There was an estimated 40 percent increase in persons seeking health services and a five-fold increase in environmental health monitoring and vector control activities after the Hurricane. The Ministry of Health fleet sustained minimal damage but fuel costs doubled in the response. Fuel was needed to maintain generators at prioritized major and hard to access primary care facilities where electricity supply was disrupted.

Hurricane Maria has demonstrated that extreme events that will increase due to climate change will greatly increase health related risks including from: acute respiratory conditions; gastroenteritis due to poor sanitation and food safety; and vector borne disease outbreaks, including mosquito borne diseases such as dengue, zika and chikungunya, as well as leptospirosis. Poor nutrition is a concern and will exacerbate chronic diseases. Increases in substance abuse, including alcohol, and increases in mental health problems are also anticipated. Men are at greater risk for leptospirosis and psychiatric conditions, and are less likely to seek care in the health system. The elderly population are also at increased risk. Out-of-pocket health care costs will increase both within and outside of Dominica. Disruptions to health service delivery will result in poorer health that will contribute to a general decrease in productivity.

6.7. Infrastructure and Human Settlements

Problems associated with inadequate solid and liquid waste management present threats to coastal resource health, while increasing urbanization is resulting in traffic congestion and associated public transportation concerns. Energy issues are also of concern to human settlement planners since relatively long distances, rugged terrain and high costs of fuel make local transportation costs high. Vulnerability to disaster risks, both natural and man-made, are also increasing with urbanization. Underlying many of these problems are significant challenges deriving from the lack of available financing for human settlements.

Vulnerability of human settlements in Dominica to existing weather and climate change can be viewed in terms of risks from coastal processes, inland flooding, and landslides. A consistent feature of human settlements in Dominica is the vulnerability of roads and buildings to storm surge flooding and landslides. Inadequate planning controls are apparent in the continuing construction of buildings, critical infrastructure and other facilities in active wave inundation, flood- and landslide-prone areas. These vulnerabilities were highlighted during recent extreme events that struck Dominica.

6.7.1. Road Infrastructure

The vehicle transportation network in the Commonwealth of Dominica comprises 320 km of main roads, 119 km of secondary roads, 127 km of urban roads, and 338 km of feeder roads. In addition, there are more than 200 bridges and water crossings across the country. Primary roads provide the main transport connectivity around the coastline and across the high hinterland in the central region. The roads intersect many of the 365 rivers on the island along the narrow coastal littoral. They are subject to storm surge in many areas, to flash flooding with heavy boulder debris in steep gullies, and to landslides in the steep terrain. Primary and secondary roads are 99 percent paved, with 22 percent recently improved to climate resilient standard. Feeder roads and urban/community roads are 64 percent paved with only 13 percent built to relatively resilient standards. Bridge, culvert and retaining wall structures are crucially important assets but many are old or have inadequate hydraulic capacity.

Tropical Storm Erika caused extensive damage and losses in the transport sector and the result is a major setback to the ambitious infrastructure rehabilitation program of the government. The floods and landslides triggered by Tropical Storm Erika destroyed and damaged extensive parts of the transportation network in the country. Approximately 17% of roads and 6% of bridges were completely destroyed. In addition, 24% of roads and 44% of bridges were partially damaged. Following the storm, approximately 60% of roads in the country were inaccessible. Extensive sections of the roads were made accessible in the first two weeks, but there remained sections of roads that would require significantly longer time to repair and reconstruct. The west coast road was severely damaged with multiple segments cut due to landslides and bridge failures (e.g. Macoucherie, Batalie, Pointe Ronde). Despite cleaning up efforts most of these landslides are still active and present an immediate danger to users and to the population living nearby. In some sections such the Boetica Gorge, the entire road and embankment of more than 10,000 cubic meter were washed away. The total damage and losses to the transport sector (roads and bridges) and additional needs were estimated to be EC$773.46 million (US$287.53 million).

During Hurricane Maria, roads across the island were covered by substantial amounts of tree and flooding debris, and a number of landslides or embankment failures were visible. The major damage wwas incurred at river crossings, where strong flash flooding carried substantial boulder debris and high water flows filled existing floodplains and destroyed settlements. In valleys and steep gullies, especially in the south and west, some structures were blocked and overtopped by 1-2 meters (m) of floodwater. Debris deposits of 1-4 m depth filled the riverbeds causing rivers to change course and erode abutments or approaches. The pavements, especially on improved roads with lined surface drainage, were generally undamaged, but more extensive damage was incurred on the less improved secondary and feeder road networks. Six major bridges were seriously damaged and closed – three on the west coast and three in the south – and major erosion or washouts occurred over an estimated 19 km combined length. Vehicles were damaged by flooding and flying tree and building debris, with an estimated one to four percent destroyed and seven to ten percent damaged. Damage in the sector totaled EC$492 million (US$182 million), of which EC$387 million (US$144 million) were public. Losses totaled EC$142 million (US$52.6 million), of which EC$120 million (US$44 million) were public. Damages were dominated by severe washouts at critical river crossings and losses are comprised of the costs of restoring road access, clearing debris and restoring river capacity, as well as traffic delays and income losses to transport service providers. The recovery strategy focused on restoring safe operation to damaged assets and on replacing major bridges and critical crossings with high resilience. Total recovery costs are assessed to be EC$815 million (US$302 million).

The vulnerability of road infrastructure to extreme events has highlighted the fact that the security of major routes in the west coast, trans-island, northern link and east coast are critical to ensuring transport connectivity and the recovery of economic activity. The opportunity to use infrastructure to reduce flooding risks is limited, and partial or substantial relocation may be needed in certain high risk areas.

6.7.2. Ports Infrastructure

In Dominica, there are two airports (Douglas-Charles and Canefield), and two main cargo ports (Woodridge Bay and Portsmouth). The two cargo ports have cruise piers associated with them, both outside the ports. In addition, Roseau also features a ferry terminal. The main airport is Douglas Charles Airport, located on the eastern shore of the island. Canefield, a small airport just north to Roseau, is a general aviation airport that has on occasion acted as a port of entry during emergency relief efforts. Both ports and airports are managed and operated by the Dominican Air and Seaports Authority (DASPA).

The cruise ship berths of Roseau and Fort Shirley in Portsmouth have received a combined 160 calls in 2016, totaling over 275,000 passengers. The Discover Dominica Tourism Authority calculated the amount spent by cruise ship passengers at nearly EC$25 million for 2016. In the period between June 2015 and July 2016, the ferry terminal in Roseau handled over 80,000 passengers, a number in excess of the entire population of Dominica. Douglas Charles Airport handles nearly all stay-over arrivals, a part of the tourism sector that contributed over EC$251 million in visitor spending in 2016. Canefield Airport, though not economically viable, has been key in the relief efforts after both Erika and Maria, and has proven again that an alternative point of entry for aid and assistance after a natural catastrophe is vital for Dominica.

During Tropical Storm Erika, the main Douglas Charles airport suffered extensive damage - with all ground-level electrical equipment such as conveyor belts, x-ray machines, walk-through security scanners, runway and approach lighting, and communications equipment having been destroyed, Both Canefield Airport and Douglas-Charles International Airport were flooded, with substantial damage occurring at Douglas-Charles due to flooding and accompanying mud deposits. The river by the airport became clogged by debris further upstream, and as the temporary natural dam gave way, the currents became powerful enough to break the dam at the western end of the airport. The airport was powered at the time, resulting in loss of all electrical equipment that came into contact with the water. The flooding was followed by an extensive deposit of mud and debris, which penetrated all buildings and fixtures on their ground floors. The total damage and losses to the transport sector (airports and seaports) are estimated to be EC$40,289,890 (US14, 977,654).

During Hurricane Maria, at the port of Woodridge Bay, all sheds lost their roofs and suffered other damage. The security fencing was compromised, windows in the main office building were blown out, the maintenance shed was destroyed, and electrical equipment and electronics were damaged. In Roseau, besides Woodridge Bay, the ferry terminal was severely damaged, both by heavy seas and river flooding. The damage incurred includes all electronic equipment, furniture, and vendor shops. There was a 3 to 4 ft layer of debris as a result of the flooding. The Roseau Cruise Ship Berth was also rendered inoperable, with railings, lighting, and the walkway being destroyed. In Portsmouth, the cargo shed had similar damage, with the roof destroyed, though the main pier remained intact. Security fencing had been compromised. The Cabrits cruise ship berth, which features a full-fledged terminal building, was badly damaged, with the walkway of the pier destroyed, and the terminal building lost most of its roof.

Due to the application of BBB principles after Tropical Storm Erika, the main pavements of Douglas Charles Airport were undamaged, and there was no flooding or debris on the runway. The adjacent river did rise beyond its banks, however, and flooded the terminal building causing the loss of all electronics, such as x-ray machines. In addition, the airport suffered some damage to its tower, and some related communications and navigation equipment needed to be repaired.

The shipping sector losses are comprised of two elements:

i. loss of traffic, some of it due to infrastructure damage; and
ii. a government moratorium on charges for non-commercial activity.

Since most of the port's shipments are now related to the relief and rebuild efforts after Maria, revenues are 25 percent down from the baseline, indicating a 75 percent revenue loss. There is no income from cruise ships since there is no infrastructure to receive them.

At Canefield Airport, there was more significant damage in that more of the basic infrastructure was involved. Debris had to be cleared from the runway. The terminal lost a substantial part of its roof (as well as the building housing fire and ambulance services). The tower was more severely damaged than at Douglas Charles, and the fencing has come down in several places. The losses at the airports are not so much a function of damage, since both reopened quickly, but the main challenge lay in terms of the main driver in demand: stay-over tourism. With a large part of the hotel stock not available, and many tourist attractions in need of repair, demand for Douglas Charles remained depressed, and the management at DASPA requested Government support to cover operating costs and keeping the airport open. Canefield Airport had another spike in traffic, since it was used to help relief workers arrive in Roseau. The ports of Dominica serve as the main cargo entry point for all trade, and the island's economy survives by importing nearly all goods. The port of Woodridge Bay is the only container port on Dominica, and is the only entryway for large machinery, large shipments of merchandise and refrigerated food items. The northern port of Portsmouth serves the local inter-island trade based on smaller freight carries, locally called "schooners". Since Dominica is not really served by any passenger aircraft belly cargo capacity, except for dedicated cargo flights, the ports of Dominica are the only way critical imports can enter the country.

Damage and disruption to ports infrastructure and services is likely to continue due to increased incidents of extreme events from climate change. Serving as key pillars of the economy and vital links to the outside world in times of disasters and being the key entry point for relief efforts, it is essential that such infrastructure be made resilient to such extreme events at the earliest opportunity.

6.7.3. Housing

According to the most recent census (2011), there are 31,352 dwelling units in the country, of which 80 percent are occupied, while the remaining are vacant. The demand for new and replacement housing, for all income groups, is estimated to average 400 units a year, of which less than 35 percent is met. Issues including land availability, tenure, adequate infrastructure and servicing, integrated planning, institutional capacities, access to appropriate finance, and construction costs all impact the sector and contribute to this gap. Main structural housing typologies include combinations of walls in different materials, among them wooden, concrete blocks and a combination of both. In terms of roofing, wood is used for framing in most of the cases covered by galvanized sheeting. Concrete block is the single most popular material for the construction of the outer walls of dwelling units. There are no climate resilient building codes enforced across the island.

Dominicans were more likely to be living in owner-occupied housing units with 71 percent indicating that they owned the units that they occupied. 29 percent of households and 39 percent of the population (reflects larger households among the poor, and by implication, more dense housing conditions) are considered poor by the poverty definition of household income under $1,500 per month. Of these, 11 percent of households (15 percent of the population) are considered "very poor" (GSPS, 2006). The quantity, quality, and adequacy of housing to meet demand remains a challenge, including the provision of basic services, further compounded by a complex topography with scattered small settlements difficult to interconnect, benefitting from an economy of scale.

Land ownership by deed is highly valued by farmers. However, the Carib Reserve for the Kalinago people which covers 3,700 acres, is communally owned by all its residents. The predominant inheritance practice is "family land", in which a parcel of land is owned jointly by descendants of the original owner, either male or female. Use of land is determined by consensus or family tradition. Oral agreements frequently lead to dispute, but no part may be sold unless all co-owners agree. Over the past years, several initiatives have targeted provision of housing, among them the "Housing Revolution" Program that looks at a comprehensive package. The program assists through various interventions such as the Squatter Regularisation Programme, a Special Mortgage Facility at the Government Housing Loans Board and the AID Bank (4 percent and 5 percent interest respectively), the Housing Renovation and Sanitation Programme, and the construction of low-income houses. The Government's approach encourages people to build their own homes, with Government involvement focusing on the utilization of Government-owned lands and delivering serviced lots.

As a result of Tropical Storm Erika, it was estimated that that 7,229 persons had been affected in the disaster declared areas, with 574 persons homeless due to complete destruction of their homes, some 713 persons evacuated due to the unsafe condition of their houses, and a further 411 provided with temporary shelter. The total damage to the housing stock was estimated to be EC$119,799,000 (US$$44,534,944). Losses for cost of demolition and rubble removal and a temporary housing scheme were estimated at EC$$25,860,315 (US$9,613,500). A permanent resettlement programme for destroyed and "at risk" housing units was launched with an estimated cost of EC$143,996,004 including a Build Back Better (BBB) component. This estimate included land acquisition, access and utilities connection.

During Hurricane Maria, predominantly observed effects of the hurricane on the built environment exposed major wind vulnerability of wood structures and unreinforced masonry buildings. In addition, houses along the coastline incurred severe damage due to storm surges, while those located in the riverbed were damaged or destroyed by river debris and flooding. Moreover, the mountainous terrain of the island led to major landslides across the country, affecting yet another share of houses located in the hilly regions. Despite lessons disseminated in the aftermath of previous disasters, the awareness of disaster exposure risks (wind, seismic, flood, and landslide) in communities remains relatively low, coupled with low uptake of improved construction practices, particularly in rural areas. It was estimated that most of the buildings that suffered severe damage were non-engineered buildings, predominantly wood construction or masonry buildings. Damages were amplified by the prevalence of deficient construction practices, poor quality materials and inadequate wind-resilient connections. Enforcement of building codes has not generally been very strong and this has contributed to the extensive damage. Total damage to the sector amounted to EC$955 million (US$353 million), fully affecting the private sector, and comprises the combined replacement cost of destroyed houses, the repair cost of partially damaged houses, as well as the replacement cost of household goods destroyed. Losses are estimated at EC$77 million (US$28.5 million), and are predominantly affecting the private sector. These include expected loss of rental income, as well as the cost of demolition and rubble removal, and shelter expenses incurred to date. Across all parishes, a total of 4,703 houses were considered as fully collapsed or damaged beyond repair, 23,514 houses were estimated to have incurred different levels of partial damage, and 3,135 were considered as not affected by the event.

As part of recovery efforts a relocation program is being implemented with government assistance. It has been recommended that this program make use of a standard housing design in low risk areas for landslides and flooding and incorporate disaster-resilient features (e.g., hurricane-resistant roofing, seismic resistance, adequate height from the ground, etc.) and a minimum architectural layout based on family size to produce a livable climate resilient home.

6.8. Tourism

Dominica's tourism industry is based largely on its position as an eco-tourism destination, with its verdant forests and other natural features being the country's principal attraction especially in relation to the cruise ship industry. Popular sites such as Trafalgar Falls and Indian River rely on rich forestry biodiversity, while the island's representation as the "***Nature Island of the Caribbean***" is based largely on a scenario of lush forests and accompanying eco-tourism oriented attractions. With the tourism industry as one of Dominica's principal economic sectors, there is considerable economic interest associated with the management of Dominica's natural resources. However, these resources are extremely vulnerable, being constantly damaged by extreme events and threatened by climate variability and associated effects on forest ecosystems and watersheds.

The tourism sector is one of Dominica's most important, with over 366,000 visitors in 2016, bringing in EC$383 million. Although the highest number of tourists comes from cruise ship passengers, the highest number of income in the sector comes from stay-overs. This can be easily explained: cruise ship visitors, of which there are roughly 276,000, spend EC$89 per day on the island, with the stay lasting one day. Holiday stay-over tourists, on the other hand, spend US$406 per day, with the stay usually lasting nine days. Both the stay-over and the cruise ship segments are mostly served by the private sector. Hotels are in private hands, and there is a cottage industry of guides and drivers that service the cruise ship arrivals. There are 73 properties, 17 tour operators, 9 dive operators, a cottage industry of 260 craft and souvenir vendors, and 273 tour guides. The taxi industry is wide and diverse, consisting of 300 buses, 270 16-seaters, and 30 coasters (larger buses with 26 to 30 seat capacities).

With the island thus being highly impacted by stay over tourism, which stays mostly in eco-type lodges, key issues are the availability of room stock, the accessibility of the actual hotels, and the accessibility and availability of attractions outside hotels. The cruise industry also depends heavily on attractions: cruise ship operators have their own arrangement in packaging excursions for passengers on the island, and the availability of, and accessibility to, attractions are vital.

The main tourism season runs from November to April, with December and January being the most important months, and August and September the weakest being the peak of Hurricane season. In most years, this gives the tourism sector a window in time to recover the most important assets before the height of the season begins. This has not been the case in recent years, when serious impacts from extreme events has prevented the tourism sector from resuming normal operations within a short period of time.

As a result of Tropical Storm Erika, the private sector reported that out of 95 hotels, 31 (33%) reported being affected by in some manner. Of the 31 affected, 20 were able to continue operating, although at reduced capacity. 11 hotels ceased operating, and two additional hotels were completely destroyed, including the Jungle Bay Resort and Spa in the East, with 35 rooms (4th largest hotel on the island). The net effect was a reduction of 8% in room capacity, from 976 rooms to 900. Water damage was most commonly reported, though 8 hotels report issues with retaining walls or structural stability, two with access roads, and one with collapsed bridges. Of the operating hotels, only one in St. Patrick Parish is currently not accessible. In addition, the storm has also affected tourist attractions. Out of the 11 dive businesses, 9 have been affected in some manner, of which 7 are operational. Of 28 tour operators, 7 reported that operations had been affected. The usual damage was centered on equipment and vehicles. Out of 9 major vehicle rental agencies, none have been destroyed, however, a very high number (7) have been affected, with a number of vehicles being flooded at Douglas-Charles Airport. The total damage and losses to the tourism sector were estimated to be EC$83,891,200 (US$31,186,320).

After Hurricane Maria, of the 73 tourism properties, 34 suffered severe damage, and 32 received light to moderate damage. The room stock of 909 rooms has seen an estimated 358 damaged to the point that they will not come on line for at least a year (39 percent of the stock, and some may never recover), 308 may be coming back within the year (34 percent), and 243 are serving the market by the end of 2017. In addition, the cruise segment was lost for the entire season. Other areas affected by both the hotel stock and the lack of cruise arrivals include tour operators (seven of the largest report a significant income loss of over EC$9 million), diver operators (the two largest reporting losses of EC$1.5 million, and damage of EC$1.9 million), and most heavily hit are the smaller tour guides, vendors, and other micro-enterprises with an estimated loss of EC$16 million. Cruiseships themselves suffer minimal losses, since they simply add another island, such as St. Lucia, St. Vincent and the Grenadines, or Grenada to their itinerary.

In the tourism sector damage amount to EC$54 million (US$20.1 million), and losses to EC$191 million (US$70.9 million). The heaviest damage linked directly to the tourism sector lies in hotel room stock. The cruise season is currently considered lost, an EC$25 million source of spending in 2016, and tour operators, vendors, and other support services, such as taxis, have suffered EC$4.3 million (US$1.59 million) in damage. Total sector recovery costs are assessed at EC$70.72 million (US$26.19 million). The tourism sector, having two separate components (stayover and cruises), faces two infrastructure challenges: rebuilding the hotel room stock, and rebuilding the piers that allow for cruise ships to dock. Though the cruise sector is not the highest earning, it is considered an easier option, because all that is needed infrastructure wise is the facility to dock ships, and in terms of services, is the ability to attract and entertain cruise visitors. This is easier in the short term than rebuilding the hotel stock. Since the main facility lies in Roseau, a first priority for the sector is to rebuild the Roseau cruise berth. This is particularly important in light of suggestions that the Government may adopt a policy of marketing for hurricane victim support cruises, i.e., developing a sector of the cruise industry where passengers arrive on Dominica with the specific intent of helping the Dominican economy in its rebuilding. The rebuilding of attractions and forms of entertainment, such as the national parks assets, walking trails, launch sites for dive operations, bars and restaurants, are high on the priority list. The cruise terminal is public infrastructure, however, the sources of entertainment and attractions are in many cases private. For the restaurant and bar businesses, the Government sis considering lending to have these enterprises up and running as soon as possible. Similar stimulus might also be established for some of the other services serving the cruise industry, such as tour operators. The stay-over sector of the tourism industry will require the rebuilding of both the moderately and severely damaged room stock. The slight to moderately damaged room stock will progressively come on line over the period of one year, however, it is important that this process not be rushed, since significant disaster risk reduction measures must be included.

6.9. Measures to Build Climate Resilience

Recognising the threats posed by climate change, Dominica has, over the last two decades, undertaken a number of initiatives to respond to this threat. Dominica ratified the *United Nations Framework Convention on Climate Change* (UNFCCC) in March 1994, and joined the community of nations committed to combating global climate change. In December 2001, Dominica submitted its *Initial National Communications* (INC) to the UNFCCC, in fulfilment of its obligations under Article 12 of the Convention. This process was followed by the development of a ***National Climate Change Adaptation Policy***, formulated with support under the *Caribbean Planning for Adaptation to Climate Change* (CPACC) Project, which was adopted by the Cabinet in 2002. In January 2005, the Phase II Enabling Activity, under the UNFCCC was completed, which involved capacity building for climate change.

Dominica has established a strong track record on climate change adaptation, and in this regards was one of the few countries chosen to pilot adaptation measures under the *Special Program on Adaptation to Climate Change* (SPACC). Additionally, as a collaborative initiative between the SPACC program and the GEF-funded *Sustainable Land Management* (SLM) project, Dominica has pioneered: (a) the vulnerability mapping and "climate proofing" of National Parks Management Plans; and (b) community-based vulnerability mapping and the development, through community engagement and input, of community adaptation plans. Dominica has a history of successful implementing projects supported by multi-lateral partners upon which the ***Low-Carbon Climate-Resilient Development Strategy*** built upon.

The adaptation initiatives undertaken before 2006 have been presented in Dominica`s *Initial National Communications* and *Second National Communications*. The following sections provide an overview of initiatives undertaken during the reporting period of the *Third National Communications*, namely during the period from 2006 to December 2017.

6.9.1. Mainstreaming Adaptation to Climate Change in the Caribbean (MACC)

A regional project funded by the Global Environment Facility (GEF), the *Mainstreaming Adaptation to Climate Change* (MACC) was implemented in Dominica and 11 other CARICOM countries from 2004 to 2007. Executed by the World Bank and the Caribbean Community Climate Change Center (CCCCC), the project's main objective was to mainstream climate change adaptation strategies into the sustainable development agendas of the Small Island and low-lying states of CARICOM. MACC adopted a learning-by-doing approach to capacity building, consolidating the achievements of CPACC and ACCC. It built on the progress achieved in these past projects by furthering institutional capacity, strengthening the knowledge base, and deepening awareness and participation.

The *Mainstreaming Adaptation to Climate Change in the Caribbean* (MACC) Programme sought to reduce vulnerability (physical, social, economic and environmental) of Caribbean countries to the impacts of climate change. It built capacity of the SIDS to develop Stage II adaptation strategies and measures (as defined by the Conference of Parties (COP) to the UNFCCC) through the mainstreaming of adaptation into national development planning process of the countries in the region. This was done through several programme areas and pilot projects.

The climate vulnerability risk assessment foci for MACC were in the areas of Water Resources, Tourism, Health, Agriculture and Coastal Zone. MACC also focused on Public Education and Outreach (PEO) strategies as a major component of the programme. **Dominica's *Low-Carbon Climate Resilient Development Strategy*** utilized strategic information from this MACC programme to develop climate change public education and outreach (PEO) activities.

6.9.2. Special Programme for Adaptation to Climate Change: Implementation of Adaptation Measures in Coastal Zones (SPACC) Project.

The four-year GEF-funded *Special Programme for Adaptation to Climate Change: Implementation of Adaptation Measures in Coastal Zones* (SPACC) Project, executed by the World Bank and the Caribbean Community Climate Change Center (CCCCC), completed in December 2011, supported efforts by Dominica, Saint Lucia and St. Vincent and the Grenadines to implement specific (integrated) pilot adaptation measures addressing the impacts of climate change on the natural resource base of the region, focusing on biodiversity and land degradation along coastal and near-coastal areas. This was achieved through:

- (i) the detailed design of pilot adaptation measures to reduce expected negative impacts of climate change on marine and terrestrial biodiversity and land degradation;
- (ii) the implementation of pilot adaptation measures.

The project also produced knowledge of global value on how to implement adaptation measures in Small Island Developing States that can be applied in other countries in the region. In

Dominica the two sites identified for the detailed design and implementation of adaptation measures were:

(a) the Morne Diablotin National Park (MDNP) and its neighbouring communities of Colihaut, Dublanc and Bioche (CDB) communities;

(b) the Morne Trois Pitons National Parks.

As collaborative initiative between the SPACC program and the GEF-funded *Sustainable Land Management (*SLM) project (see below), Dominica has pioneered:

(a) vulnerability mapping of the country's National Parks and World Heritage Site and "climate proofing" of the World Heritage Site Management Plan and National Parks Management Plans; and

(b) community-based vulnerability mapping and the development, through community engagement and input, of community adaptation plans.

Tourism in Dominica is intricately linked to forests (beaches are not the primary attraction since the country is largely devoid of "white" sandy beaches), with the country promoting eco-tourism as its primary tourism product. The SPACC project has made considerable advances in "climate proofing" Dominica's forests and protected areas upon which the country's tourism industry relies. This has been achieved by mapping vulnerability of these areas from encroachment and consulting with communities to establish an appropriate buffer area that will reduce threats from human encroachment. Investments under the *Climate Resilient Development Pathway* of **Dominica's *Low-Carbon Climate Resilient Development Strategy*** built on these pioneering adaptation initiatives and will support the transition to improved climate resilience in Dominica.

6.9.3. Capacity Building and Mainstreaming of Sustainable Land Management (SLM) in the Commonwealth of Dominica

This three-year GEF-funded project, which commenced in 2009 and was executed by the UNDP and Dominica's ECU, developed capacities for sustainable land management (SLM) in appropriate government, civil society institutions, communities and other user groups in order to mainstream SLM management considerations into government planning and strategy development. The project sought to build capacity to contribute to the enhancement and maintenance of the ecological integrity and productivity of terrestrial and near-shore ecosystems the integrated management of land resources. Through the establishment of comprehensive legal, policy and institutional framework for environmental protection and sound natural resource management, the project ensured that agricultural, coastal, forestry and other terrestrial land and resources uses in Dominica are sustainable, thereby enhancing ecosystem resilience and allowing for the maintenance of productive systems that assure ecosystem productivity and ecological functions while contributing directly to the environmental, economic and social wellbeing of the people of Dominica. The project worked with the SPACC project to develop *Community Vulnerability Atlases* and *Community Climate Change Adaptation Plans* that can be replicated throughout Dominica and the Caribbean region. Investments under the Climate Resilient Development Pathway of **Dominica's *Low-Carbon Climate Resilient Development Strategy*** build on these initiatives towards improved climate resilience in Dominica.

6.9.4. Growth and Social Protection Strategy

The Government of Dominica's *Growth and Social Protection Strategy* (GSPS) articulates a medium-term strategy for growth and poverty reduction over the next five years. Priorities set in this document make poverty reduction the principal focus of Government's economic and social policy. The Government of Dominica regards the pursuit of sustained strong economic growth to be the main strategy to alleviate poverty. The GSPS provides the framework that informs the medium-term macro-economic framework, the structural reform agenda, the medium-term public investment programme, and the annual budgets to be presented to Parliament. The Government's policies and programmes will seek to ensure that opportunities are available to all, and benefits from growth are shared across the society as widely as possible. To this end, targeting and management of the existing social programmes will also be improved.

The GSPS provides the framework for Dominica's economic and social policies over the following five year period and sets out the macroeconomic framework; the growth strategy including the enabling environment for private enterprise and sectoral strategies; and poverty reduction and social protection programmes. It also provides for the monitoring and evaluation of the progress in implementing the strategy on an annual basis. The consultative process to which it has been subjected ensures that the GSPS has a high degree of public ownership. The first edition of the GSPS was published in April 2006. The Government has updated the Strategy on an annual basis so that the document is a "rolling plan" that takes account of changing circumstances and is thus of continuing relevance and usefulness. The third edition of the GSPS is currently before Cabinet for approval.

Investments under **Dominica's *Low-Carbon Climate Resilient Development Strategy*** are anchored in the *Sector Strategies for Growth* defined in the GSPS, including:

Agriculture

- agriculture diversification and agro-processing to address threats to food security from climate change;
- rehabilitation and climate proofing of farm access roads to improve access to markets;
- embarking on programme of action to establish Dominica as an 'Organic Island' with a view to establishing agricultural practices that will enhance the resilience of natural ecosystems by reducing the introduction of harmful substances into rivers and soils and establish a sound and sustainable basis for the growth of the agricultural sector so as to address threats to food security from climate change;
- improving climate change risk micro-insurance and micro-finance in existing financial institutions for small-scale operators to make resources available to farmers who need to invest in irrigation equipment in order to bring water onto their farms;

Natural Resources

- accessing opportunities for international or regional agreements for carbon sequestration for forest that can contribute to the socio-economic development of Dominica where appropriate by promoting the carbon neutral status of Dominica;
- enhancing the resilience of natural resources, through:
  - working to increase by 50% the number of agro-forestry farmers through REDD+ programs; and

  - implementation of projects to expand organic banana production, improve integrated pest management; and increase the utilization of farm organic waste;
- promotion of sound land-use planning to improve the resilience of natural resources and address impacts from flooding, landslides, and other extreme events;
- climate proofing of houses and promotion of building controls to prevent housing construction in vulnerable areas;
- establishment of integrated coastal zone management to enhance the resilience of coastal and marine ecosystems and address climate change and anthropogenic impacts;
- enhancing ecosystem resilience by reducing user conflict and promoting sustainable use of all natural resources, through the formulation of a coastal zone management plan;
- improving water management through preparation and execution of a national water inventory and water management policy;

Fisheries

- climate proofing of fisheries infrastructure improvements to meet requirements of international standards and to facilitate fish export trade, improve access to and from sea, and the overall capacity to process greater volumes of catch;
- improving climate change risk micro-insurance and micro-finance in existing financial institutions for fisher folk;
- promotion of aquaculture industries to address threats to food security from climate change impacts on marine resources;

Tourism and Private Sector

- building capacity for climate change and disaster risk management in the private sector and tourism industry;
- addressing high energy costs for business and the tourism industry;
- enhancing marine and terrestrial ecosystem resilience as a key element of the country's tourism product;
- climate proofing proposed tourism infrastructure developments including Roseau Waterfront, Cabrits/Portsmouth marina, Marine Visitor Centre, the redevelopment of the Marigot Fisheries Harbour to facilitate sea access from Guadeloupe, upgrade to Melville Hall airport and construction of the new airport to accommodate long haul services from North America and Europe;

Environmental Protection

- legally establish the Department of Environment, Climate Change and Development (DECCD) responsible for coordinating Dominica's climate change risk management program, enhancing ecosystem resilience by controlling pollution, and regulating development in flood prone areas;
- legally establish Climate Change and Disaster Trust Fund (5% of PSIP) to cover adaptation/mitigation and disaster prevention costs;
- climate change risks and environmental management capacity building to provide support for technical evaluation, regulation and monitoring of development projects;

Green Economy

- supporting micro and small business access opportunities in the Green Economy;
- attract suitable Green Economy businesses into Dominica;
- provide education, training and capacity building to enhance the skills base of the workforce to support Dominica's transition to a Green Economy;
- integrate green principles into national economic management and planning, and marry environmental preservation and management into Dominica's strategy for achieving higher levels of sustained economic growth;

Energy Conservation and Renewable Energy

- conserve energy and promote renewable energy options to address rising energy costs affecting the cost of living and quality of life, cost of manufacturing and services increase, and the challenge to competitiveness;
- increase percentage of national energy from renewable sources by harnessing geothermal, solar, wind and hydro energy potential;

Vulnerable Communities

- Address impacts of climate change on vulnerable segment of society, including indigenous Kalinago and women.

The Government takes the position that poverty reduction over the long term requires the creation of sustainable employment and income earning opportunities for all Dominicans, an objective that will come about only with increased levels of economic growth and development. Supporting the continued transition to a Green Economy will require the building of national capacity to implement **Dominica's *Low-Carbon Climate Resilient Development Strategy*** which is regarded as a key element in Government's plan to create sustainable quality employment opportunities.

6.9.5. Strategic Program for Climate Resilience (SPCR)

Dominica's ***Strategic Program for Climate Resilience*** **(SPCR)** and ***Low-Carbon Climate Resilient Development Strategy*** were developed in 2011-2012 through an extensive consultative process that was supported under the Pilot Program for Climate Resilience (PPCR) funded under the Climate Investment Funds (CIF).

Dominica's ***Low Carbon Climate Resilient Development Strategy*** provides an overview of the country circumstances, the development context and identifies climate change vulnerabilities in key sectors, for specifically vulnerable groups, for the private sector, important eco-systems and natural resources. It also provides an overview of linkages to existing development plans and programs, most importantly Dominica's *Growth and Social Protection Strategy* (GSPS) and Dominica's *National Climate Change Adaptation Policy*. Section 5 of Dominica's *Low Carbon Climate Resilient Development Strategy* contains a policy, legal and institutional analysis that list key agencies involved in managing climate change risks, together with the associated legal/policy framework.

Dominica's *Low-Carbon Climate Resilient Development Strategy* and compendium *Strategic Programme for Climate Resilience* (SPCR) were developed through an extensive consultative process that was supported under the *Pilot Program for Climate Resilience* (PPCR) funded under the Climate Investment Funds (CIF). As part of the process to develop Dominica's *Low-Carbon Climate Resilient Development Strategy* and SPCR, *v*arious assessments and studies were undertaken and reviewed with and by national stakeholders to provide the technical foundation for the preparation of the Strategy and this compendium SPCR. Key steps in Dominica's SPCR prioritization planning process included:

(a) ***Document stocktaking, review and analysis*** including a critical review of *Dominica's Climate Change Adaptation Policy and Action Plan* (2002) (endorsed by Cabinet in 2002) that was developed with support under the *Caribbean Planning for Adaptation to Climate Change* project, and analysis of current and ongoing national development policies, programs and initiatives in particular the Government of Dominica's *Growth and Social Protection Strategy* (GSPS) which articulates a medium-term strategy for growth and poverty reduction over the next five years and sets priorities to make poverty reduction the principal focus of Government's economic and social policy;

(b) Broad-based stakeholder ***climate change risk assessment*** (including prioritization and ranking of climate change risks affecting Dominica) adapted from the risk assessment approach/methodology/guidelines which were developed under the *Adapting to Climate Change in the Caribbean* (ACCC) project and based on climate change trend analysis and projections contained in Dominica's *Initial National Communication* (INC) and *Second National Communication* (SNC) to the UNFCCC;

(c) Critical review of Dominica's *National Capacity Self Assessment (NCSA)* and an ***Adaptive Capacity Assessment*** (assessing institutional, systematic, individual capacity) for public and private sector, vulnerable communities/sectors that served to update and validate recommendations contained in the NCSA;

(d) ***Community Surveys*** undertaken to identify climate change vulnerabilities, capacities and priority needs that built upon community vulnerability mapping and adaptive capacity assessments, undertaken under Dominica's *Sustainable Land Management* project and *Special Program on Adaptation to Climate Change* (SPACC) project;

(e) Identification of ***priority needs and investment opportunities*** to facilitate Dominica's transformation to a climate-resilient development path, that was undertaken during the SPCR National Consultative Workshop;

(f) ***Cost-benefit Analysis*** of proposed SPCR investment opportunities that was undertaken with technical support/methodologies provided by the Caribbean Community Climate Change Center (CCCCC) under Phase 1 of the regional track SPCR program.

During this stakeholder consultation process, several hundred individuals have been consulted including Cabinet Ministers, representatives from government agencies (national, local and municipal), the private sector, civil society, and vulnerable segments of society including indigenous Kalinago, women and youth. This level of consultation has ensured a high level of national ownership for **Dominica's *Low-Carbon Climate Resilient Development Strategy***.

6.10. Climate Change Risk Assessment

As part of the process to develop **Dominica's *Low-Carbon Climate Resilient Development Strategy,*** a risk assessment was undertaken by national experts and a broad range of national stakeholders to identify and prioritise areas where Government needs to focus resources (financial, technical, human).

The ***climate change risk assessment*** built upon the ***Stocktaking*** and ***Institutional Analysis*** undertaken under the *National Capacity Self Assessment* (NCSA) and the vulnerability assessments undertaken to develop Dominica's *Climate Change Adaptation Policy*, *Initial National Communication* and *Second National Communication* (SNC). The climate change risk assessment was modeled on the process outlined in the *Risk Management Guidelines for Climate Change Adaptation Decision Making*[10]**.** Using a multiple criteria analysis, each PPCR Technical Working Group (TWG) undertook a sector specific assessment as follows:

(a) Identification of ***event risks*** and ***outcomes risks*** based on vulnerability assessments contained in Dominica's *Initial National Communication*, *National Climate Change Adaptation Policy*, and *Second National Communication*;

(b) Ranking of event/outcome risks in terms of ***severity of social/ economic/ environmental/ impacts*** (11 indicators used for ranking);

(c) ***Probability/frequency analysis*** on prioritized event/outcome risks that scored the highest in terms of severity of social/economic/environmental/impact;

(d) Once each sector TWG had completed the sectoral risk assessment – stakeholders during the National Consultative Workshop verified the outcomes and ***developed the list of national priority risks*** based on top ranked risks for each sector.

Through this ***climate change risk assessment***, national stakeholders identified the following as priority risks from climate change (see Table 6.1.)

[10] Developed under the "*Mainstreaming Adaptation to Climate Change*" and "*Adapting to Climate Change in the Caribbean*" (ACCC) projects funded by GEF/World Bank/CIDA. 2003.

Table 6.1. Summary of Climate Change Risks in Dominica

Event Risks and *Outcome Risks*	Ranking of Risks
Increase in extreme events and climate variability (Cumulative Risks) - *Physical damage to crops and agricultural access roads, impact on agricultural and fisheries productivity, increase of pests/disease, impact on livelihoods and food security*	**10**
Increase in extreme events -*More frequent economic setbacks, prolonged recovery periods, stress on economy (including increase in loss of life, impact on tourism arrivals, impact on agricultural production, food security, forest cover, human health and social capital), and less attractive environment for foreign investment due to cumulative destruction of critical infrastructure for tourism, manufacturing, agriculture, trade*	**10**
Increase in extreme events (increased intensity of hurricanes, flooding, landslides) – *Increased damage to houses, human settlements, critical infrastructure, forest resources, business and other properties*	**10**
Sea level rise – combined with increased incidents of storm surges - *Damage to coastal infrastructure (roads, ports, jetties, storage, processing, packing, landing sites) used for agricultural trade and access to markets*	**9**
Increased frequency of extreme events -*Water shortages due to increased drought and storms* **(Note: includes loss to crops)**	**9**
Sea level rise – combined with increased incidents of storm surges - *Damage to coastal tourism facilities (beaches, hotels, airports, sea ports and cruise ship/ferry terminals)* **(NOTE: Includes impacts on Kalinago people and lost income to farmers)**	**8**
Sea level rise and storm surge - *Loss of coral reefs – loss of protection to coastal areas and impact of marine ecosystem and associated effect on livelihoods and food security*	**8**
Climate variability -*Loss and impact on marine and terrestrial biodiversity which is key pillar for tourism*	**8**
Changes in rainfall intensity -*Increased coastal marine habitat degradation (including corals) and damage to fisheries infrastructure*	**8**
Increased climate variability -*Changes in fish and marine mammal migration patterns affecting food security and tourism*	**8**
Changes in rainfall patterns - *Increased incidents of landslides affecting houses, human settlements and infrastructure, and forest resources, in addition to costs for insurance and building loans*	**8**
Increase in extreme events –*Damage to coastal property and infrastructure due to storms surges*	**7**

Increase in extreme events -*Reduced availability of international donor funding due to increased demand for emergency assistance from vulnerable countries*	7
Changes in national and local temperatures regimes -*Increased damage to buildings and water cisterns from extreme dry conditions*	7
Sea level rise – combined with increased incidents of storm surges - *Increased costs for insurance, re-insurance and costs to banks providing loans for coastal infrastructure*	6
Increased climate variability - *Increased land degradation* (variation in temperature) (Note: impact on food production, water quality, health and nutrition)	6
Changes in rainfall patterns - *Impact on water quality/supply and costs of water treatment/delivery and damage to water/communication infrastructure* (NOTE: hotels and restaurants at tipping point and loss of income due to lack of water could put them out of business)	6
Increased climate variability - *Decline in tourism visitor arrivals due to more mild conditions affecting winter tourism market*	6
Sea level rise and storm surge- *Damage to coastal infrastructure from sea level rise and higher storm surges and associated impact on tourism (hotels, dive industry, yachting)* (Note: Significant cultural loss in Carib Territory and loss of beaches for recreation)	6
Increase in extreme events - *Increase cost of coastal resources management*	6
Increase in extreme events-*Damage to water resources/infrastructure and impact on water quality and costs for water supply*	6

6.11. Adaptive Capacity

As part of the SPCR ***Adaptive Capacity Assessment***, a *National Adaptive Capacity Assessment* was undertaken to evaluate national adaptation capacity needs/priorities. This assessment highlighted the fact that Dominica has made considerable progress in implementing *Stage 1* adaptation measures. However, the implementation of *Stage 2* and *Stage 3* measures have not been possible due to serious resource (human, technical, financial) constraints. PPCR *National Adaptive Capacity Assessment* identified *considerable limitations in climate change risk management capacity* at the systematic, institutional and individual levels, at the national, sectoral, district and local level, and within the public sector and civil society, highlighting the *need for considerable capacity building*. The *National Adaptive Capacity Assessment* confirmed the need for improved levels of *earmarked financial resources for climate change risk management and resiliency building* as articulated in the NCSA, and the need for *improved coordination* amongst key state and non state actors involved in climate change risk management. Other identified key challenges include:

- Critical infrastructure in the country is vulnerable to significant loss and damage from extreme weather events, sea level rise and storm surges;
- Lack of systems, expertise and facilities to collect, store and analyze relevant information and data on topics related to climate change;

- Inadequate knowledge and awareness of potential impact of climate change and lack of technical skills to address them;
- Policies, laws, rules and regulations related to climate change and disaster risk reduction need strengthening and the capacity to enforce these revised regulations need enhancement; and
- Planning for coordinated response to climate change and disaster risk reduction activities need improvement.

Additionally, using the household survey piloted under the SLM/SPACC projects, a community survey was undertaken during the SPCR prioritization planning process which served to refine and validate the risks/needs of vulnerable communities as articulated during community vulnerability mapping and adaptation planning undertaken during the SLM/SPACC projects. Building upon earlier analysis undertaken on climate change impacts on gender and other vulnerable segments of society (outlined in Section 9 and the Annex of Dominica's ***Low Carbon Climate Resilient Development Strategy***) the household and community surveys highlighted ***concerns over food security***, the urgent need to provide vulnerable communities with ***micro-insurance and micro-finance*** to address risks from climate change extreme events (floods, drought, landslides, crop damage, loss of fishery) affecting subsistence agriculture/fishery production, and the urgent need for ***community based early warning systems, community-based vulnerability/hazard mapping, community multi-use emergency shelters,*** and ***community risk management frameworks.*** Improved access to readily available ***financing to support priority community-based adaptation projects*** was also been highlighted as a priority. These investments are urgently needed to support ***transformational change in vulnerable communities whereby households and individuals assume the lead role in building resilient communities rather than relying on overstretched government resources.*** Lessons learned from Tropical Storm Erika that devastated Dominica in August 2015 and Hurricane Maria in September 2017 has highlighted the need to implement these priority interventions which, despite US$20 million being secured under the SPCR program, remains largely unfunded.

By addressing the deficiencies identified during the SPCR priority planning process, SPCR interventions were intended to support ***the establishment of an appropriate enabling framework to guide and facilitate Dominica's transformation to a low-carbon climate resilience development pathway that can serve as a model for other small island developing States in the region.*** By positioning climate change as a development issue rather than an environmental issue, Dominica's SPCR provides the opportunity to demonstrate viable interventions to address climate change risks within the context of a national development framework that establishes the country firmly on the path to a Green Economy.

SPCR interventions are to be sustained in the long-term by ensuring that climate change planning/management becomes an ***integral part of the national development planning process*** under Dominica's *Growth and Social Protection Strategy* (GSPS) and ***Low Carbon Climate Resilient Development Strategy***, the latter having been formulated during the SPCR planning process. In supporting the ***transition from the situation whereby government is solely responsible for climate change risk management to a country where this is a shared responsibility***, SPCR interventions have to opportunity to demonstrate a model for transformation changes that could benefit other developing countries. Sustainability will be achieved by establishing ***effective partnerships*** with all stakeholders (public sector and civil society, technical and financial partners, local governments, vulnerable communities, grass-roots organizations) to transform Dominica to a low-carbon climate resilient country that will make a significant contribution to sustainable development in the country, and add value by ensuring that the SPCR is not a standalone activity***, but becomes a responsibility assumed by all stakeholders.***

6.12. Disaster Vulnerability Reduction Project (DVRP)

Dominica's SPCR is being implemented under the US$35 million *Disaster Vulnerability Reduction Project* (DVRP) which was officially launched in September 2014. The DVRP is funded by the World Bank, International Development Association (IDA), Pilot Program for Climate Resilience (PPCR), Strategic Climate Fund (SCF) and the Government of the Commonwealth of Dominica. The total approved financing is US$39.5 million.

6.12.1. Disaster Risk Management

Integral to its work on climate adaptation, the country is enhancing its disaster preparedness and emergency response. Disaster risk management (DRM) efforts in Dominica are implemented under the authority of the *Emergency Powers Act* of 1951 (amended in 1973 and 1990). A *National Disaster Plan* (NDP) was initially developed in 1988 and subsequently revised, most recently in 2006.5 The NDP includes policy documents to guide prevention, mitigation and response. Together with the *National Climate Change Adaptation Policy* and the *National Hurricane Disaster Management Plan* and *Disaster Preparedness Plan for the Agriculture Sector*, these documents guide disaster mitigation, management and response by assigning specific responsibilities and procedures under a policy framework for disaster risk management and reduction. The Office of Disaster Management (ODM), which operates under the auspices of the National Emergency Planning Organization (NEPO) chaired by the Prime Minister, is charged with handling disaster preparedness, planning and response, and risk mitigation activities.

Dominica has developed and approved a number of policies, plans and standard operating procedures relevant to disaster risk reduction. These include:

- *2010 National Integration Water Resources Management Policy (Draft);*
- *2009 Disaster Management Plan;*
- *2009 National Emergency Management Policy;*
- *2009 National Shelter Policy;*
- *2004 National Environment Policy/National Environment Management Strategy;*
- *2002 Dominica's Policy on Planning for Adaptation to Climate Change;*
- *2002 Physical Planning Act;*
- *1998 Plan to Reduce the Vulnerability of School Buildings to Natural Disasters.*

Regionally, Dominica is a signatory to the Caribbean Disaster Management Response Agency Agreement, which provides disaster management related institutional strengthening, capacity building and technical assistance support to member states. In addition, Dominica is part of a multi-country risk pooling facility, the Caribbean Catastrophe Risk Insurance Facility (CCRIF), which was established in 2007 and is owned, operated, and registered in the Caribbean for Caribbean governments. The Facility allows participating countries to purchase insurance coverage to finance immediate post-disaster recovery needs and to finance their risks through risk pooling, risk retention, and risk transfer.

With support from the World Bank, Dominica implemented the *Emergency Recovery and Disaster Management Program* (ERDMP) in the early 2000s. The ERDMP's objectives were to: (a) strengthen key economic and social infrastructure and facilities with the aim of minimizing damage caused by future natural disasters and reducing the disruption of economic activity in the event of disaster emergencies (pre-disaster works); (b) to reconstruct and rehabilitate key social and economic infrastructure following disasters; and (c) to strengthen the country's institutional capacities to prepare for and respond to disaster emergencies in an efficient and effective manner.

The DVRP Project Document noted that, overall, while some progress has been made in reducing the country's vulnerability to disasters and in implementing climate change adaptation programs – primarily with a strong focus on biodiversity protection - Dominica still faces challenges in strategically and comprehensively managing natural hazard risk, particularly in the context of a changing climatic environment that threatens to increase disaster risk, further expose existing vulnerabilities, and complicates the search for efficient long-term solutions. Similar to other Eastern Caribbean countries, an overall structure for analyzing and integrating disaster risk information in the development process is lacking. Development decisions in Dominica commonly do not account for disaster risk and expected climate change impacts due to a lack of available information on hazards, vulnerability, exposure, and expected climate change impacts. Secondly, information sharing among agencies is weak, largely due to limited capacity and lack of an overall mechanism to share information with low transaction costs. Finally, disaster risk management (DRM) responsibilities are dispersed among various government agencies, with limited collaboration between entities.

To overcome these challenges, the DVRP focuses on the urgent need to improve the overall information base upon which national policymakers can better plan physical development and design more effective climate change adaptation measures. This would also facilitate the move from primarily response and recovery after natural disasters to a more proactive approach of making systematic and strategic DRM decisions. Moreover, a mechanism for data sharing is required to make information available to all agencies involved in carrying out disaster risk reduction and climate change adaptation measures.

6.12.2. Focus of the DVRP

The DVRP sought to contribute to vulnerability and risk reduction within Dominica through a combination of civil works, capacity building, and institutional development activities at the national and local levels. The focus of the DVRP largely moved away from the priority areas that had been identified by national stakeholders during the extensive PPCR planning process, and targeted building resilience in critical infrastructure – a strategic area of focus of the World Bank.

Despite priorities being clearly defined in the Dominica SPCR and such being approved by the PPCR Steering Committee (PPCR–SC), the DVRP supports sound design and construction measures to enhance resilience of selected road and drainage sub-projects, which would occur in parallel to the development of Component 2. Component 2 would have a transformative impact in the transport and other sectors by focusing on enhancing resilience of critical infrastructure and supporting improved data collection to support climate resilient construction and design standards of future investments. Improved planning to minimize climate risks will benefit from digital surveys using LiDAR technology for the entire country to identify, among others, the potential landslide areas in advance to prioritize drainage and road improvements as well as other opportunities for resiliency in other sectors, such as agriculture, water supply, and land use planning. Lessons learned will be analyzed and shared across sectors.

These activities were designed to improve national resilience to natural hazards and longer-term impacts resulting from climate change. Although broadly in line with the goal of the Dominica ***Strategic Program for Climate Resilience*** (SPCR), the DVRP does not fully implement SPCR priority resilience building and risk management activities that were defined and proposed during the PPCR planning process, neither does it fully implement the thee priority component activities that were approved by the PPCR Steering Committee (PPCR-SC) which comprise donors to the PPCR. This change of focus not only undermines national efforts to build capacity for climate resilience, but also frustrates the priority objective of the PPCR program, namely supporting country-driven and country-owned adaptation planning.

6.12.3. DVRP Component Activities

The DVRP Project consists of the following four components: (1) Prevention and Adaptation Investments; (2) Capacity Building and Data Development, Hazard Risk Management and Evaluation; (3) Natural Disaster Response Investments; and (4) Project Management and Implementation Support.

<u>Component 1: Prevention and Adaptation Investments (US$29.125 million – IDA (US$16 million), SCF credit (US$9 million); SCF Grant (US$3 million); Counterpart Financing (US$1.125 million)).</u> This component was designed to reduce physical vulnerability and pilot adaptive measures to build resilience to current and future hydro-meteorological shocks. Activities under this component include a suite of civil works to improve infrastructure resilience to disaster events and climate change adaptation measures. Subprojects financed under this component, through the provision of works, technical advisory services, operating costs, and acquisition of goods, include: (a) construction of water storage and distribution infrastructure; (b) slope stabilization interventions; (c) climate resilient rehabilitation of primary and secondary roads and bridges along the East Coast and in the South; and (d) improved climate resilient drainage systems. Integrated hazard/climate analysis will inform engineering designs with respect to future service demands and infrastructure design life and will be built into the pre-engineering phase of each subproject.

Component 2: Capacity Building and Data Development, Hazard Risk Management and Evaluation (US$7 million SCF Grant; Counterpart Financing (US$375,000)). The Project supports building the capacity for analysis and assessment of risks from natural hazards and climate change, including the integration of this analysis in the development decision making process at both the project/investment level and at the national level to inform policy and investment plans. This component supports the creation of relevant core data and data collection systems as well as the integration analytical tools to permit improved decision making and engineering design for risk reduction and climate change adaptation. Core data systems to be developed under this component include: (a) creation of a high resolution digital topographic and bathymetric model for Dominica; (b) creation of a high resolution soils survey map including chemical and physical characteristics for each soil unit; (c) design and deployment of a robust hydromet network to provide high resolution hydrologic data for use in a wide range of activities to support, for example, engineering design, national land use and coastal zone planning, disaster management, resilient road construction practices and design, agricultural development and others; and (d) development of district and community level climate adaptation plans and training.

Component 3: Natural Disaster Response Investments (US$1 million IDA – no SCF/PPCR funds). This provisional component would allow rapid reallocation of the IDA credit, under streamlined procurement and disbursement procedures, to cover emergency response and recovery costs following an adverse natural event that causes a major disaster in Dominica. The contingent emergency component would be triggered, by an official Government of the Commonwealth of Dominica declaration of a national emergency, following an adverse natural event. Dominica may ask the World Bank to re-categorize and reallocate financing from other project components to partially cover emergency response and recovery costs. This component could also be used to channel additional funds, should they become available, in response to the emergency. Disbursements would be made either against a positive list of critical goods, both domestic and imported, and/or against the cost of procuring goods, works, consultant services, and emergency operations required to support the immediate response and recovery needs. All expenditures under this component, should it be triggered, would be in accordance with the World Bank’s policy BP/OP 10.00 and would be appraised, reviewed, and found to be acceptable to the Bank before any disbursement is made. A specific Operations Manual (OM) would apply to this component, detailing financial management, procurement, safeguards, and any other necessary implementation arrangements.

Component 4: Project Management and Implementation Support (US$2 million SCF Grant). Activities under this component support strengthening and developing the institutional capacity for project management, including: (a) financing the establishment of a new Project Coordination Unit (PCU) within the Ministry of Environment, including staffing, training, and operating costs; (b) preparation for designs and tender documents; (c) preparation of project reports; (d) processing of contracts and tender evaluation; (e) coordination of participating line Ministries; (f) supervision of the quality of works; (g) training of staff in project management and implementation support; (h) monitoring and evaluation of project and PPCR program progress and results; and (i) related activities to support efficient project management and implementation, through the provision of technical advisory services, training, operating costs, and acquisition of goods. The project also supports knowledge sharing and lessons learning activities at the program level and coordination with the PPCR Caribbean Regional Program in terms of knowledge management and M&R. There is a process underway at the country level supported by the CIF to align the project indicators with the PPCR core indicators and streamline M&R framework across the OECS.

6.13. Global Climate Change Alliance (GCCA) Project

The European Union funded GCCA project is focused on Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean including Dominica, with the OECS Commission serving as Executing Entity. The project runs from 2013-2018. The specific objective of the project is to improve the region's natural resource base resilience to the impacts of climate change, through effective and sustainable land management frameworks and practices and through specific adaptation pilot projects focused on physical infrastructure and ecosystems. In Dominica, the GCCA is supporting a physical adaptation pilot for slope and road stabilization in the Antrim Valley and Belles, in order to mitigate the effects of slippage which poses a threat to commuters and residents who live downstream and to maintain access to the main airport, as well as soil erosion management for farmers at Duck Pond and Blake's Estate.

6.14. Priorities for Building Climate Resilience

While there are several sectors and issues identified by national stakeholders during the SPCR and INDC planning processes as being important to address climate change risks in Dominica, there are a few that require priority attention if building of climate resilience is to be achieved. These priorities have bee identified by national stakeholders during the SPCR planning process and INDC development process to be a priority for Dominica, have not yet been funded or implemented under the DVRP, and which possess the greatest potential to contribute to the successful transformation of the country to a climate resilient low carbon development path.

(l) Addressing climate change ***mitigation measures*** on the basis that savings in energy costs will allow Dominica to invest more in priority and much needed ***adaptation measures***;

(m) Establishing ***community off-grid mini-grid or micro-grid renewable energy electrical supply systems*** (backed up by emergency alternative energy systems such bio-diesel generators should local conditions allow for the operation to be efficiently established) in vulnerable communities on the east and south east coasts that are periodically without electricity as a consequence of storm and hurricane events;

(n) Establishing ***early warning systems, multi-use disaster shelters (powered by renewable energy and back up bio-diesel generators) and emergency preparedness training programs*** in vulnerable communities;

(o) Facilitating ***capacity building*** through education, awareness and training programs on climate change risk management and resiliency measures in order to strengthen capacity at the community and sectoral level, within municipalities and local authorities, and the private sector;

(p) ***Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development*** to build climate resilient communities by strengthening capacity to address climate change risks to food security associated with changing precipitation patterns;

(q) Establishing the ***enabling legal/institutional framework to facilitate coordination/implementation*** of priority climate change measures and the mainstreaming of climate change activities into national, sectoral and community planning/development;

(r) ***Creating the supportive enabling framework whereby communities and vulnerable segments of society (women, youth, elderly, people with disabilities) can manage their own climate change risks,*** thereby addressing climate change impacts on vulnerable sectors (particularly agriculture, fisheries and water resources) and threats to food security, human health, poverty alleviation, sustainable livelihoods and economic growth;

(s) Establishing a ***sustainable financing mechanism*** to ensure timely and direct access to international climate change financing to implement priority climate change risks management measures by the private sector and vulnerable communities;

(t) ***Legal establishment of the Department of Climate Change, Environment and Development and the financing of key technical personnel*** needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`*s Low Carbon Climate Resilient Development Strategy*, and to serve as National Implementing Entity (NIE) to facilitate direct access to and management of international climate change financing under the Green Climate Fund;

(u) Design and implementation of ***climate change adaptation and disaster risk management education and awareness program*** at all levels to be coordinated by the Department of Climate Change, Environment and Development;

(v) ***Legal establishment of Climate Change Trust Fund*** in addition to US$5 million seed funding to the *Climate Change Trust Fund* to provide support to priority community climate change risks management measures identified through community vulnerability mapping and adaptation planning and the establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisher-folk, women and vulnerable communities in particular the Kalinago people).

Dominica`s INDC indicates that costs for the abovementioned priority adaptation measures that are to be undertaken over the next 5 years are US$25 million.

6.15. Building Capacity for Climate Resilience with Support from the Green Climate Fund (GCF).

In support of national efforts to address the deficiencies in and change of focus of the DVRP and address capacity building priorities defined by national stakeholders during the SPCR and INDC planning processes, the Government of Dominica has sought support from the Green Climate Fund (GCF) to establish two programs that target these priorities.

6.15.1. Enhanced Direct Access (EDA) Project

In 2016, the Green Climate Fund (GCF) announced a pilot initiative for Enhancing Direct Access (EDA) with the objective that the pilot allow the GCF to effective operationalization its enhance direct access modality at the sub-national, national and regional public and private entities to the Green Climate Fund. This include devolved decision-making and stronger local multi-stakeholder engagement. The pilot phase will offer the GCF an opportunity to gain experience and additional insights through such an approach.

Led by the Government of Antigua and Barbuda, a US$20 million Enhanced Direct Access (EDA) project is being presented to the Green Climate Fund (GCF) Board at its next meeting in the Republic of Korea in early March 2018. The project aims to build integrated resilience to climate risks of individuals and their businesses, communities and governance systems through grant and loan award mechanisms in each country that are transparently managed through decision-making by those impacted by climate change. The project is an Enhancing Direct Access pilot project to be implemented in Antigua and Barbuda, Grenada and the Commonwealth of Dominica, which was developed in response to a request for proposals issued by the Green Climate Fund in 2016.

Two out of the three participating countries suffered severe impacts last year, with Antigua and Barbuda sustaining damage and losses of about US$155 million due to Hurricane Irma, while the Commonwealth of Dominica is estimated to have lost US$1.37 billion, which is 226 percent of its Gross Domestic Product (GDP). The third country participating country, Grenada, has taken many years to recover from Hurricane Ivan which struck the island over a decade ago.

If approved by the Fund's Board, the Enhancing Direct Access project will transparently channel climate financing to vulnerable people and communities in the pilot countries to retrofit buildings (houses, small businesses and community buildings) using the new OECS model climate resilient building code. The project will also fund small-scale community watershed and drainage improvements to cope with flooding. The Commission of the Organization of Eastern Caribbean States (OECS) will monitor and evaluate the impact of the interventions, which will assist the participating countries to report on their *Nationally Determined Contributions* under the *Paris Agreement*.

Entitled *Integrated Physical Adaptation and Community Resilience through an Enhanced Direct Access Pilot in the Public, Private, and Civil Society Sectors of Three Eastern Caribbean Small Island Developing States*, the Enhancing Direct Access (EDA) pilot project will be implemented by the Department of Environment in Antigua and Barbuda, which was accredited to the Green Climate Fund in October 2017. The Ministry with responsibility for Environment in each of the pilot countries will serve as the Executing Entity for their country, and will benefit from capacity building in programming climate financing to vulnerable men, women and children.

The outputs of the EDA project are:

Output 1: Enhanced capacity for climate adaptation planning, implementation, and monitoring and evaluation via direct access. This will operationalize and strengthen direct access modalities in each of the small island pilot countries to strengthen financial institutions, promote openness, transparency and country ownership of climate adaptation actions across sectors and scales (national, community and individual).

Output 2: Governments implement concrete adaptation measures using ecosystem-based approaches where appropriate. This will demonstrate enhanced direct access in the public sector through an on-granting mechanism that aligns GCF-financed concrete local area adaptation projects to climate-proof ongoing investments and co-financing from the Government.

Output 3: Community resilience to climate impacts is enhanced through tangible adaptation benefits. This will demonstrate enhanced direct access for CSOs and NGOs through an on-granting mechanism for adaptation in community buildings that promotes resilience to droughts, floods and hurricanes.

Output 4: Privately owned physical assets of vulnerable populations are more resilient to climate variability and change through concessional microfinancing. This will demonstrate enhanced direct access in the private sector through a concessional on-lending revolving loans programme for adaptation in buildings (homes and small businesses).

Amongst other activities in Dominica, the EDA pilot project will support the implementation of the following priority climate resilience building measures that were identified by national stakeholders during the SPCR and INDC planning processes:

(a) Establishing the *enabling legal/institutional framework to facilitate coordination/implementation* of priority climate change measures and the mainstreaming of climate change activities into national, sectoral and community planning/development;
(b) *Creating the supportive enabling framework whereby communities and vulnerable segments of society (women, youth, elderly, people with disabilities) can manage their own climate change risks*, thereby addressing climate change impacts on vulnerable sectors (particularly agriculture, fisheries and water resources) and threats to food security, human health, poverty alleviation, sustainable livelihoods and economic growth;
(c) Establishing a *sustainable financing mechanism* to ensure timely and direct access to international climate change financing to implement priority climate change risks management measures by the private sector and vulnerable communities;
(d) Legal establishment of the Department of Environment, Climate Change and Development and the financing of key technical personnel needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`*s Low Carbon Climate Resilient Development Strategy*, and to serve as National Implementing Entity (NIE) to facilitate direct access to and management of international climate change financing under the Green Climate Fund;
(e) Design and implementation of climate change adaptation and disaster risk management education and awareness program at all levels to be coordinated by the Department of Environment, Climate Change and Development;
(f) Legal establishment of *Climate Change Trust Fund* in addition to provision of US$6 million seed funding to the *Climate Change Trust Fund* to provide support to priority community climate change risk management measures identified through community vulnerability mapping and adaptation planning and the establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisher-folk, women and vulnerable communities in particular the Kalinago people).

6.15.2. National Adaptation Plan (NAP)

During late 2017, with support from the Department of Environment in Antigua and Barbuda, which was accredited to the Green Climate Fund in October 2017, the Government of Dominica prepared a proposal to the Green Climate Fund (GCF) to formulate a National Adaptation Plan (NAP). Antigua and Barbuda's Department of Environment has been requested by the Commonwealth of Dominica to serve as Delivery Partner for the NAP application, in furtherance of a mandate provided to Antigua and Barbuda by the OECS Ministerial Council in 2016. The Department of Environment in Antigua and Barbuda through serving as GCF Delivery Partner for Dominica's NAP application will facilitate transfer of knowledge and lessons learned as the Commonwealth of Dominica implements a similar process of using OECS model legislation (based heavily on Dominica's draft Environment Bill of 2012) to implement the climate change multilateral environmental agreement (MEA) commitment to undertake adaptation planning processes. This project is expected to be approved in 2018.

The Government and people of Dominica are receiving considerable assistance from neighbouring countries and the international community in ongoing response to Hurricane Maria, but are determined to lead these efforts to ensure that lessons learned from Hurricane Maria and Tropical Storm Erika inform and guide future reconstruction and development along a path that ensures resilience to the devastating impacts from climate change. Sensitive to the possibility of being pulled along a path that supports the agendas of well-meaning development partners rather than the needs of the country, the Government and people of Dominica are undertaking a country-owned and country driven process to develop and implement an *Action Plan for a Climate Resilient Dominica* to tackle short-term needs that will support long-term climate resilience.

The *Action Plan for a Climate Resilient Dominica* will establish a High-Level Steering Committee Co-Chaired by Prime Minister and the Minister of Health and Environment (technical lead on climate change) to provide overall guidance and support to the process, and establish a Secretariat in the Ministry of Health and Environment (jurisdictional lead for climate change and focal point) to the High-Level Steering Committee. This National Adaptation Planning (NAP) project will foster an enabling environment within legislation, institutional arrangements, and technical capacity across the public, private and NGO sectors.

The NAP project will achieve the following key outcomes:

- *Legislation*: Support the advancement of the national climate change and environment law using the OECS model legislation (that borrowed heavily from Dominica's draft Environment Bill 2012) to provide a national adaptation planning mandate and framework, and legal capacity building of the national climate change focal point;
- *Institutional arrangements*: Empowered Environmental Coordinating Unit (ECU)/Department of Environment, Climate Change, and Development to coordinate the Government's policies and programs relating to climate change; high level and participatory governance bodies are constituted and convened with adequate support; climate financing architecture is vetted and strengthened;
- *Technical capacity*: Data infrastructure for adaptation and recovery are strengthened to include cloud-based storage (significant data has been lost to Hurricane Maria), and update and validation of baseline adaptation-related data;
- *Financing adaptation*: Key adaptation priorities will be identified at the national level through the NAP-supported development of up to 3 sectoral adaptation plans (e.g. Finance, Agriculture, Tourism); at the local/community level via up to 3 local area climate resilient

development plans for vulnerable communities; and at the individual/private sector level with up to 22 localised resilience action plans and investment strategies the NAP's focus on institutional capacity building.

The main impact of this project is to address key barriers to adaptation planning and implementation in Dominica. The country's experience on adaptation projects has delivered significant technical outputs and achievements. However, these project outputs are often not taken up and implemented by the Government due to capacity constraints, which has been further set back after the devastation of Hurricane Maria. The proposed NAP project will overcome this barrier by focusing on the enabling environment. The NAP project will support stakeholders to review the outputs of Dominica's various projects and donor-supported initiatives, and identify modifications and/or mainstreaming priorities. Implementation of transformational adaptation towards the goal of climate resilient development will require large amounts of accessible and predictable resources. The NAP project will therefore enable the Commonwealth of Dominica to access scaled-up accessible and predictable financing, including through direct access modalities as a result of the NAP's focus on institutional capacity building.

This project will support and compliment Dominica in ongoing efforts to develop its Country Programme to the Green Climate Fund with support from its first "Readiness" support grant. UNDP is serving as the Delivery Partner for Dominica's first GCF Readiness grant, to be implemented from 2018 – 2020.

6.16. Implementation

Implementation of priority climate change programs is a joint responsibility led by the Ministry of Health and Environment. The Council for Environment, Climate Change and Development (CECCD) and the Department of Environment, Climate Change, and Development (currently the ECU) that are to be legally established under the proposed *Climate Change, Environment and Natural Resource Management Bill 2015* (which has been developed through broad-based consultation and is to be presented for enactment before the end of 2018) will be responsible for coordinating climate change programming in Dominica. The Department of Environment, Climate Change, and Development is to establish and manage the National Climate Change Trust Fund established under the *Climate Change, Environment and Natural Resource Management Bill 2015*, which together shall serve as the National Implementing Entity (NIE) for climate change programs in Dominica. Dominica will seek assistance under the NAP, EDA and "Readiness" program operated by the Green Climate Fund to establish the necessary legal, institutional and fiduciary management framework and accredit the Department of Environment, Climate Change, and Development as the National Implementing Entity (NIE) to facilitate direct access, thereby reducing dependence upon intermediary agencies for the design and implementation of priority adaptation interventions.

The Department of Environment, Climate Change, and Development will report to the CECCD and prepare regular reports on the implementation and administration of climate change programming in Dominica. Given the very substantial volume of climate change investments proposed and the additional institutional capacity required to undertake climate change programming, implementation capacity will be closely monitored and assessed periodically throughout implementation. The Government of Dominica is committed to providing the necessary resources to ensure the timely and successful implementation of the ***Low-Carbon Climate-Resilient Development Strategy*** and compendium SPCR, which have been endorsed by the Hon. Roosevelt Skerrit - Prime Minister and Minister for Finance (letter of endorsement as of 5th April 2012) and approved by Cabinet on Tuesday, 11th April, 2012. However, when proposing its contribution, Dominica recognizes that the country faces its own challenges and its contribution has been assessed in parallel with, and subject to the country priorities in term of poverty alleviation, sustainable economic development and equitable GDP growth. In light of limited resources, the implementation of the climate change program outlined in the INDC is conditional upon receiving timely access to international climate change financing, technology and capacity building support for priority adaptation/mitigation measures.

Chapter 7: Research and Systematic Observation

7.1. Overview

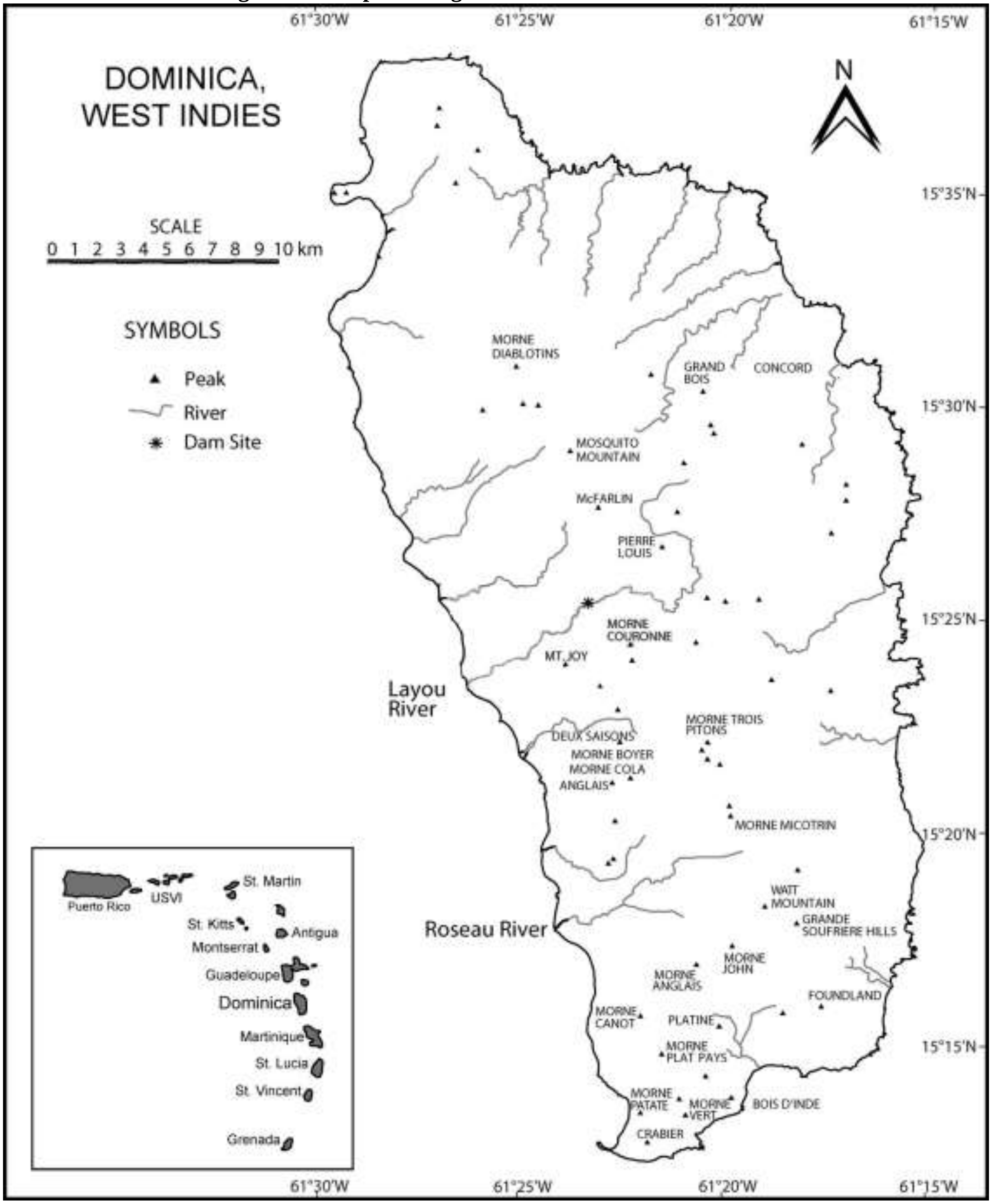
Having suffered considerable loss of life and damage from extreme precipitation events in recent years that have caused extensive flooding and landslides, the priority in Dominica is the establishment of a comprehensive hydrometeorological data collection network to inform the design of effective risk management and early warning systems. Accordingly, support was provided under the DVRP project for a comprehensive assessment of the country's hydrometeorological data collection network. This Chapter is largely drawn from the report *Improving Hydrometeorological Data Collection Network, Data Management, and Relevant Institutional Frameworks in the Commonwealth of Dominica* (April 2015) which was undertaken under the Disaster Vulnerability Reduction Programme (DVRP). No corresponding assessments have been undertaken during the reporting period in regards to systematic observation systems pertaining to other climate parameters (temperature, evaporation, extreme events) in order to update information provided in the INC and SNC.

7.2. Context

Because of the sufficiency of water supplies and relatively small population, the water resources infrastructure of Dominica is underdeveloped compared to island nations that have more complex water resources issues or larger populations. Figure 7.1. shows the scale of the island with key rivers and mountain peaks that form the head of catchment areas.

In the context of climate resilience, accurate long term hydrometeorological data are most valuable. The period of records maintained on the island varies between data types and collecting agency. Long term climate records from the two airports on the island (Canefield and Douglas-Charles) are archived in accordance with WMO standards by the Caribbean Institute for Meteorology and Hydrology (CIMH). Understanding of potential impacts of climate change on water resources availability requires data sufficient to perform water balance calculations at watershed and aquifer scales. Accurate water balance computations require accurate measurements of as many components of the hydrological cycle as possible, aided with well informed estimation methodologies for those components that are difficult to measure directly such as actual evapotranspiration. Data provisioning using information technology is nonexistent in Dominica. While some of the long-term climate records collected by Dominica Meteorological Service (DMS) are archived by CIMH, there are no in-country data portals.

Figure 7.1. Map showing Distribution of Water Resources



7.3. Analysis of Meteorological Network

An important application of meteorological data is validation of downscaled climate simulations. These methodologies require simulation of past conditions and comparison with past observations in a statistical sense. One criteria that is used to evaluate the value of existing data sets is the question: “Do sufficient quantities and qualities of data exist to allow closure of the water balance in a watershed with uncertainty less than the sum of the measurement errors?”

High quality measurements at enough points to describe spatial variability, at consistent intervals and locations, over a long time period are required. In the face of a changing climate, there is no such thing as a “long enough” period. Consistent, continual, data collection of indefinite duration is required.

A number of key gaps were identified in each monitoring network with the assistance of agency personnel, and through analysis of existing monitoring sites. Analysis under the DVRP, which focused on rainfall measurements, is described below. Rainfall measurements were taken as the prime focus because rainfall tends to be more varied in space and time than other meteorological parameters such as temperature, dew point, and wind speed. Another highly variable quantity in time is net radiation, which is strongly affected by the occurrence of cloudiness, but more highly correlated in space. An assessment in 1967 analyzed the spatial distribution of annual rainfall across Dominica. The result of that analysis is shown in Figure 7.2. The units of rainfall shown in this figure are inches (1 in. = 25.4 mm). Dashed lines indicate estimated rainfall, not measured. The data used in this 1967 assessment consisted of rainfall accumulations from a number of plantation sites dating from the 1930's. The location of those rainfall records is unknown.

7.4. Rain Gauge Network

There are two long-term rain gauge sites in Dominica. These are the two airports on the island, Canefield and Douglas-Charles near Marrigot. Starting in 2007 an experiment run by a group from Yale University installed an ad-hoc rain gauge network across the southern portion of the island to examine topographical factors on tropical rainfall. This experiment was called “DOMEX”, and Figure 7.3. shows locations of the ground-based DOMEX instrumentation. Following the end of the experiment, the rain gauges and loggers were left in the care of the Dominica Meteorological Service, which continues to operate it. An analysis was undertaken under the DVRP project of rainfall space-time variability and precipitation vs. elevation relations using the DOMEX tipping bucket data. The hypothesis that there is a significant increase in precipitation with elevation was tested, by analyzing monthly rainfall data vs. station elevation.

The DOMEX tipping bucket data were recorded as date/time stamps for individual tips. The HOBO rain gauges (Onset Computer Corp.) used in DOMEX had a 0.2 mm per tip resolution, and the HOBO data loggers recorded the date/time of individual tips to the nearest second. HOBO data loggers are known to suffer from clock drift in an amount up to several minutes per month. Because some of the sites were not visited more frequently than after several months, there might be time errors associate with the individual tips up to approximately 10 minutes or more.

Figure 7.2. Spatial distribution of annual rainfall across Dominica (inches)

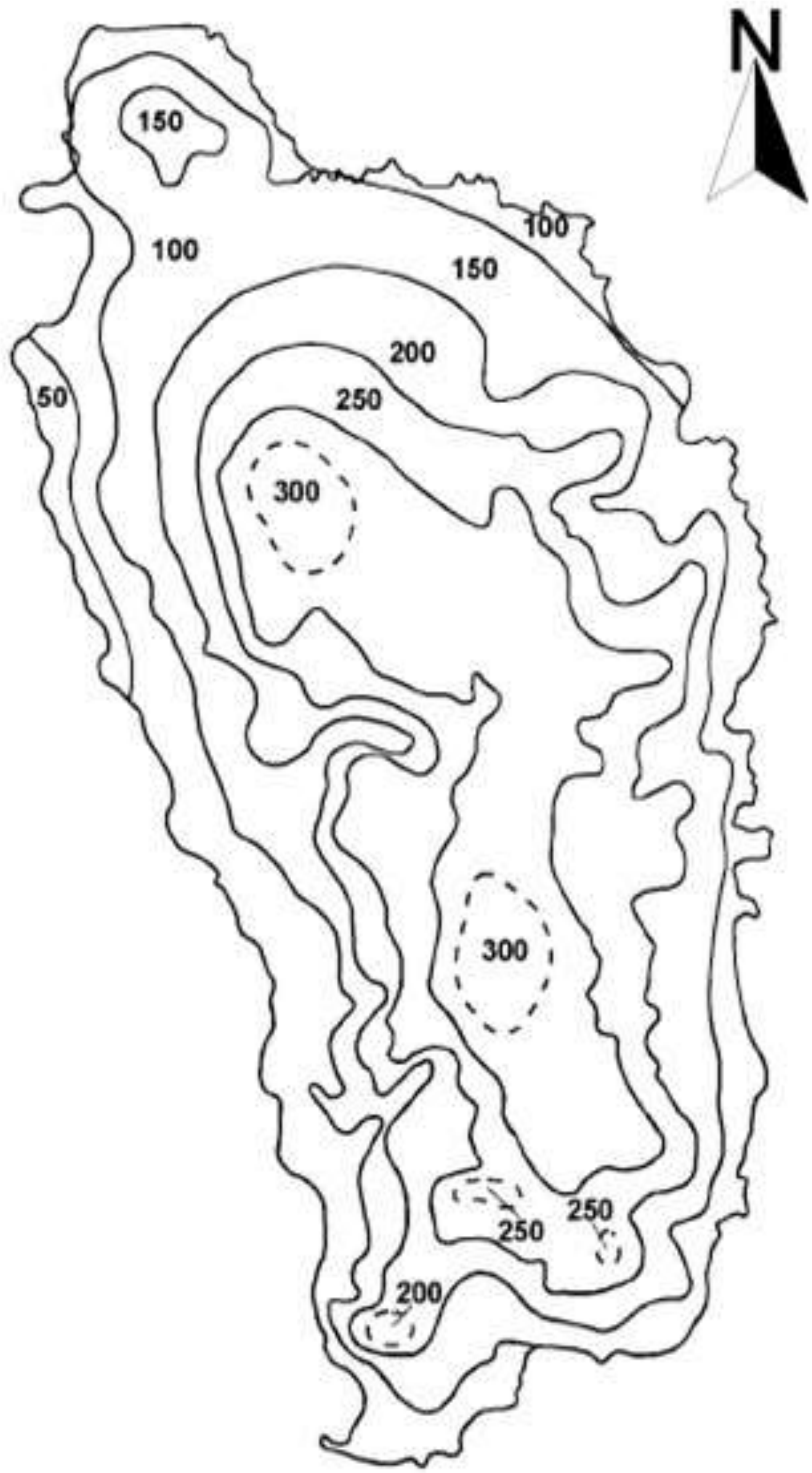
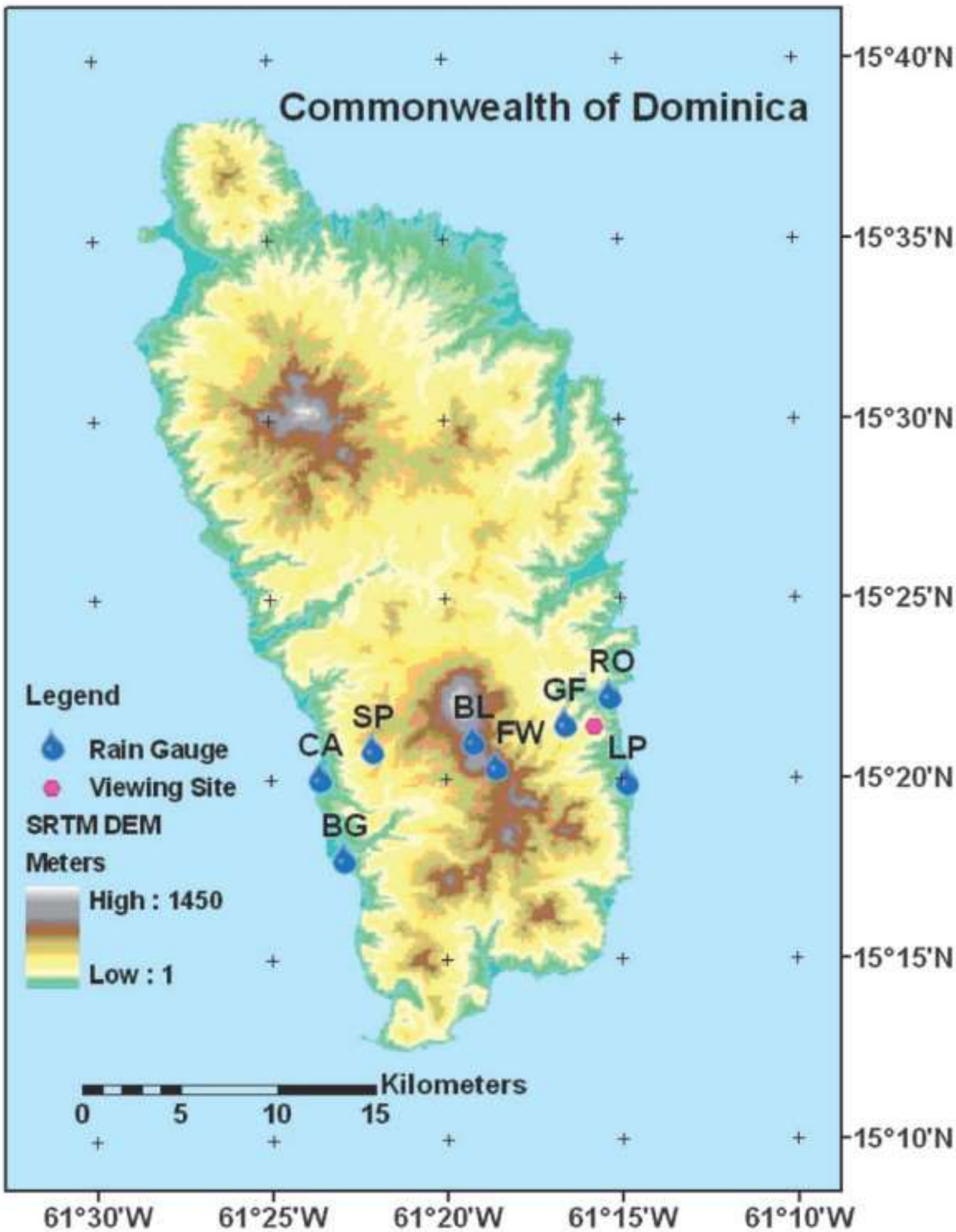


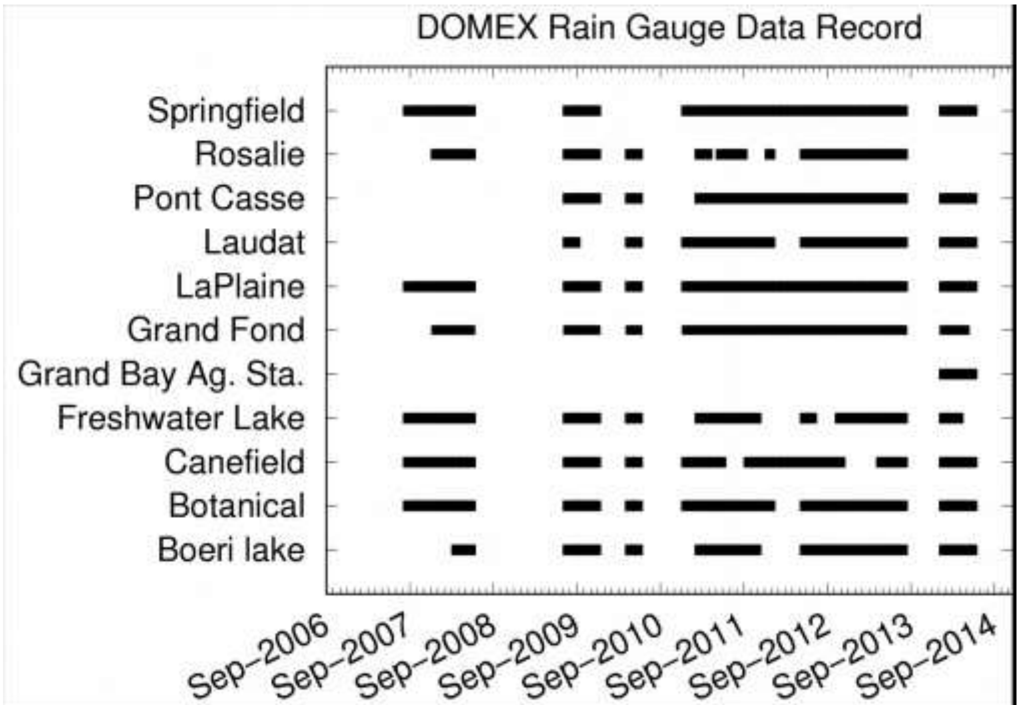
Figure 7.3. Location of DOMEX tipping bucket rain gauges

(BG=Botanical Garden, BL=Boeri Lake, CA=Canefield, FW=Freshwater Lake, GF=Grand Fond, LP=LaPlaine, RO=Rosalie, SP=Springfield.)



The DOMEX tipping bucket data were binned into hourly, daily, and monthly values for each gauge in the period of record. There are gaps in the data set. Figure 7.4. shows the nature of the monthly rainfall database by plotting months with/without data for each of the 11 DOMEX stations over the period of record.

Figure 7.4. Tapestry plot showing the quantity of data in the DOMEX database after conversion to monthly values. (Note: Each small black square denotes one monthly value of rainfall at one station. Missing squares denote missing data. Note intermittent network-wide data gaps that indicate lost or misplaced data. Not all months are complete.)

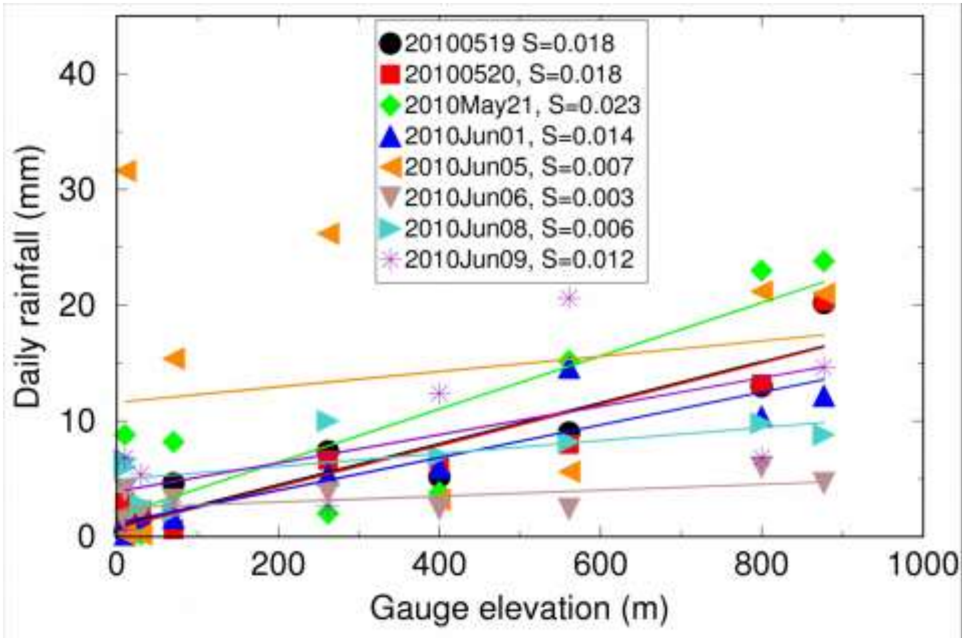


7.5. Annual Precipitation vs. Elevation

It is widely held that precipitation amounts increase with elevation on tropical islands. Potential impacts of climate change, downscaled to smaller scales from climate model output should be able to reproduce this effect, if it is present. For this reason, the DVRP project analysed the DOMEX tipping bucket rainfall dataset with coverage of parts of 2007, 2008, 2009, 2011- 2014, to determine if these data capture or suggest a precipitation vs elevation (P-E) relationship. Annual rainfall amounts for stations with no missing values during a particular year using monthly rainfall data for the period of record (all data shown in Figure 7.4). Figure 7.5. shows daily rainfall vs station elevation during the extremely wet rainfall period from May-June, 2010.

Results shown in Figure 7.5. clearly indicate that at the daily level, there is a significant precipitation vs elevation relation. The t-statistics of the regression indicate confidence in the regression slope on 6 of 8 days. There are occasionally stations at lower elevations that receive more rainfall than the highest stations in the network, but this seldom occurs.

Figure 7.5. Daily rainfall vs station elevation for all stations with no missing data during the extremely rainy period in May-June, 2010. (Note: Lines show linear regressions. Legend shows slope of regression S in mm m-1 over the time period of one day.)



7.6. Monthly Precipitation vs. Elevation

Only station-months with complete records (no missing data in any month during a particular season) were included in the analysis. Figure 7.6. shows precipitation vs elevation for the months of data shown in Figure 7.4.

Results shown in Figure 7.6. confirm the existence of a very strong precipitation vs. elevation relationship over the island of Dominica. This outcome has very important implications for rain gauge siting. Elevation is extremely important in siting rain gauges. The assumption that nearby rain gauges that lie at significantly different elevations, for example greater than 100 to 200 m, are correlated is likely not valid.

The results shown in Figure 7.7. indicate that there is considerable variation in the slope of the precipitation vs. elevation relationship at the monthly time scale. The median value is 0.423 mm m-1, while the mean value is 0.462 mm m-1.

Figure 7.6. Monthly precipitation vs. elevation relations for 27 months with complete records shown in Figure 7.4. from DOMEX rainfall data. (Note: Regression slope S has units of mm per m over the time period of one month.)

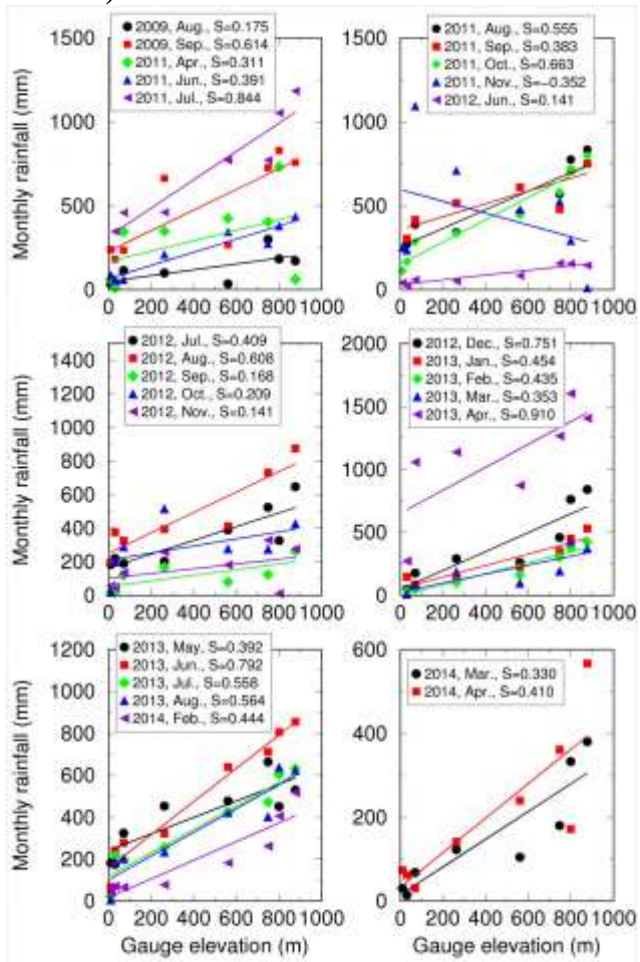
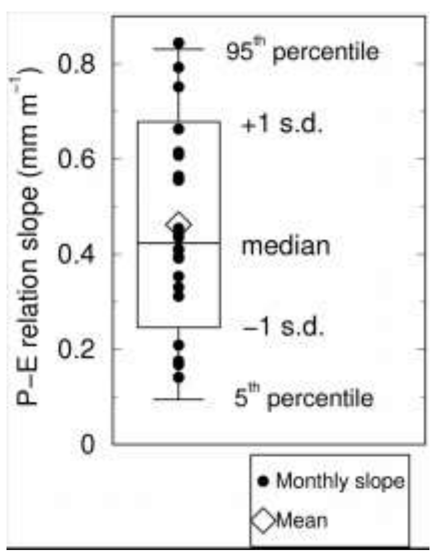


Figure 7.7. Distribution of monthly precipitation-elevation relation slope, from DOMEX data.



7.7. Spatial Correlation of Rainfall

The adequacy of the spatial distribution of stations in a rain gauge network to capture the spatial variability of rainfall is an important question. This adequacy depends upon the time scale of interest. In general, the correlation of rain gauge measurements at two stations at fixed locations increases as the time-period increases. Similarly, as the distance between stations increases, the correlation between their rainfall measurements over a fixed time period will decrease. At some distance, the two stations are considered to be completely uncorrelated. This distance is called the "correlation length". The correlation length is defined as the distance between two stations where for a given period of rainfall measurement, there will be some correlation between the two stations. The calculation of spatial correlation is best performed using data from a wide range of events. In this regard, extreme events are not considered separately from "ordinary" events, as they are all members of the expected event population.

The sampling period (e.g. hourly, daily, monthly, annual) has a very large effect on the correlation length. Hourly correlation lengths for tropical rainfall in Panama are less than 6 km, while daily correlation lengths range from 20 to 30 km. The rainfall regime of Panama is maritime and very similar to that of Dominica, because the narrow isthmus of Panama does not have a significant influence on convection. In this regard, convection in Panama is very similar to that occurring on large tropical islands such as Dominica.

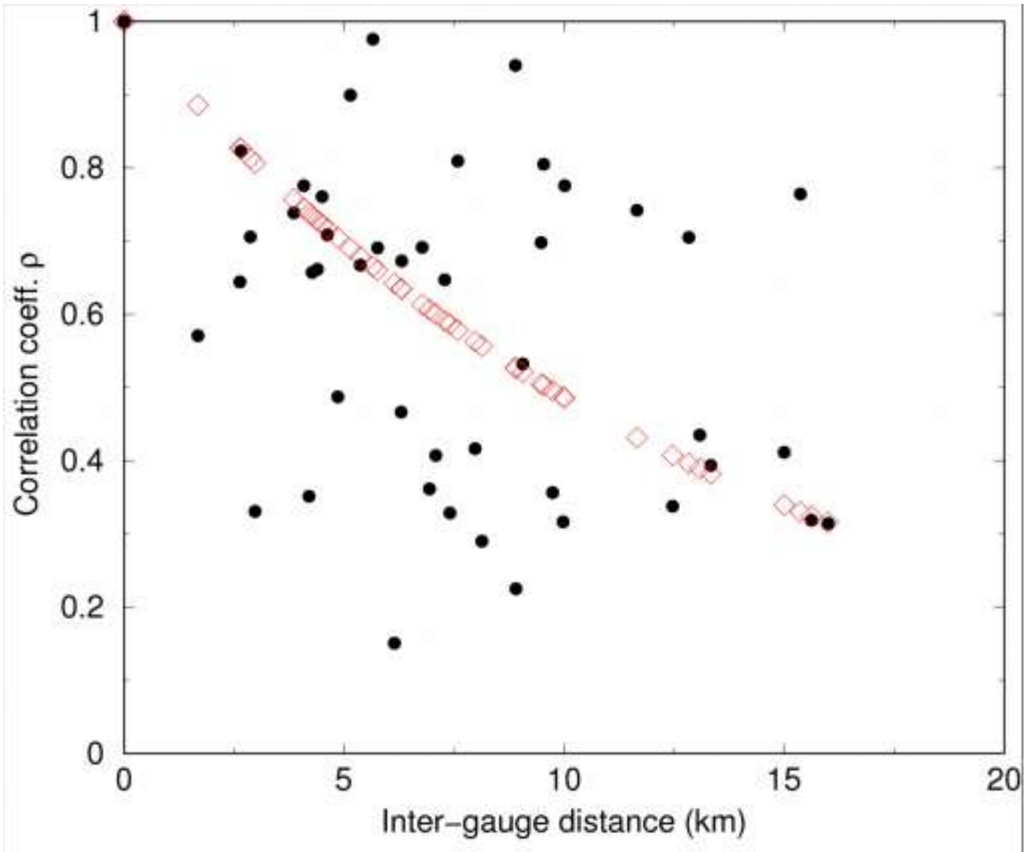
In general, the correlation length increases with increasing integration time. Calculation of the correlation length requires mathematical operations on a complete set of data. Missing values can be estimated, but this data filling exercise is tedious and can confound the results; it is best to start with a complete, non-filled data set with no missing values. The DOMEX rain gauge network data set shown in Figure 7.3. was processed to identify the largest period of complete rainfall data in the record. This processing revealed that there were 11 months of complete data with rainfall at 10 gauges. This results in 110 gauge-months of data. Monthly rainfall from these 11-months of data from 10 station were used to calculate the covariance and correlation coefficient for each pair of stations at the monthly time scale. Those results are shown in Figure 7.8. A one parameter exponential was fit to the data to model the correlation (ρ) vs distance (d) relation. The model used is:

$$\rho = e^{-bd}$$

where the parameter b is the inverse of the correlation length Lc (b=1/Lc). The use of a one parameter correlation model (Eqn. 1) assumes that rain gauges installed adjacent to each other will be perfectly correlated. In essence, this assumption neglects measurement errors due to systematic effects such as rain gauge miscalibration, wind effects, and random measurement errors.

The inter-gauge distances varied from a maximum of 16 km to a minimum of 1.6 km. The median and mean inter-gauge distances were 7.1 and 7.7 km, respectively. The elevation of these 24 gauges ranged from 10 m to 870 m above sea level. The results shown in Figure 8 have two interesting features. There are two populations of correlations that deviate from the "typical" situation. These anomalous stations are those that are far from the modeled correlation (red squares). Given that the inter-gauge distances are quite close, the spread from the model indicates that something else is affecting the correlation.

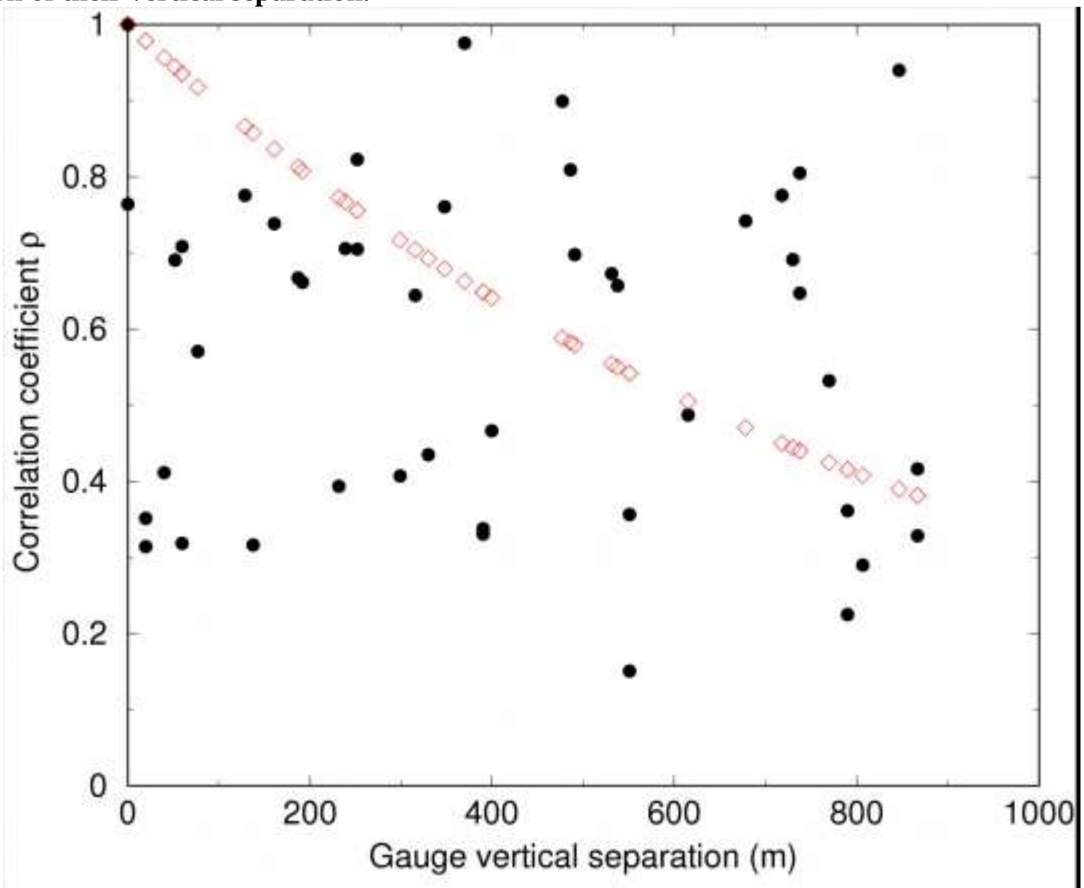
Figure 7.8.: Correllelogram for monthly rainfall accumulations vs. inter-gauge distance.



Some station pairs at short separation distances (<15 km) have anomalously low correlations. These low correlations with space are due to factors other than rainfall variability that cause rain gauges to disagree such as malfunctioning or mis-calibrated rain gauges, plugging of the rain gauge, poor gauge placement near structures or trees, or data entry errors. Including these malfunctioning gauges in the fitting of the exponential model is conservative and will lead to a shorter correlation length estimate.

There are some station pairs with large inter-gauge separation distances that have anomalously high correlations. Including these station pairs when fitting the exponential model will result in a bias that will lead to over-estimation of the correlation length because these stations are not typical. These highly-correlated but widely-separated stations were removed from subsequent analysis to avoid their effect in increasing the correlation length. The correlation between gauge pairs separated by vertical distance was analyzed to ascertain if gauge elevation is a key determinant of correlation. These results are shown in Figure 7.9., which plots correlation between gauge pairs vs. the vertical separation distance (m).

Figure 7.9. Plot showing correlation between monthly rainfall recorded at pairs of rain gauges as a function of their vertical separation.

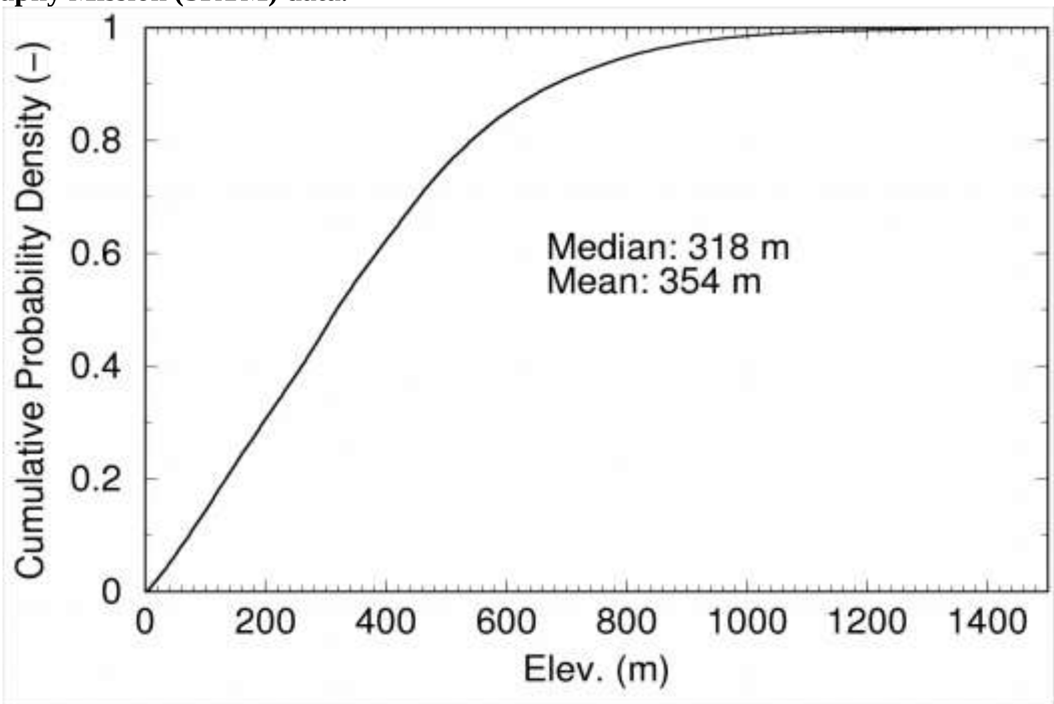


The results shown in Figure 7.9. clearly indicate that vertical separation is not a reliable predictor of correlation between rainfall gauges. Compared with the spatial correlelogram shown in Figure 7.8, the agreement in Figure 7.9. is quite poor. Taken together the results shown in Figures 7.8. and 7.9. indicate that topography is the dominant control, and that spatial extrapolation of rainfall more than a few km horizontally or 100 m vertically is not recommended. Conversely, this result indicates that ***rainfall measurements are required in each watershed where flash flood warnings are needed.*** The only exception would be in smaller watersheds (<5 km2) where there are rain gauges in adjacent watersheds.

7.8. Rainfall Topographic Concerns

Given that topography has such a dominant effect on rainfall spatial variability in Dominica, an analysis was performed under the DVRP project to identify the distribution of elevation across the island. Data used were three arc-second (90 m) Shuttle Radar Topography Mission (SRTM) processed data, downloaded from the Consortium for Spatial Information (CGIAR, 2015). These results are shown in Figure 7.10., which shows the hypsometric distribution of the island of Dominica. Note that about 80% of the island lies at or below 600 m elev.

Figure 7.10. - Hypsometric curve of the island of Dominica as calculated using 90m Shuttle Radar Topography Mission (SRTM) data.



Given the strongly linear precipitation vs. elevation relationship identified in Figure 7.6. the implications are that the mean precipitation occurs at the mean elevation. As shown in Figure 7.10., this occurs at a cumulative probability density of 0.5, or an elevation of 354 m. As such the hypsometric curve shown in Figure 7.10. can be used to guide placement of rain gauges at the catchment scale. In smaller catchments less than approximately 5 km2, one rain gauge placed at approximately the mean elevation of the catchment would suffice. For larger catchments, particularly those that span a significant range of elevation, two or more rain gauges might be necessary. In that case, road access and cleared area might determine the placement of one rain gauge at an elevation that is different from the mean elevation. For example, consider that a gauge is placed at an elevation of 200 m. Notice that according to Figure 7.10. this corresponds to approximately the 28th quantile, which is 22 quantiles below the mean. A second gauge might be best placed at the elevation corresponding to 22 quantiles above the mean elevation, the 72nd quantile. According to Figure 7.10. this elevation would be approximately 460 m. Of course, separate hypsometric curves may be developed using topographic data from the catchment of interest for more accurate analysis.

7.9. Rainfall Network Analysis Observations and Conclusions

The assessment under the DVRP project provided the following recommendations and conclusions.

i. The existing DOMEX rainfall data set from 2008-2014 has some gaps, due to missing data. These gaps reduce the utility of these data in climate research and studies, where uninterrupted data are most valuable.

ii. The DOMEX data set that was obtained under the DVRP project from the Dominica Meteorological Service was difficult to use. Most of the data were stored as date/time tips. However, some of the data were binned into 5-minute intervals. During different deployments, the HOBO data loggers sometimes recorded different parameters such as temperature on an even interval, which made the file format change from one data period to the next for the same site. This required writing separate data processing/binning codes each different data format.

iii. There is a very strong precipitation vs. elevation (P-E) relationship in Dominica. The slope of this relationship is approximately 0.42 mm per meter of elevation. In other words an increase of 1000 m in elevation results in a 420 mm increase in rainfall.

iv. Because of the strong P-E relationship in Dominica, the correlation length of monthly rainfall is quite short (< 15 km). The vertical correlation length is less than 200 meters elevation, so interpolation of rainfall fields using rain gauges will require a significant number of rain gauges and a technique such as co-Kriging. Key watersheds for water supply or flashflooding/landslide potential should be instrumented more densely with rain gauges, depending upon the response time of the watershed.

v. Data gaps must be minimized. Data infilling is one partial solution, depending upon the distance to nearby stations. However the short spatial correlation distance prevents this without a redundant network design. Data gap filling is difficult. Depending upon the integration interval (hourly, daily, monthly), gap filling is impossible without several nearby stations within the correlation length for that time interval.

vi. Telemetry to identify problems with equipment in the field in near real-time will be a benefit to help minimize data gaps.

vii. Installation of redundant rain gauges at each station will also help. Installing at least two rain gauges at each site helps to identify a malfunctioning rain gauge. Installing three rain gauges on each station allows determination of which rain gauge is bad. One of the three rain gauges should be of a very high-quality, while the redundant gauge(s) can be of lower cost.

viii. Annual calibration of tipping-bucket rain gauges and meteorological sensors is essential. Swapping calibrated and cleaned spares in the field for dirty rain gauges that are in need of calibration is good practice. Without calibration on an annual basis drift will increase measurement error.

ix. Gaps in the instrumental record must be minimized. Procurement of high-quality instrumentation that can withstand the rigors of long-term deployment and harsh environmental conditions is important. Sometimes the most convenient equipment is not the most reliable or durable equipment.

x. Security of instrumentation is a concern. Private sector interests such as hotels/resorts, plantations, mines, and telecommunications companies can provide valuable data. Telecommunications companies often have secure facilities on hilltops. Perhaps siting regulations could be altered to allow government access for installation and maintenance of hydrometeorological equipment. Concrete instrument shelters should be constructed at long term historical monitoring sites that are not located in secure sites.

xi. Hydrometeorological data management is an important gap. The current state of the hydrometeorological data base is minimal. While there exist a number of vendors that sell database software, this software is often proprietary and requires an expensive commercial database engine (e.g. Oracle). There are a host of open-source alternatives (mySQL, PostgresSQL). The Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) in the United States has developed a hydrological database known as Hydrologic Information System (HIS). See http://his.cuahsi.org and http://www.cuahsi.org/HydroShare.aspx for more details on this set of tools, which is free and sustained by a significant user's community.

xii. Training on database operations and web dissemination of data using open source tools will help move agencies along a sustainable path.

xiii. Basic data should be disseminated to the public free of charge on-line. Data products that involve analysis above and beyond quality assurance/quality control such as synthesis, statistical analysis, modeling, etc., should be reimbursable at all agencies. Cost recovery for these activities will allow sustainable staffing and help maintain technical capabilities.

xiv. Data backups using cloud computer services provided by reputable vendors is a cost-effective approach for insuring data permanence. Similarly, basic data should be regularly transferred to outside agencies such as WMO or the U.S. National Climatic Data Center for archival storage.

xv. Training by equipment vendors on instrument setup and maintenance is required, and should be a component of any request for quotation.

The assessment under the DVRP project recommended that Meteorological instruments be sited, to the extent possible by terrain, according to WMO (2003) Class 1 or Class 2 standards wherever possible. The World Meteorological Organization (WMO) and U.S. Climate Reference Network (USCRN) have general guidelines that classify a site for precipitation gauge siting. This detailed information is available online in publications WMO-No. 8 CIMO Guide (2010) and U.S. Climate Reference Network Site Information Handbook (NOAA/NESDIS 2012). The following summarizes these guidelines:

Class 1 Precipitation Measurement Site:

- Flat horizontal ground with a slope less than 1/3 (an elevation change of 1 unit over a horizontal distance of 3 units) or 19 degrees with no impact from surrounding terrain features (such as mountains, etc.).
- Surrounding trees, shrubbery or other obstacles of a uniform height at a distance equal to or greater than 4 times the height of the precipitation gauge inlet.
- Uniformity for the above purpose means that there is less than a factor of 2 difference in lowest and highest obstacle and an obstacle is defined as material that subtends over at least a 10 degree arc as viewed from the gauge.

Class 2 Precipitation Measurement Site (Site induced measurement error up to 5%):

- Same as Class 1 site except the obstacle is located a distance of at least 2 times the height of the precipitation gauge inlet.

Class 3 Precipitation Measurement Site (Site induced measurement error of 10% to 20%):

- Open land surrounding gauge with a slope less than 1/2 (30 degrees).
- Obstacles are located at a distance of at least 1 times the height of the precipitation gauge inlet.

Class 4 Precipitation Measurement Site (Site induced measurement error over 20%):

- Land surrounding gauge with a slope greater than 1/2 (30 degrees).
- Obstacles are located at a distance of less than 1 times the height of the precipitation gauge inlet.

Class 5 Precipitation Measurement Site (Site induced measurement error over 50%):

- Obstacles overhanging the gauge, such as trees, roof edges, etc.

7.10. Recommendations for Stream Gauging/Monitoring

Under the DVRP project, the Hydrometeorology Technical Working Group was asked to provide a list of desired stream gauging locations. This list was to include the name of the river, approximate coordinates, and a justification. The following were recommended.

7.10.1. DOWASCO Recommended Sites

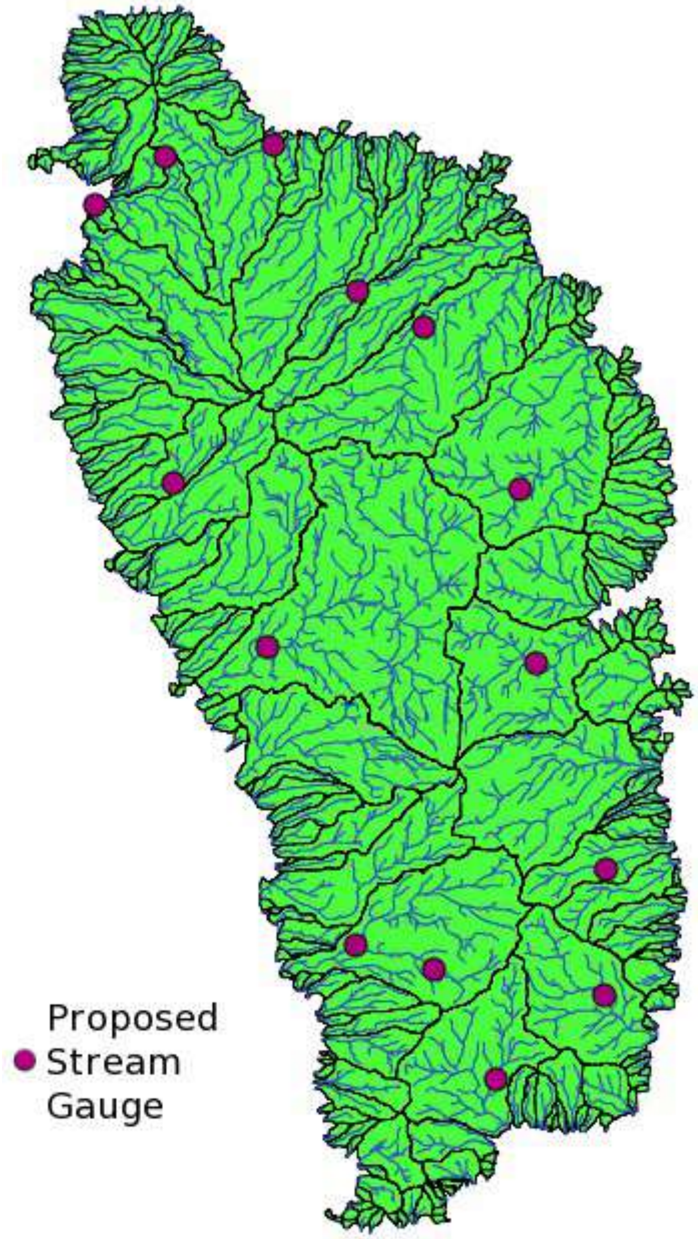
The stream gauging sites proposed by DOWASCO and listed in Table 7.1., and shown in Figure. 7.11.

Table 7.1. DOWASCO Proposed Sites for River Guages

RIVER NAME / COMMUNITY	POTENTIAL INSTALLATION LOCATION	JUSTIFICATION
Demetrie River, Peinville	N15:37'16" W61:25'47"	Water supply
Blenheim River	N15:35'30" W61:23'25"	Bulk Water Export Potential
Hodges River, Calibishie	N15:32'24" W61:21'35"	Water supply, Irrigation
Melville Hall River	N15:31'37" W61:20'11"	Bulk Water Export Potential
Pagua River, Concord	N15:28'10" W61:18'05"	Flood Risk
Fond Figues River, Fond Melle	N15:24'30" W61:17'46"	Irrigation
Ouayaneri River, La Plaine	N15:20'07" W61:16'18"	Water Supply
White River, Delices	N15:17'28" W61:16'21"	Only river originating from Boiling Lake
Pichelin River	N15:15'40" W61:18'42"	Water Supply
River Claire, Giraudel	N15:18'01" W61:20'02"	Water Supply Expansion potential (Water Area 1)
Roseau River	N15:18'33" W61:21'44"	Flood Risk
Layou River	N15:24'51" W61:23'38"	Flood Risk, Dominica's longest river
Coulibistrie River	N15:28'22" W61:25'39"	Water Supply to majority of West Coast
Indian River, Portsmouth	N15:34'15" W61:27'17"	Only river navigable by boat, tourism and ecological interests (mangroves, etc.)

[1]Note: one of the reasons for choosing these rivers is to cover a wide geographical spread of the island and cover different types of watersheds.

Figure 7.11. Stream gauge sites suggested by DOWASCO, corresponding to those in Table 7.1.



7.10.2. Environmental Health Department Recommended Sites

The Environmental Health Department identified the following rivers for stream flow monitoring which will assist in flood prediction and increase recreational safety and enjoyment.

- The Roseau River: transverse the city of Roseau and has a history of overflowing its banks and impacting households and businesses since parts of the city lie directly on the river banks.

- The Layou River: this river has a history of flash flooding which has resulted in the evacuation of almost the entire Layou community. This river accommodates a great amount of aquatic recreation and supports agricultural activities in the upper Layou Valley.

- The Indian River: The deepest river on the island flows though the town of Portsmouth. This river is supplied by a number of tributaries that meander throughout the neighbouring communities. The Indian River is also impacted by the town's waste and storm water. The river supports a number of ecosystems and provides sufficient biomass for migratory birds. Because of its ecological structure the river also provides habitat for reproduction of a large number of animal species and birds. The economic value of the Indian River supporting artisan fishermen and tourism cannot be understated. Because of the location of this river as well as its size it is of particular concern in times of heavy continuous rainfall.

- The Belfast River: (no comments provided).

- The Checkhall River: This river flows through the urban communities of Mahaut and Massacre and during heavy rains can be further filled by runoff from storm drains on the slopes in the communities. The river has a history of flash flooding and was the cause of significant economic loss in recent times.

- The Castle Bruce River: this is an extensive body of water that meanders from the base of Mount Trois Piton. Many agricultural holdings can be observed on its banks as farmers of that community depends on this water for farming. Fishing is also noticeable. Presently Waters from the Castle Bruce River is being used for agricultural irrigation project supplying water to farms miles from its banks. The eco-environmental benefits from this river can be observed in the estuary as it supports both aquatic and terrestrial ecosystems. If this River is to overflow its banks the losses which will be incurred would be considerable both in agricultural losses as well as damage to infrastructure.

- The Castle Comfort River: This body of water flows from the heights of the Roseau Valley it flows through a number a number of communities most of which are agricultural. This River can be classified as medium to large by Dominica's standards and sustains fishing and recreational activities by residents of the area. This River has a history of flooding and has the potential for serious economic losses if there is a major overflow of that river.

- The Loubiere River: This is a small free flowing river flowing through the urban community of Loubiere it is inhabited on both banks. It is impacted by the waste water and storm water of most of the community. The river is also impacted by the Dominica Brewery and Beverage factory which is on the banks of the river.

- The Canefield River: (no comments provided).

The Environmental Health Department also recommends measurements for rivers that serve as the source for drinking water. These were listed by DOWASCO in Table 7.1. with the exception of the Springfield River, which is the primary source of potable water for the capitol.

7.10.3. Dominican Meteorological Service Recommended Sites

The Dominican Meteorological Service could not provide coordinates, and some of the rivers that they recommended are quite small. The primary reasons for recommending monitoring of these streams is flash-flooding and landslides. Appropriate siting for stream gauging locations will depend upon personal inspection of each site as described in Table 7.2., and shown in Figure 7.12.

Table 7.2. Proposed Streams for Placement of Guages Recommended by Met Service

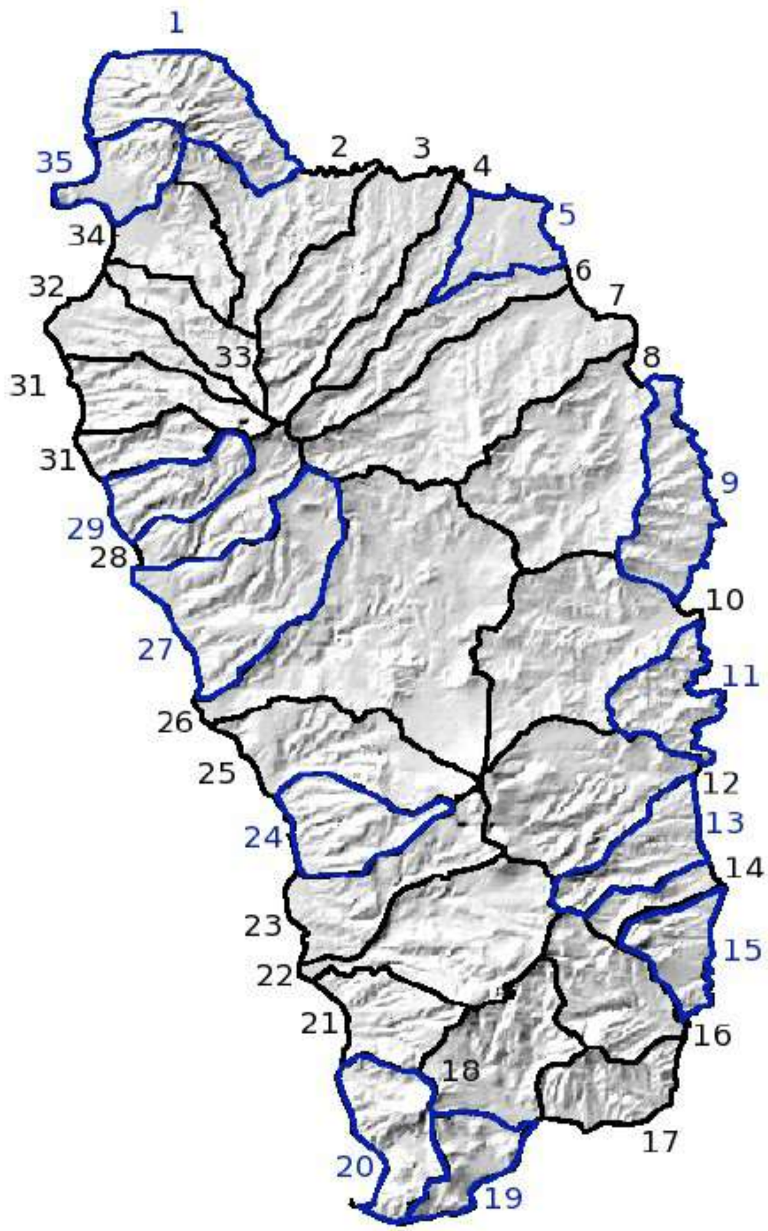
RIVER NAME / COMMUNITY	POTENTIAL INSTALLATION LOCATION	JUSTIFICATION
Mahaut	Above Mahaut town	Flooding and landslides
Checkhall	Above Canefield town	Flooding and landslides
Picard	Above Picard town	Flooding and landslides
Colihaut	Above Colihaut town	Flooding and landslides
Massacre	Not provided (small stream)	Flooding and landslides
St. Joseph	Not provided (small stream)	Flooding and landslides
Campbell	Not provided	Flooding and landslides
Bellevue	Not provided	Flooding and landslides

Figure 7.12. Location of Guages Recommended by Met Services.

7.11. Appropriateness of Stream Gauging Sites

A report was prepared in 2005, through funding by the Australian government, wherein a watershed management strategy was proposed. The report identified the watershed management units shown in Figure 7.13. The watershed boundaries shown in black in Figure 7.13. are watersheds containing rivers that reach the sea at a single point. The watershed unit "complexes" shown with blue boundaries contain a number of small streams, each with its own point of discharge to the sea. The primary distinguishing feature of black watersheds is that they represent convergent topography and a major river or stream, while the blue watershed "complexes" represent divergent topography with numerous small streams.

Figure 7.13. Watershed Management Units



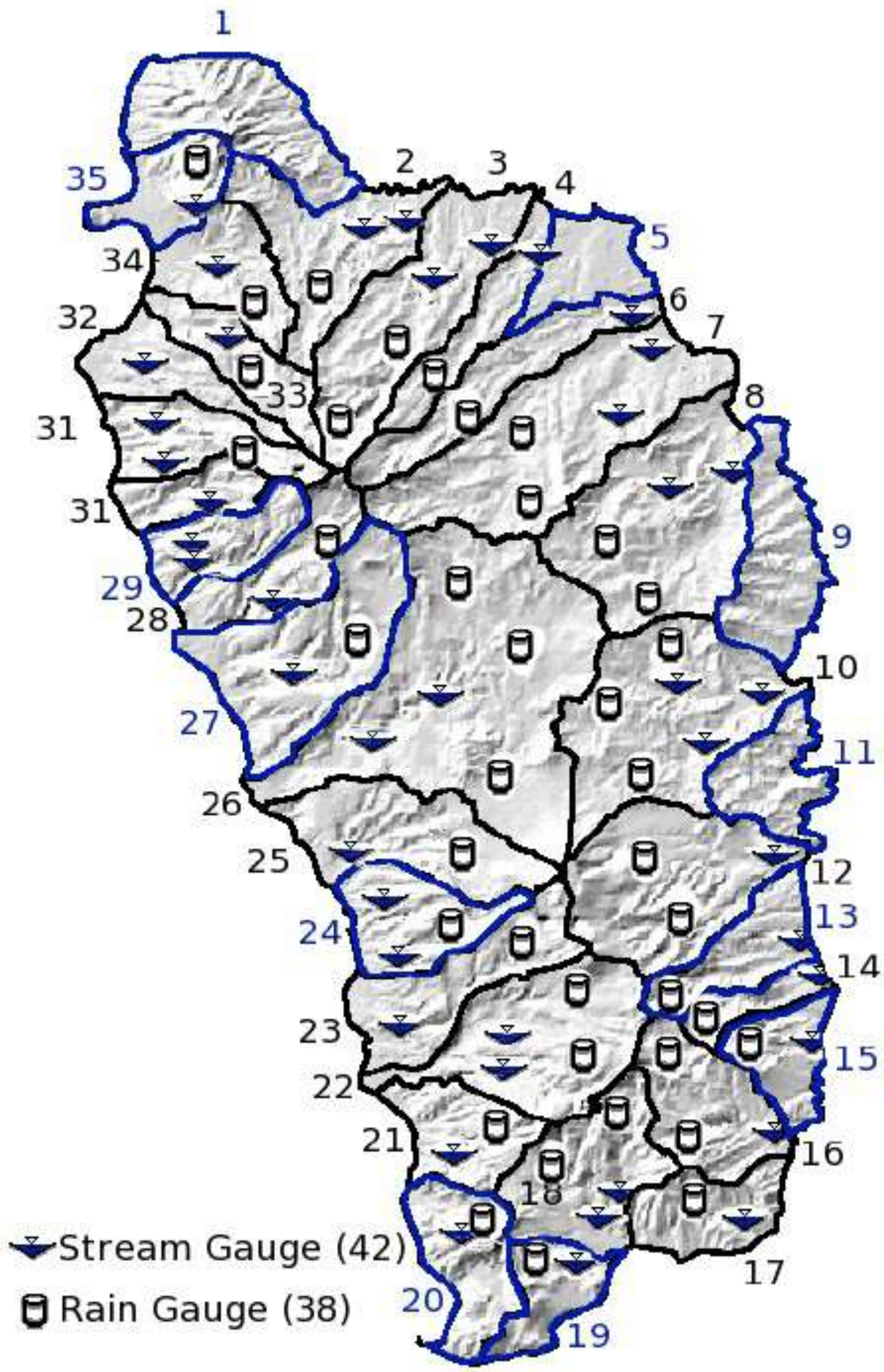
KEY TO WATERSHED MANAGEMENT UNITs
1 Morne Aux Daibles complex
2 Blenheim*
3 Hampstead*
4 Salee
5 Woodford Hill complex
6 Eden
7 Clyde*
8 Pagua*
9 Morne la Source complex
10 Belle Fille
11 Good Hope complex
12 Rosalie
13 Ouayaneri-Morne Jaune complex
14 Sari-Sari
15 Boetica complex
16 Pt. Mulâtre
17 Petite Savanne complex
18 Stewart
19 Grand Bay complex
20 Soufriere-Scotts Head complex
21 Sibouli*
22 Roseau
23 Boeri*
24 Massacre-Mahaut complex
25 Belfast*
26 Layou
27 Macoucheri complex
28 Batali
29 Coulibistri complex
30 Colihaut*
31 Dublanc*
32 Jargie*
33 Picard
34 Indian
35 Cabrits/Douglas Bay complex

(*NOTES: Watershed management unit complexes are an amalgamation of more than one watershed basin. Watershed areas of less than 500 ha were amalgamated to form complexes.*
** Watershed management units dominated by a main drainage basin but amalgamated with a small adjacent basin*)

Under the DVRP project, Figure 7.13. was used as a basis for preliminary design of an island-wide flood warning network. The design is preliminary because the sites selected for rainfall stations and streamflow stations were selected based solely on geometrical considerations. Site access or physical appropriateness were not considered. This preliminary network design is shown in Figure 7.14., and consists of 42 stream gauge and 38 rain gauge locations.

The DVRP evaluation concluded that Figure 7.14. provides an example of a thorough network that covers most of the Commonwealth, as if each drainage basin of appreciable size is worthy of installation of a flash-flood warning system. According to the prioritised lists provided in Tables 7.1. and 7.2., this is not the case. However, this preliminary design provides a realistic point of consideration, and supports the notion that the recommended number of stations is realistic.

Figure 7.14. Large, island-wide flash flood warning network, shown as built-out example (preliminary).



Selection of desirable stream gauging stations depends on a number of factors. Included in these are: (1) cost risk of adverse consequences due to low/high flow in terms of loss of life, damage to property, adverse environmental impacts on habitat or water quality; (2) ability to establish a stage-discharge relationship with certainty; (3) ability to transmit data from the site; (4) flood wave travel time from the gauging site to the location where a flashflood warning is desired; and (5) site access for routine maintenance and flow measurements.

These five considerations are essentially equally important. The potential stream monitoring sites listed in Sections 7.10.1. to 7.10.3. provide a starting point for creation of a prioritized list of sites. The relative importance of each site must be established by thorough consideration of the benefits of gauging at a particular location compared to the risks of a catastrophic event occurring with little or no warning. Ranking these sites is beyond the scope of the study undertaken under the DVRP project. Selection of sites from a hydraulic standpoint will require that project technical staff receive training in site selection from a competent authority or hiring of an expert with considerable experience in stream gauging. Each prospective stream gauging site will require individual assessment using the above five criteria.

7.12. Water Quality Measurements in Association with Stream Gauging

The DVRP project determined that the run-of-the-river nature of public drinking water intakes operated by DOWASCO make the public water supplies in Dominica sensitive to hydrological events. The primary contaminant of concern is turbidity. Public drinking water intakes along rivers are frequently closed during runoff events to minimize the amount of turbid water that enters the potable water supply system.

The equipment budget includes turbidity and electrical conductivity probes. The turbidity probes are intended for connection to stream level stage recorders. These probes shall have integral wipers to automatically clean their optics, and other anti-fouling measures to help ensure long-term operation in the field with maintenance visits once per month. These turbidity probes would be best installed at public water supply intakes together with telemetered stage measurements. Telemetry will allow these turbidity measurements to serve as a real-time warning of increasing water turbidity that can instruct field workers to close intake valves in a timely fashion.

The conductivity probes are a less expensive way to measure water quality. In many instances there is a relationship between total dissolved solids (TDS) and turbidity. Co-installation of these sensors will allow identification of such relationships in Dominican rivers. Widespread installation of conductivity probes will allow creation of a baseline TDS data set for the country.

7.13. Data Archiving, Sharing and Dissemination using Information Technology

The assessment under the DVRP project noted that data sharing is important and in the best interest of the people of Dominica. Data sharing avoids redundancy, enhances information flow, and promotes network reliability and consistency because an increase in the number of regular users results in increased inspection and data quality control. Redundancy is not always bad. However, different agencies collecting identical data at the same point is wasteful and inefficient. If a site is high priority for more than one agency, they should work together to ensure data quality, rather than set up redundant measurements at the same location in the absence of cooperation.

Different agencies have different objectives during routine operations. The quasi-private Dominica Water and Sewer Company Ltd. (DOWASCO), is focused on water supply, and is run using a business model, and they have the budgetary ability to plan for equipment operation independently from other agencies. However, DOWASCO does not at present have the hydrologic and hydraulic expertise to operate hydrological networks and prediction networks that fill the needs of the general public.

The DVRP evaluation recommended that agencies train their staff in the use of open source software tools, and recommended Linux as a powerful operating system with a nearly infinite supply of free open-source software. Databases, web servers, data processing tools, compilers, integrated software development environments, and a host of other tools come with a basic Linux installation.

The DVRP evaluation provided recommendations concerning Hydrometeorological Equipment Purchase Specifications for consideration in the development of the Terms of Reference and Request for Bids for the equipment under the DVRP project. The DVRP project is currently supporting the establishment of the necessary hydrometeorological equipment to facilitate the creation of early warning systems to reduce risks to vulnerable communities affected by flooding and landslides.

Chapter 8: Mainstreaming Climate Change in Development Planning

8.1. Overview

This Chapter provides an overview of ongoing efforts to mainstream climate change considerations into national development planning, and builds upon information on climate change mitigation and adaptation initiatives that have been described in earlier Chapters of the TNC.

8.2. Context

As indicated in earlier chapters, the Commonwealth of Dominica has initiated an array of strategies and undertakings in support of the commitment to mainstream climate change (adaptation and mitigation) into national and sector development planning. These are evident in programmes, projects and initiatives that are mirrored in national development priorities, instituted social and economic programmes, environmental policies and ongoing institutional capacity enhancement.

The obligations entrenched in the UNFCCC and numerous international and regional accords to which Dominica is party, as well as the many principles espoused by the government dictates that appropriate actions should be taken to address, give due consideration to and integrate climate change (adaptation and mitigation) into all developmental planning processes. In a recent address to the United Nations General Assembly (UNGA) in September of 2017, the Prime Minister of the Commonwealth of Dominica captured the mood of the nation following the devastation unleashed by Hurricane Maria (on 18th September 2017), as well as the manner in which the State's "responsiveness" to climate change should be addressed. He highlighted the clear political will of the State with the pronouncement that " *Let these extraordinary events unleash the innovation and creativity of global citizens to spark a new paradigm of green economic development that stabilizes and reverses the consequences of human-induced global warming…………….Let us take serious action against the realities of climate change…"*[11]

Dominica's President, H.E. Charles Savarin in addressing the nation's Parliament almost a year before, on the theme "Building Resilience and Fostering Social Cohesion and Recovery in a Post Erika Reconstruction Period" also validated national sentiment when he noted: ……"*Central to the effort at fostering resilience are considerations of human capital formation, institutional capacity building, as well as technology transfer and adaptation, aspects of which already constitute policy priorities for Government".* [12]

Notwithstanding the foregoing statements and the timing, Dominica's vulnerability to climate change cannot be overstated. It is real and is further exacerbated by the island's present economic performance, its socio-economic structure as well as the location of its major coastal population centres and physical infrastructure, in areas susceptible to flooding and landslides

[11] Prime Minister's address to UN General Assembly, September 2017
[12] Presidents address to Parliament, 2017

among other natural phenomena. The consequences and accompanying stress of climate change places on ecological and socio-economic cannot be understated.

The political will to put in motion mechanisms to address climate change's related manifestations, is clear. However, despite these sentiments articulated from such authoritative voices, implementation does not always follow a logical strategic path, as is evident from key national planning documents.

8.3. Low Carbon Climate Resilient Development Strategy

Dominica's *Low-Carbon Climate Resilient Development Strategy* was developed in 2011 through an extensive consultative process that was supported under the Pilot Program for Climate Resilience (PPCR) funded under the Climate Investment Funds (CIF). As part of the process to develop Dominica's *Low-Carbon Climate Resilient Strategy*, various assessments and studies were undertaken and reviewed with and by national stakeholders to provide the technical foundation for the preparation of the strategy.

According to Dominica's Prime Minister, "the *Low-Carbon Climate-Resilient Development Strategy* will not only serve as the programmatic nexus for capturing conventional and innovative sources of sustainable development and climate financing, but should also assist facilitate Dominica's transformation to a climate-resilient economy while implementing, monitoring and building upon existing low-emission climate-resilient development projects and programmes."[13] In so doing Dominica would have achieved its sustainable development aspirations while meeting critical social development and poverty reduction goals.

The *Low-Carbon Climate-Resilient Development Strategy* aimed at facilitating the country's continued transformation to a green economy while ensuring the survival of its productive and export sectors." This "strategy outlines the government's vision and agreed approach in transforming to a low-carbon climate- resilience development pathway, and summarizes the proposed program for investments, including activities for finance under the Pilot Program for Climate Resilience (PPCR), the Adaptation Fund, and the Global Environment Facility (GEF)."[14]

The document goes on to outline the areas and various facilities where financing, which can be a major hurdle to effective implementation, can be accessed. It goes further to build on several climate resilient and adaptation initiatives (local and regional) and recommendations inclusive of features on energy conservation, renewal energy and the green economy. Most importantly, the document deliberates extensively on mechanisms and entry points for mainstreaming climate change in national development planning. The *Low Carbon Climate Resilient Development Strategy* has been approved by Cabinet and endorsed by the donor community, but it has not been fully implemented.

In laying out the strategic framework in support of climate resilience capacity building and mainstreaming, the Strategy makes a compelling case for appropriate legislation to support

---

[13] Foreword to *Dominica Low Carbon Climate Resilient Development Strategy*
[14] Ibid

effective implementation and mainstreaming. The Strategy highlights that there are substantial gaps and overlap between existing legal mandates for climate change resilience and natural resource management amongst various ministries with resultant confusion over jurisdictional roles – more particularly there is no legal basis to ensure functional coordination and site specific coordination for building climate resilience. Although the SPCR included component activities to support the development and enactment of such legislation, these measures were not undertaken under the DVRP. As such, the government has been obliged to pursue other avenues to assist with the development of this priority legislation, including through support from the Green Climate Fund under the EDA and NAP projects as outlined in Chapter 6.

8.4. Growth and Social Protection Strategy (GSPS)

This document articulates government's overarching strategic framework for pursuing sustainable development (economic growth, environment development, social development) through sound policies geared at improving the quality of life of all Dominicans. The 4th mid-term *Growth and Social Protection Strategy* (GSPS) 2014 – 2018 seeks to pursue 'a broad medium-term strategic framework for sustainable development and economic transformation.'[15]

Preceding this fourth edition of the GSPS were the first edition published in April 2006, with updated versions in 2008 and 2012, which were adopted by the Government. A revised version, the 2012 - 2014 edition was tabled at a government led Donor's Conference in December 2011 in Dominica under the theme "Re-doubling the Effort". A relatively wide spectrum of partners of the global donor community were in attendance.

Following this conference, the 3rd GSPS was reviewed and developed into the 4th version which " includes an update of the accomplishments, challenges and lessons learned and creates a revised platform for pivoting the development strategies to respond more directly to the new challenges ……………which continue to dominate the global economic landscape."[16] This document recognized the challenges the country faces in pursuit of its sustainable management practices and the need to "gain access to climate change funding facilities to meet some of its investment needs."[17]

The GSPS 2014 – 2018 asserts that the *Low Carbon Climate Resilient Development Strategy* 2012-2020 provides the framework and strategies for critical investments, and that the Strategy is a key platform supporting Government's GSPS goals and objectives.[18] This synergy between national development planning and the key national strategy for climate resilient low carbon development has served to anchor national and sector strategies since 2012 when the *Low Carbon Climate Resilient Development Strategy* was adopted by Cabinet. This synergy is an example of the integrated approach to mainstreaming that is seldom found in national developing planning efforts in the Caribbean region.

[15] GSPS 2014 -2018
[16] ibid
[17] ibid
[18] *Dominica Low Carbon Climate Resilient Development Strategy*

8.5. National Resilient Development Strategy (NRDS)

In the aftermath of Hurricane Maria in September 2017, the Government of Dominica embarked upon a process to develop a *National Resilient Development Strategy* (NRDS) which will build upon the existing *Growth and Social Protection Strategy* (GSPS). The NRDS is meant to have broader scope than the GSPS being a derivative of a postulated *Climate Resilient Recovery Plan* which will go on through to 2030. The NRDS and builds upon the framework outlined in the Dominica's *Low Carbon Climate Resilient Development Strategy* (2012 – 2020).

At the end of 2017, another agency, the Climate Resilience Execution Agency of Dominica (CREAD) was launched "to coordinate all reconstruction work to avoid duplication, maximize economies of scale, spot and fill critical gaps, avoid bureaucratic infighting and ensure all reconstruction activities are focused on a single Climate Resilient Recovery Plan". This agency like the NRDS, is in its formative stage and information of their activities are not well articulated at the time of the preparation of this report. It is too early to determine whether their work will actively support mainstreaming of climate change measures, or merely serve to implement a narrow range of disaster recovery measures rather than building adaptive capacity at the national, sector and community level and within civil society.

8.6. Climate Change, Environment and Natural Resource Management Bill.

In light of ongoing reviews over the past 15 years it has been generally concluded that there is need for, as a matter of urgency, a comprehensive climate change, environmental and natural resource management legislation in Dominica. "Save for a few pieces of legislation, present legislation does not meet Dominica's obligations under the 27 Multilateral Environmental Agreements (MEAs) to which the country is a signatory – most notably the agreements dealing with Climate Change…."[19]. The 105 pieces of laws in Dominica meant to govern the environment and natural resource management are outdated and "focus on dealing with a specific problem rather than taking an integrated approach to managing natural resources and the environment in a sustainable manner."[20]

In light of the aforementioned, a new proposed bill has been developed since 2011, namely the *Climate Change, Environment and Natural Resource Management Bill*. It is a result of a series of reviews and consultations along with key presentations to the Cabinet of Ministers, which occurred during 1997, 1998, 2001, 2004, 2011, 2012, 2014, and 2016. This piece of legislation is a single consolidated Bill with broad spectrum mainstreaming in mind, that would implement the 15 key international environmental treaties (rather than 15 individual Bills).

This proposed Bill represents what is at the core of the thrust to mainstream climate change in the development planning processes. In addition to the comprehensive approach to ensuring that various provisions are in place for the proper administration of the environmental sector such as a fully delineated authority as a dedicated minister/ministry, sections of that Bill give rise to an

[19] Green Paper on proposed Dominica *Climate Change, Environment and Natural Resource Management Bill*. (2011)

[20] Ibid.

obligation for the establishment of an authority/agency responsible for coordinating the bill and all its adjuncts, including climate resilience measures.

This Bill makes provisions for mandatory instead of ad-hoc appointment of entities such as:

(1) the *Council on Environment, Climate Change and Development* (section 8) to coordinate government response to climate change (section 14);
(2) the *National Climate Change Committee* (section 30) with mandate to regularly update Climate Change Policy and coordinate commitments under *United Nations Framework Convention on Climate Change* (UNFCCC);
(3) the *National Emergency Planning Organisation Advisory Committee* (section 34) to coordinate government response to natural and man-made disasters;
(4) the *National Emergency Management Office* (section 35) with mandate to coordinate disaster contingency planning and management (section 36).

This proposed piece of legislation makes no attempt to minimize or exclude any authority but rather builds concrete inclusiveness to augment provisions of other pieces of environmental legislation which may be lacking. This is referenced as follows:

Part V, Section 39 – 44 under the caption: Climate Change and Environmental Impact Assessment;

> "*Purpose*
> *39. The purpose of this Part is to establish the policy, legal and institutional framework to facilitate the integration of climate change adaptation and mitigation into the environmental impact assessment process in keeping with commitments under the United Nations Framework Convention on Climate Change.*
>
> *"Non-Derogation*
> *40. The provisions of this Part are in addition to and do not derogate from the provisions of the Physical Planning Act 5/2002 and Regulations thereunder.*
>
> *"Definitions*
> *41. In this Part, unless the contrary intention appears -*
> *"Authority" means the Physical Planning and Development Authority established under section 4 of the Physical Planning Act 5/2002*;"

In making Dominica the first "climate resilient" country as committed by Prime Minister Roosevelt Skerrit following the devastations of Hurricane Maria and Tropical Storm Erika, the ***enactment of comprehensive environmental legislation to build climate resilience***, is unequivocally one such measure.

Provisions in this Bill clearly demonstrate the synchrony that will persist in the management of environmental matters and climate change whereby it empowers appropriate authorities irrespective of what sector of the government one belongs. The Bill vividly depicts what mainstreaming is meant to effect. History has proven that there has been no success in coordinated approach to management without the appropriate laws, particularly where management has been by neglect. Up to this point the Bill is awaiting the Cabinet of Ministers approval to be enacted.

8.7. Mainstreaming at the Sector Level

The Post Disaster Needs Assessment (PDNA) report (December 2017) from the World Bank, UNDP and European Union that was prepared following the passage of Hurricane Maria reflects the challenges facing rebuilding Dominica in the bid to build back better and stronger. The report highlights adaptation deficiencies and the absence of comprehensive measures to mainstream climate change risk management within various sectors in the pre-hurricane era. Without exception, sectors such as Agriculture, Fisheries, Tourism, Water, Forestry, Disaster Preparedness, Works, Lands, Environment, and Public Health all face major constraints to mainstreaming climate change risk management is a cohesive and strategic manner. Among the major challenges that negate mainstreaming of climate change risk management in the development planning processes is the lack of cross sectoral dialogue because of poorly structured administrative entities which is a derivative of inept institutional capacity – a legacy of the colonial era. Consequently, many opportunities that seek to implement provisions of various conventions meant for the advancement of developing countries like Dominica have been allowed to go by unheeded.

In the wake of the recovery process that Dominica is facing post hurricane Maria, every effort is being made to ensure that mistakes, shortcomings and deficiencies of the past are lessons which guide the recovery process along the path to a climate resilient Dominica. Only by working steadfastly towards mainstreaming of climate change risk management in sector development planning can Dominica be better prepared for any onslaught from extreme events in the future. By building resilience to current incidents of extreme events, Dominica will be better placed in the future to address vulnerability and ongoing risks from climate change.

8.8. Mitigation Mainstreaming

Under similar caption in the *Second National Communication* (SNC), the following was stated: "the Government's objectives for the energy sector among other things highlights minimizing of the cost of energy, diversify energy sources, reduce the reliance on fossil fuels, and conserve energy, while at the same time, reducing emissions of Greenhouse gases. The short term goal is to have at least 25% of all electricity generated in Dominica from renewable sources by the year 2010, while encouraging and promoting the need for energy efficiency and energy security."[21]

In Dominica's *Intended Nationally Determined Contribution* (INDC) submitted in 2015, the following policy objective is stated:

> "*the Government of Dominica in seeking to reduce the increasing costs of electricity generation and ensure a cleaner, more environmentally friendly energy source is aggressively exploring the possibilities of alternative energy. While hydroelectric generation does occur (contributing up to ~ 38% of electricity generation), and Dominica*

[21] SNC on Climate Change 2012

> *has considerable additional potential, hydro-power development is severely affected by changing precipitation patterns association with climate change*."
>
> "*Dominica, being a volcanic island has tremendous potential for geothermal energy. Site assessments, and feasibility studies have been carried out that indicate that the energy capacity in the Roseau Valley Geothermal Resource area is at least 300 MW. The current production capacity based on wells already drilled is approximately 10 MW. Further generation capacity can be added with the drilling of additional production wells as assessed and necessary. A limited amount of solar and wind energy is used in Dominica, mainly at the residential and commercial levels for both water heating and electricity production. It is hoped that hydro, solar, wind, wave and biomass as alternative energy sources, will eventually be considered on a commercial scale*."[22]

The policy of government to reduce dependency of fossil fuel and to remain in the realm of a carbon neutral country is linked to the harnessing of the potential of geothermal, hydro-power and solar energy while at the same time managing forests to ensure that they continue as carbon sinks. Government's latest immediate forecast is to develop a 7 MW geothermal plant (7MW gross, 6.4MW net) facility to generate electricity for local consumption by the year 2020. Drilling of productions wells are in an advance stage and the decision as to features of recommended mechanisms to proceed with the commercialisation of the venture are yet to be publicly articulated.

The development of Dominica's renewable energy sector is guided by several policy documents and initiatives, among them being the Low *Carbon Climate Resilient Development Strategy* and the *INDC* (under the *Paris Agreement* which guides and informs national investments in sustainable energy and climate change mitigation/adaptation measures), the *National Energy Policy*, and the *Sustainable Energy Plan*. These initiatives have been supported by a number of technical surveys and reports and the recent establishment of the Dominica Geothermal Development Company (DGDC) Limited, a special purpose vehicle established by the Government of the Commonwealth of Dominica to lead all activities relating to geothermal exploration in Dominica.

The Dominica Electricity Company (DOMLEC) the local provider of electricity, supplies Dominica's power generated from hydro-electricity and fossil fuel. This company's facilities were severely impacted by the passage of Hurricane Maria. In its efforts to build back better, "DOMLEC in partnership with the Government of the Commonwealth of Dominica (GoCD), plans to build back a national electricity system that is more reliable, more efficient, contains more renewable sources, and above all, is more resilient in the face of climate change challenges."[23]

The volume of loss as a result of the hurricane has adversely affected DOMLEC and the Government has had to commit to secure funding to assist with the recovery of electrical services, recognizing that the costs of restoring the power systems are estimated between US$40-

---

[22] Dominica's INDC 2014
[23] DOMLEC Building Back Better (December 2017)

60M. Government's intervention is meant to reduce the burden of recovery cost on the consumers that would otherwise cause DOMLEC to raise rates. The support by the Government is envisioned to seize the opportunity of the disaster to rebuild a greener and more resilient power system as articulated in Dominica's *Low Carbon Climate Resilient Development Strategy* and *Nationally Determined Contribution* under the *Paris Agreement*, to reduce the cost of power to customers, and to adapt to climate change including the impacts of increased incidents of extreme weather events.

The Government and DOMLEC will establish a partnership agreement, subject to approval from the Independent Regulatory Commission (IRC), to jointly mobilize resources (grants, concessional financing and in kind support from governments and organizations) and activities in support of the following objectives, among others:

> *"…… restoring electrical power to all consumers; reducing and stabilizing the cost of electricity for consumers, including the use of donor funding for the transition to renewable distributed energy; maximizing the use of affordable renewable energy solutions including geothermal energy; establishing the renewable energy micro-grids; improving climate change resilience of the power system to enable future restorations, including undergrounding, and energy storage enabled distributed grid systems…*"[24]

In efforts to mainstream climate change mitigation measures, it is apparent that strategies and policies have, over the years, provided little meaning momentum. The total collapse of the electrical supply system after Hurricane Maria resulting in a forced re-structuring of vulnerable transmission and distribution (T&D) systems in support of off-grid and micro-grid renewable energy systems has been far more instrumental in moving Dominica along the renewable energy path outlined in the *Low Carbon Climate Resilient Development Strategy* and *Nationally Determined Contribution.*

8.9. Mainstreaming activities relating to climate change education, training and public awareness

Although the ECU does not have a specific budget allocation to support climate change education, training and public awareness, a number of such activities have been undertaken during the reporting period. These initiatives were largely supported under individual projects.

8.9.1. Survey of Knowledge Attitudes and Practices (KAP) towards climate change

A survey of Knowledge Attitudes and Practices (KAP) towards climate change was carried out during the period June 2012 to June 2013, in six Participating Member States of the Organization of Eastern Caribbean States (OECS). The KAP survey was part of a series of initiatives undertaken under the project titled, "Reducing the Risks to Human and Natural Assets Resulting from Climate Change (RRACC)," which was implemented by the Organization of Eastern Caribbean States (OECS) Secretariat, in partnership with the United States Agency for International Development (USAID). The six Participating Member States were:

- Antigua and Barbuda;

[24] Draft Partnership Agreement between GoCD &.DOMLEC (December 2017)

- Dominica;
- Grenada;
- Saint Kitts and Nevis;
- Saint Lucia; and
- Saint Vincent and the Grenadines.

Two surveys were conducted concurrently in each Participating Member States: one targeted households (one respondent per household) and the other targeted staff at institutions that work in climate-related sectors.

The structured questionnaire for the household survey collected data on:

- Residents' perceptions of climate change in relation to other problems;
- Residents' perceptions of the seriousness of climate change;
- The extent to which residents feel informed about climate change – its causes, consequences and ways of fighting it;
- Residents' attitudes towards energy conservation;
- Whether residents feel that climate change is stoppable or has been exaggerated, and what organizations in their country, including government agencies, are doing in relation to climate change;
- Whether residents have taken personal action to fight climate change; and
- What residents think should be done to deal with the consequences of climate change.

The information collected from staff at organizations in climate-related sectors sought to gather the views and opinions of the staff members themselves rather than being representative of the agency or department. The structured instrument for the institutional survey collected data on:

- Staff perception - whether their work is directly related to climate change;
- Whether staff think that they are informed about the causes, consequences and ways of dealing with climate change;
- Perceptions of staff about the financial and other adverse consequences of climate change; and
- Current actions being taken by organizations to conserve energy and recycle waste.

A self-administered online survey was made available to decision-makers and members of staff in all relevant government departments, as well as relevant nongovernmental organizations (NGOs) and community-based organizations (CBOs), so as to cover as wide a grouping as possible. This web-based survey required the respondents to have internet access: this was not a significant problem in offices in the OECS countries.

Key findings from the Household Survey in Dominica are as follows:

1. households participating in the survey had good access to information and technology;
2. the use of solar water heaters in the OECS was notably low - the proportion of households with solar heaters in Dominica, Grenada, Saint Kitts and Nevis and Saint Vincent and the Grenadines was less than the OECS average of 6.5 percent;
3. 9.2 percent of households had water tanks compared to Saint Lucia, another water-rich country, where a little over 36 percent of households had water tanks;
4. responses concerning the most serious issue facing the Caribbean today listed unemployment (39%), crime and violence (23%), poverty (13.1%), with health and

disease (6.5%), the global economic downturn (5.6%) and corruption (4.6%) among the other responses - less than 2 percent of all respondents listed climate change as the most serious issue facing the Caribbean while the level of respondent's perception of the seriousness of climate change was higher when they perceived their communities were susceptible to natural disasters;

5. respondents in Dominica had the lowest level of awareness of changing weather patterns (20.0% of respondents had not heard that weather patterns were changing), while awareness in Grenada was highest (89.0%), followed by Saint Kitts and Nevis (87.5%) - young persons (15-24) and older persons (55+) were less likely than persons of other age groups to have heard about the changing climate, while more educated persons were significantly more likely to have heard about the changing climate than their less educated counterparts;
6. most persons (reported having experienced changes in rain patterns and in temperature (hotter days and nights), while about 17.2 percent of respondents had experienced or noticed that storms/ hurricanes were either more frequent or were stronger;
7. most persons (86.5%) had at least heard mention of the term 'climate change', although the awareness level varied significantly by country, with lows of 80.5 percent in Saint Lucia and 80.0 percent in Dominica and highs of 91.7 in Antigua and Barbuda and 90.2 in Saint Kitts and Nevis - respondents with a high level of education were more likely than their less educated counterparts to have heard mention of the term 'climate change';
8. most respondents, irrespective of country or sex, had heard about climate change either on the radio or on television, while younger persons were more likely than persons 55 years and older to have heard about climate change on the internet, in school or in a movie;
9. of those who indicated having used the Internet to source information on climate change, most reported no difficulties in accessing and using information on climate change from the Internet -however, a significant proportion of respondents reported that the information was either too technical/difficult to understand (21%) or that poor internet connectivity (9.0%) affected their searches;
10. respondents in Dominica and Saint Kitts and Nevis were more likely than in any other country to support the view that persons working in climate change were making a big deal over nothing;
11. 35.8% of respondents shared the perception that Caribbean countries were not responsible for causing climate change;
12. 58% of respondents disagreed with the proposal that "We are way too small to do anything about climate change" while 52.6% strongly disagree with the suggestion that "we can fix the damage to the environment with technology";
13. 49.3% of respondents indicated that they need more information about climate change, with only a small percentage indicating that they had information about the causes (14%) and effects (18%) of climate change – with the degree to which respondents felt informed about the consequences of climate change being inversely related to their age with the group of older respondents (aged 55+) feeling significantly less informed than younger counterparts;
14. 35.7% of respondents felt that they were not at all informed about what can be done to reduce the effects of climate change;

15. 56% of respondents felt that climate change is just "natural changes" or "acts of God", while 37% believed it was caused by the burning of fossil fuels;
16. one third of all respondents (33.1%) claimed to have taken personal measures to guard against the impacts from climate change, while 66.9 percent indicated they have taken no measures, with "Taking personal action" being significantly more common among respondents with higher levels of education and in higher wealth brackets;
17. in regards to action taken to protect against the impacts of climate change, actions included purchasing torch lights (59.8%), cleaning drains (42.8%), cutting trees and branches (53.5%), strengthening roofs (44%), stocking canned foods (37.5%), installation of hurricane shelters (18.7%) – only 7.5% purchased house insurance as a risk management measure;
18. residents generally claimed to employ a wide range of energy conservation actions - most respondents indicated that they turn off lights when not in use (92.2 0%); use energy saving light bulbs (85.8%); switch off standby devices (71.5%), re-use or recycle waste whenever possible (58.9.5%), use public transport (60.7%), use energy saving appliances (46.8%), use solar water heaters(8.8%);
19. respondents indicated they would most likely seek the assistance of either their family (22.4%); the government (21.5%); or a bank loan (18.1%) to pay the costs of climate change risks management measures.

Key findings from institutions that work in the area of climate change were as follows:

1. over half of all institutional respondents (54.0%) indicated having some knowledge of how climate change will affect their organizations – with Saint Lucia and Dominica being the only Member States to have more workers claiming to be knowledgeable about the issue than not;
2. 55 percent of all workers think that climate change will have negative financial consequences for their organizations;
3. 39.1 percent of all institutional respondents said that their organizations started incorporating climate change impacts into planning for future activities, while 33.2 percent of all workers did not know whether or not their organizations had begun implementing changes;
4. the majority of all workers indicated that their country was not prepared to handle the impacts of climate change (70.7%);
5. only 16.7 percent of respondents felt that the government was doing anything to deal with the effects of climate change – with some of the responses including increased disaster preparedness and awareness events, increased insurance, and increases in Government expenditure to protect the environment;
6. most persons (75.6%) said that government should provide more information/increase public awareness on the issue, replant trees/introduce reforestation programme (56.7%); undertake regular maintenance of roads/bridges (55.5%); improve waste/garbage collection (52.0%); promote rainwater harvesting and the wise use of water (44.4%); updatte/enforce relevant legislation (41.1%); and conduct more research (36.9%);
7. 69.4% indicated that more information is needed concerning what action government is taking to address the impacts from climate change;
8. institutional respondents received the most information about climate change from the Internet (26.6%), mass media (24.8%), print media (15.7%), Schools/Universities (5.6%), conversations with friends and family (5.3%), and community meetings (1.3%).

The report on the KAP survey made the following commentary and recommendations:

1. The reality is that social issues preoccupy the minds of the population – unemployment, crime and violence and poverty. Climate change is relatively low on their scale of critical issues generally. It would be important to show the link between current social and environmental issues and climate change.

2. There should be a component of the public education programme which targets persons working in sectors that would be hard hit by climate change. At present, there seemed to be the perception that climate change is an environmental issue. However, it is critical for the population to understand the far reaching potential of climate change to impact Caribbean societies.

3. Age, level of education and socio-economic status are intervening variables in the level of concern about climate change. While the whole population should be targeted, special efforts should be used to pitch the messages of climate change to women, persons with low educational levels and the elderly in the public education programme.

4. Information on the use of the electronic media in reaching the population provides useful leads in most of the countries. Popular local television channels and radio stations, particularly during the morning commute, as well as the involvement of popular radio and TV personalities are a conduit to be explored in bringing information to the population.

5. In improving awareness of issues relating to the environment, it will be necessary to develop a strategy for lower socio-economic groups in the OECS. The radio may be the most efficacious medium in that regard, but the message has to be configured for a clientele largely engaged in commuting to and from work.

6. Internet use is increasing, and through information centres can be accessible to the general public. It should be remembered however that 1 in 5 persons considers that the climate change information found online is too technical and therefore the education materials (both online and offline materials) should be simple and relate to the everyday lives of individual learners.

7. Cellular phones have penetrated the OECS market and are now in widespread use. Smart phones are gaining in popularity. It may be possible among OECS countries for cellular phones to be used in getting targeted messages to the population. Mobile app technologies can also be used to tailor specific messages to the younger population. The Governments can make the availability of free messaging about climate change and other important environmental concerns, a condition for the granting of telecommunications licences.

8. A similar public interest principle can be made to apply to radio stations, and the providers of local television and cable services.

9. Morning radio shows can be used in the first instance as a conduit to inform the population on the commute, without compromising the need to be engaging.

10. Almost 25 percent of the population never listens to the radio, and a significant share does not read newspapers. These populations will have to be closely studied in order for development of a media campaign that will also reach them.

11. Given that television is the second most popular mass medium, it will be important to involve favourite television personalities and channels in bringing the message of climate change across. The survey results do provide some insight into viewer's preferences that can be incorporated into the campaign.

12. Participatory methodologies have proven to be very effective in bringing messages across to targeted segments of the Caribbean population. It is vital to explore and research the use of such methodologies in the OECS PMS.

The results of the KAP survey will inform the development of a regional awareness strategy and action plan for improving public awareness and education on the predicted impacts of climate change and on the importance of implementing measures for adaptation and resilience in the OECS. The KAP survey undertaken in 2012 served to establish a baseline in Dominica concerning public awareness, education and perceptions concerning climate change, with a follow-up survey being scheduled by the OECS in 2018 to monitor, determine and report on any changes.

8.9.2. Supporting Sustainable Ecosystem by Strengthening the Effectiveness of Dominica's Protected Area System (SSE) Project Training Programme as it relates to Climate Change

The SSE project aims to fulfil the mandate within the *National Parks and Protected Areas Act* No. 16 of 1975, amended by subsequent Acts relating to a Protected Area (PA) management system in Dominica. Systematic and site management of the PAs in Dominica is poor and the revenue generation potential is not maximized. Hence the PA is undercapitalized, and local and global benefits are at risk. More specifically, the SSE Project will develop a PA management system, build Dominica's capacity at the systemic and community level to effectively manage PAs and their buffer zones with emphasis on the UNESCO World Heritage Site (WHS), the Morne Trois Pitons National Park and its buffer zone to improve management effectiveness, create livelihood activities and improve biodiversity conservation in the wake of climate change.

In this context, the implementing agency, the Environmental Coordinating Unit (ECU) through the executing agency of the SSE Project, UNDP with GEF incremental support secured the services of three consultants in part to fulfil the mandate aforementioned. Training of Forest managers and frontline staff as well as communities surrounding the WHS was one component of the project. The training was initially carded at the end of 2017, but this was halted following the passage of Hurricane Maria that devastated the entire island on September 18, 2017. This resulted in the execution of the training post hurricane from April to June 2018, while the project refocused on priority needs to address community livelihoods that are climate resilient shortly following the hurricane towards end 2017 into 2018.

The training programme was synchronized by the three consultants to ensure that all angles were taken into consideration inclusive of climate change by means of delivering theoretical and practical sessions where relevant. Training to Forestry | National Parks staff included: PA Planning Methods; Tools & Processes for the Preparation of a PA Management Plan; How to Implement, Monitor and Review Management Plans for PAs; Research and Monitoring; Organizational Management & Leadership; Site Operations & Management; Visitor Management; Financial Management; Enforcement; and Fire Management.

Training delivered to community members including offenders surrounding the WHS included: Natural Resource Management; Ecosystem Conservation and Management focused on increasing information of threatened and species within the PA Monitoring; Co-management; Gender Equity; Communications; Community Empowerment, Outreach and Dispute Resolution. The two consultants held the training jointly for one day given the fatigue of communities from other demands, responsibilities and trauma post hurricane. There were 18 participants representing farmers, community groups, Village Councils, community development groups including tourism, agriculture and conservation, the Dominica Organic Agriculture Movement and the Global Environment Facility Small Grants Programme.

Supporting training material were provided to the participants for their reference and future use in their work and livelihood practices. The material included every component of the training, inclusive of content, handouts, activities conducted and proposed for use in daily operations, as well as responses from the management team who participated on some of the activities executed. Additional reference information on some topics was also included in the training material.

Of note, development of the manual did not only entail conducting research online and a desk review. It also included holding meetings with the various department officers in finance, national parks, surveillance, education and others to inform of current issues, past examples and proposed plans, so that they could be incorporated in the training with a view to improve and apply them in the work place with immediate effect to build capacity and improve the management of PAs through pragmatic means that address issues such as climate change and invasive species.

8.10. Mainstreaming Constraints, Gaps, and Related Financial, Technical and Capacity Needs

8.10.1. Macroeconomic Situation

Within recent times, two extreme weather events conditioned Dominica's macroeconomic profile. In 2015 Tropical Storm Erica visited the shores of Dominica bringing an estimated damage of 96% of gross domestic product (GDP). This amounted to a 9.7% of GDP decline from the previous year. In 2017 Hurricane Maria accounted for damage to the tune of 226% of GDP which amounted to a 14.7% decline in GDP. Together these two extreme events devastated the economic sector and the public infrastructure of the country. The reconstruction costs were estimated at US$1.3 billion and it was estimated that Dominica will require at least five (5) years to recover with negative growth expected over much of that period.

A marked deterioration of the country's fiscal situation was evident with a decline in export earnings, a decline in tax revenues, and unsustainable debt. Dominica was declared as high risk for debt stress as central government debt soared to 88% of GDP and external debt soared to 99.6% of GDP. The fiscal situation exacerbated weaknesses in the financial sector which was characterized by under capitalization, low productivity, high levels of underperforming loans and the looming impact of de-risking and black-listing.

Dominica thus faced a flight of investment capital and stymied foreign direct investments due to perceived increased investments risk. A case in point; the decision made by Ross University to relocate its services to Barbados in the wake of the destruction caused by Hurricane Maria. This single decision was a significant blow to Dominica's private sector and potential foreign investors indeed received a very negative investment signal. Thus, in the wait of Hurricane Maria, the Dominica private sector can best be described as decimated.

Another important consideration for Dominica's macro-economic reality was the demise of the Petrocaribe arrangement following political and economic turmoil in Venezuela. Dominica was thus exposed to supply uncertainties and the higher costs of imported fossil fuel to meet its energy needs - despite the country's renewable energy potential - as much of the country's infrastructure lay in ruins. It meant therefore that in addition to being forced to incur further debt for capital infrastructure reconstruction, Dominica was also forced to incur debt for food, fuel, basic necessities and other recurrent expenditure, thereby making the financing of mainstreaming measures an added challenge.

The policy response to this macroeconomic situation was clear. Dominica vowed to become the world's first climate resilient country through a comprehensive program to "Build Back Better" as stated by the Island's Prime Minister. A Climate Resilient Executive Agency, a Policy Advisory Board and a Public Private Sector Investment Committee were created to oversee the resilience building process.

The cornerstone of the rebuilding process included several aspects as follows: grant based reconstruction resources from a range of donors; insurance facilities and bilateral arrangements; debt reconstruction including debt forgiveness; strengthening of the citizen by investments programs; investment in climate resilient infrastructure; investment in critical social infrastructure; cost effective fiscal policies and reform; expenditure controls; controls on extending external debt; diaspora engagement and establishing legal and regulatory frameworks to address the threats, causes and consequences of climate change.

8.10.2. Socio-economic Situation

Social infrastructure and services were not spared the devastation from the extreme weather events. Several deaths were recorded and significant damage to education, health, housing and

Dominica's entire social fabric. The destruction exacerbated the already high poverty rates and unemployment rates and significantly reduced the income earning potential.

In the wake of Hurricane Maria, it was estimated that in excess of twenty thousand persons migrated from Dominica taking with them the skills and expertise necessary for reconstruction. It was also revealed that with the migration of Dominicans there was an influx of Haitians and other foreign nationals which has the potential to create other social problems. The inflow of labor from Haiti and elsewhere was seen by many as a potential area of concern for long term social stability. Many called for an aggressive diaspora engagement policy to encourage citizens of Dominica to return to the country.

The recurrence of severe weather events on Dominica due to climate change and the impact of natural disasters call for measures to strengthen disaster recovery and response, and to build climate resilience systems. Investments in the natural and built environment were seen as an imperative. There was undisputed high political will to invest in resilience social infrastructure. Further, the abundance of natural capital in Dominica was also undisputed and was indeed seen as a basis for recovery.

It was revealed that the past disaster needs assessments did not take into considerations social costs and damage to the natural environment and the loss of ecosystems services. There is a growing recognition that the implementation of the Sustainable Development Goals is a beacon for social recovery of Dominica.

Dominica was seen as a caring society and coupled with the international goodwill in the face of its vulnerability, Dominica has the political capital to become a climate resilient economy. The old *Nature Island* brand and the new climate smart country branding is seen as entirely complementary, and together constitute a sound platform for mainstreaming efforts aimed at building a climate resilient Dominica.

8.11. International Climate Change Discourse and Impacts on Mainstreaming

The international climate change discourse is now focused on agreeing on the rules for implementation of the *Paris Agreement* including the mitigation ambition goal of limiting global warning to well below two degrees Celsius and to pursue efforts to limit global warming to below one point five degrees Celsius.

Dominica's vulnerability rests heavily on the global green house gas mitigation ambition. Given that currently global temperatures have risen by about one degree Celsius since the pre-industrial era and that the country now experiences devastating climate change related impacts, the thought of higher temperatures indeed suggests future devastating impacts unless significant investments are made in building resilience.

The *Paris Agreement* envisages adaptation actions to cope with the impacts of climate change aided by finance, technology and capacity building. The negotiations on these issues are protracted and difficult on account of geopolitical, global economic competitiveness, equity, transparency and beggar-thy-neighbor policy considerations.

For Dominica, climate change amounts to an existential threat to the country and like other Small Island Developing States has called for the recognition of the special circumstances and unique vulnerability of all Small Island Developing States. Dominica has also championed the need for urgent and ambitious mitigation and adaptation actions and adequate and timely means of implementation in particular access to finance, technology and capacity building resources. Building climate resilience in agriculture, forests and oceans are also major areas of focus for Dominica's negotiators.

The issue of loss and damage to extreme events and to slow onset events also remains a priority for Dominica. Dominica's commitment to keeping the issue alive, for calling for further research and filling knowledge and data gaps, for enhanced public education and awareness and for political sensitivity on loss and damage, is an essential strategy.

Reform of the insurance sector is also seen as a key strategy for building resilience in Dominica. Following Hurricane Maria, Dominica received a payout from the Caribbean Catastrophic Risk Insurance Facility (CCRIF). The payout was basically for budgetary support immediately following the event. A more systematic and comprehensive insurance facility geared at disaster risk reduction is warranted. This can begin with reform and recapitalization of the CCRIF but also includes national level insurance reforms and resilience building for risk reduction. Further mechanisms must be in place for the insurance sector to take a greater responsibility and accountability profile, including through the provision of micro-insurance to cover losses by farmers, fisherfolk, small businesses and homeowners.

It was evident that the insurance sector in Dominica was characterized by lack of insurance on critical infrastructure and services, inadequate levels of insurance, and lack of adequate insurance regulations. Many Dominicans were unable to afford high-level insurance premiums and chose instead to take the risk of non-insurance. In some cases, it was noted that several properties were uninsurable due to non-adherence to building codes and standards. The call for reform in the insurance sector to include innovative solutions is another key strategy for building national resilience to climate change. Reinforcing compliance with building codes and standards is of utmost importance.

8.12. Regional Strategy for Climate Resilience and Impacts on Mainstreaming

The regional policy on mainstreaming climate change takes its departure from the *Liliendaal Declaration on Climate Change* agreed by the Heads of Government of the Caribbean Community (CARICOM) in 2009. This declaration was operationalized through the agreed strategy elaborated in 2009 covering the period 2009 to 2015 and the subsequent Implementation Plan covering the period 2012 to 2022.

The regional strategic elements include activities for climate change integration into national development including: the implementation of the Sustainable Development Goals; adaptation actions to reduce regional vulnerabilities; reduced resilience on imported fossil fuels as the primary source of energy; sustainable forest management; ocean governance; accessing climate finance; climate technologies and capacity building for climate resilience; loss and damage and regional cooperation; and integrated approaches to climate resilience.

At the recently concluded CARICOM Heads of Government meeting, the Heads have affirmed their commitment to highlight the special circumstances, unique vulnerabilities and the need for building resilience, the need for urgent mitigation and adaptation actions commensurate with climate change summit, the need for facilitated access to new and additional climate finance, climate technologies and capacity, and the need to advance the work on loss and damage. The Heads of Government committed to put in place the regional infrastructure for identifying and sourcing climate finance, to mainstream climate change in development planning, to address gaps in legislative, regulatory and institutional frameworks, and to enhance national and regional level coordination, collaboration and involvement.

8.13. Adequate Climate Change Financing – Key for Mainstreaming

Dominica, like other SIDS, faces many challenges in accessing climate finance despite the *Addis Ababa Action Agenda on Financing for Development* and despite the SAMOA pathway. The evidence is clear that Overseas Development Assistance (ODA) has been declining and has not reached the agreed levels hence there is a tendency to rationing of ODA funds. The call for new and additional climate finance, while addressed to some extent through the establishment of the Green Climate Fund, has failed to materialized the scale of funds required to address the climate change problem. As it stands at the moment there are serious concerns with the replenishment of the GCF given that the trigger for replenishment following the initial capitalization has been reached.

The Global Environment Facility (GEF) has been replenished but again not at the level required to adequately address the problem. While other multilateral and bilateral climate financing is available, access to these funds may be difficult and problematic and surely requires national level institutional capacity to overcome the barriers to access and deployment.

Two emerging trends in climate finance are the focus on mobilization of national and domestic resources and the substitution of private finance for public finance. These emerging trends pose great concerns for Dominica given the fragile fiscal balance, the flight of capital, and the state of the private sector.

The issue of de-risking and associated non-corresponding banking regulations also amount to a major threat for Dominica. Financial inclusion of small states including Dominica in the global economy is critical to addressing the unique vulnerability to climate change. The current unilateral practice of backlisting of states for not doing enough to combat money laundering and terrorist financing due in part to inherent capacity limitations is counter towards the plan to address the climate financing problem.

Additionally, there is also the issue of eligibility for increasing financing using the per capita income graduation threshold. Dominica, like several SIDS, has been classified as a middle-income country and as such excluded from concessionary development finance. Yet Dominica is mired in the trap of fiscal instability through high fossil fuel import bills, recurring devastating climate change impacts, high reconstruction costs, high debt burden and social instability.

The call for an appropriate vulnerability index as a criterion for accessing climate finance is yet to be addressed although pioneering work in this regard is being done by the Caribbean Development Bank and the United Nations Economic Commission for Latin America and the Caribbean. It is clear that given the unique vulnerability, Dominica can benefit from a representative vulnerability metric as the criterion for accessing concessionary financing.

Dominica can pursue efforts to explore new financing tools to complement traditional sources of finance. References is made here to financing modalities in the *Addis Ababa Action Agenda*, the *Sustainable Development Goals*, climate change financing under the UNFCCC, the SAMOA pathway and the *Hyogo Framework for Disaster Risk Reduction*. Additional financing modalities include multilateral agencies and bilateral agreements including south-south and triangular cooperation.

These frameworks and modalities do have specific characteristics, for example, under the *Hyogo Framework* financing is of voluntary and humanitarian in nature, while under the UNFCCC the argument holds that financial support is a binding obligation on developed countries to finance mitigation and adaptation efforts of developing countries.

Regardless of the outcome of the negotiations, the reality remains that innovative financial instruments are imperatives for addressing the financing gap needed for effective and meaningful mainstreaming. Such innovative financing includes: state contingent instruments; hurricane clauses in sovereign debt instruments; debt for nature swaps; green bonds; blue bonds; blue insurance instruments; risk insurance guarantees; multi-country risk pooling instruments; and crowd funding. A range of technologies including block chain technologies, information and communication technologies, and mobile technologies can be used to underpin these innovative financing instruments.

8.14. Possible Funding Sources for Mainstreaming in Dominica

Given the foregoing review and analysis, the possible funding sources for mainstreaming climate change mitigation and adaptation in Dominica are as follows:

8.14.1. National Level Funding

The national level funding available for mainstreaming climate change mitigation and adaptation in Dominica is severely limited on account of the impact of the recent severe climate change related events. The macro-economic outlook remains weak due to continuing fiscal imbalances. The Dominican private sector has been decimated and there is a flight of investment capital from regional and international investors domiciled in Dominica. As stated before, the decision made by Ross University to relocate its operations to other countries due to in part to perceived increased risks to climate change provided a negative signal to the private sector.

Generally, as it stands for the moment, national level funding is limited to the counterpart funding required to attract external grant funding. In many instances the fiscal space will not be able to accommodate the counterpart funding as there are no primary or secondary surpluses in the annual budgets. Further, given the limited capacity for further borrowing, climate financing will be totally dependent on external grant sources.

8.14.2. Regional Level Funding

The possibilities for regional level funding emanate mainly from regional institutions empowered with mandates for building change resilience. The opportunities for funding through the regional private sector are slim.

Under auspices of the CARICOM Secretariat an initiative was launch on the theme “Building a More Resilient Community.” A pledging conference was held in late 2017 which generated pledges of US$ 1.3 billion in grant funding and US $ 1 billion in loan financing and debt relief. In fact, during that conference Dominica received a US$100K debt forgiveness from Venezuela. A regional resilience fund was established by CARICOM but the modalities for draw down are yet to be determined. Dominica being one of the countries most impacted by the hurricane is expected to benefit from this fund. The estimated recovery costs for the region on account of Hurricane Maria estimated by CARICOM was estimated in the order of $5 billion.

Another possible source for funding on the regional level is through the activities of the Caribbean Community Climate Change Center (5Cs) and the OECS Secretariat which have portfolios of regional and sub-regional climate change resilience projects which can benefit climate adaptation and mitigation projects in Dominica. Through the Caribbean Development Bank (CDB), Dominica can also access funds for climate change related projects. The CDB in collaboration with Inter-American Development Bank (IDB) has announced a multi-million-dollar fund for climate resilience in the Caribbean.

Funding is also possible through the SIDSDOCK initiative which has a portfolio of projects for technological innovations for renewable energy and energy efficiency in the Caribbean. The OECS Secretariat in St. Lucia has also been empowered with capacity to build climate resilience in the OECS sub region.

Dominica should endeavor to take a proactive stance to build the national capacity to access these funds and other regional level climate resilience funds.

8.14.3. International Level Funding

Possible funding sources from the international level are from multilateral agencies like the Green Climate Fund (GCF), the Adaptation Fund (AF), the Global Environment Facility (GEF), the World Bank Climate Investment Fund, Special Climate Change Fund, IRENA and the Commonwealth Secretariat. Whereas each agency has its own modalities for accessing these funds, it is instructive to briefly illustrate the access modalities for the GCF being the primary grant funding source for climate change adaptation and mitigation projects.

GCF funding areas are targeted to reduce Green House Gas (GHG) emissions mainly through renewable energy and energy efficient technologies and to respond to climate challenges by building resilience and reducing climate vulnerabilities and to promote a paradigm shift towards low emission and climate-regional development pathways. The six (6) investment criteria employed are as follows:

- Impact Potential:
- Paradigm Shift:
- Sustainable Development Potential;
- Responsive to Recipients Needs;
- Promote Country Ownership;
- Efficiency and Effectiveness.

Based on the above, the key features for evaluating financing proposals are as the following:

- Multi-faceted basis;
- Cross-cutting results;
- Explicit contribution to SDGs;
- Clear measurable results;
- Sustainability of results;
- Robust technologies and technical/scientific background;
- Innovation in country context;
- Articulated theory of change;
- Gender specific targets;
- Benefits to beneficiaries;
- Demonstrable ownerships;
- Co-financing (domestic, bilateral, other funds, private sector) and use of revenues.

It is now clear that while other funding agencies do not directly specify these evaluation criteria that these criteria do in fact feature in funding decision making. Thus, this requires that the national capacity in Dominica must be built to address these issues.

The GCF has a window of funds to build the capacity in all developing countries to this end. Specific allocations are earmarked for mitigation and for adaptation in SIDS. The GCF has also piloted a simplified approved process (SAP) and enhanced direct access (EDA) entities to facilitate easier access to GCF funds. Dominica stands to benefit at the moment from three regional projects approved by the GCF. Dominica must avail itself to the readily available resources of the GCF for readiness and institutional strengthening. The key national requirements that constitute the basis for evaluation of climate resilience projects are climate relevance, transformational and inclusive approaches, absorptive capacity, country ownership, and strong implementation capacity on the technical, administrative and fundraising level, strategic framework for climate programming consistent with national development programming.

Bilateral funding is also available for Dominica's climate adaptation and mitigation mainstreaming initiatives though North-South, South-South and Triangular cooperation agreements. Many developed countries have pledged to contribute to multilateral as well as bilateral funding for climate change mainstreaming projects. The traditional bi- lateral donors will be encouraged by the resilience building philosophy. New bilateral opportunities for climate resilience financing are also available. Within recent years developing countries like China and India have expanded their reach of climate financing for other developing countries.

As stated earlier, Dominica may not benefit much at the present time from international private sector funding for climate adaptation and mitigation due to perceived increased investment risks. Building resilient systems will be a positive signal and opportunity for private sector engagement. Investments in renewable energy technologies like solar applications and sustainable transportation infrastructure are indeed possible but the business cases for these investments are the major concerns. The GCF is currently considering modalities to enable domestic and international private sector actors to engage in GCF activities in SIDS including adaptation actions on the national level, and including through their private sector window.

However, the current environment in the country amounts to significant barriers for the private sector. The situation is characterized as follows:

- Inability to make the business case for investment;
- Macro-economic and socio-economic realities of the country including impact of climate change exhausted by -
  - capital flight due to increase investments risks;
  - high levels of unemployment, low skills set due to outward mitigation of skills;
  - lack of data to inform decision making;
  - high cost of doing business;
  - lack of incentives for investments;
  - lack of predictability and consistency in policy and regulatory approaches;
  - lack of economics of scale;
  - insufficient capacity due to low income earnings.

Significant investments are required to overcome the barriers to private sector participation in climate mitigation and adaptation planning and to enhance the growth prospects needed to further encourage more private sector participation in the economy.

8.15. Institutional Framework

There are several institutions across the various sectors that perform significant climate change and national resilience building activities. The key agencies are the following:

- Environmental Coordinating Unit;
- National Designated Authority;
- National Direct Access Entities;
- National Designated Entity for Technology Development and Transfer;
- UNFCCC Focal Point;
- IPCC Focal Point;
- Other Relevant Focal points;
- CREAD;
- Policy Advisory Board;
- Public Private Sector Investment Committee;

- GEF Focal Point;
- Adaptation Fund Focal Point.

The institutional framework for the mainstreaming of climate change in Dominica pivots around the Environmental Coordinating Unit (ECU) at the core. There is need for greater collaboration among the national agencies which can be facilitated through a sector based National Climate Change Committee with the specific terms of reference to advance climate change programming based on national priorities. The new institutions established following Hurricane Maria is a step in the right direction. Enhanced collaboration of the various agencies across the country is an imperative. The legal establishment of important institutional structures envisioned under the *Climate Change, Environment and Natural Resource Management Bill* is an important next step to enhancing collaboration.

8.16. National Priorities

The national mainstreaming and climate resilience building priorities for Dominica are connected with that of other Small Island Developing States and are as follows:

- Maintaining the unique vulnerability and special circumstances of Dominica in the global climate change discourse;
- Urgent need for mitigation and adaptation actions commensurate with the science and reflective of the national circumstances including the impact of severe climate related events;
- Facilitated access to grant-based climate finance for adaptation and mitigation and for building resilience;
- Advancement of actions to address loss and damage considering permanent loss, tipping points, slow onset events in the wake climate change events;
- Promotion of capacity building activities and access to appropriate climate technologies;
- Promotion of REDD+ and ocean initiatives as critical components of climate change mitigation.

The *Third National Communication* is anchored in the national legislative and policy frameworks for climate action. The *National Adaptation Policy*, the *Low Carbon Climate Resilient Development Strategy* including the *Nationally Determined Contribution*, are critical to the institutional framework for climate change programming and mainstreaming.

The Environment Coordinating Unit (ECU) and National Designated Authority (NDA) should be empowered to lead the programme of activities to engender national ownership of climate change programming, with projects to facilitate stakeholder involvement, education, public awareness and outreach. The ECU and NDA should serve as the joint focal points to interface with the global community and serve as the national hub to determine the direct access modality for accessing international climate finance agenda the UNFCCC and other sources of international climate finance. A mapping of the climate finance architecture should be carried out by the ECU, endorsed nationally and geared to enhance collaboration, efficiency and effectiveness.

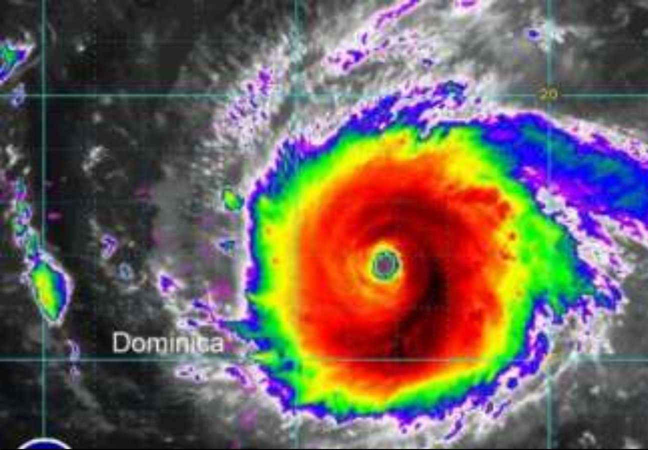
8.17. Conclusion

Dominica is poised to be a beacon for all Small Island Developing States by being the first global climate smart country. Given the political will and the announced policy direction the country has to build the national capacity to access and deploy climate finance to build national resilience to climate impacts while consistent with long term low carbon growth strategy, poverty eradication strategy, and the Sustainable Development Goals. The current macro-economic and socio-economic situation of the country are indeed dire but this can be remedied with sustainable reconstruction activities, prudent macro-economic and fiscal management aided to as large extent by grant financing from the international community to build a climate resilient country.

ANNEX 1

Dominica *National Climate Change Policy and Action Plan* (2019-2024) (Draft)

(See over)



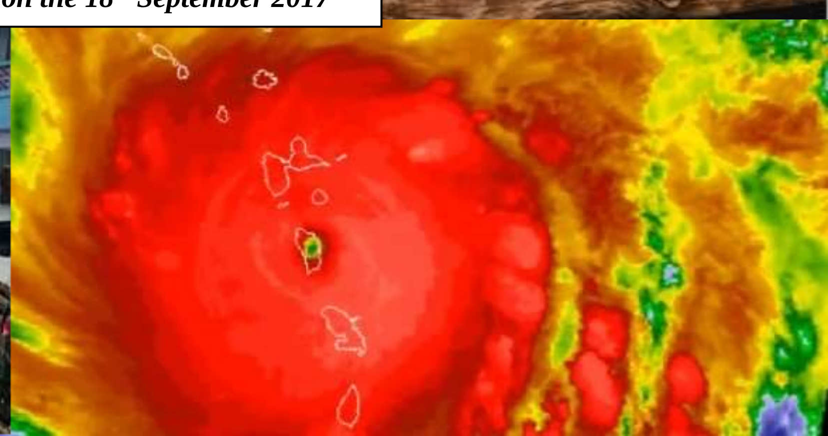
Tropical Storm Erika passing over Dominica 27 August 2015

Special Disaster Areas after Tropical Storm Erika

Douglas Charles Airport after Tropical Storm Erika

NATIONAL CLIMATE CHANGE POLICY AND ACTION PLAN (2019-2024) : BUILDING A CLIMATE RESILIENT DOMINICA WHILE SUSTAINING CARBON NEGATIVE DEVELOPMENT

Devastation after Category 5 Hurricane Maria struck Dominica on the 18th September 2017



Extracts from the address to the United Nations General Assembly on the 23rd September 2017 by the Dominica Prime Minister Roosevelt Skerrit in the aftermath of the devastation caused by Tropical Storm Erika and Hurricane Maria.

I come to you straight from the front line of the war on climate change. With physical and emotional difficulty I have left my bleeding nation to be with you here today because these are the moments for which the United Nations exists!

In the case of Dominica, it has been only 2 years since we lost lives and endured substantial physical and infrastructural damage from the ravages of the floods and mud slides of Tropical Storm Erika.

Mr. President to deny climate change is to procrastinate while the earth sinks; it is to deny a truth we have just lived! It is to mock thousands of my compatriots who in a few hours without a roof over their heads will watch the night descend on Dominica in fear of sudden mud slides…and what the next hurricane may bring.

We as a country and as a region did not start this war against nature! We did not provoke it! The war has come to us!! Mr. President my fellow leaders there is no more time for conversation! There is little time left for action. While the big countries talk, the small island nations suffer. We need action….and we need it NOW!!

We in the Caribbean do not produce greenhouse gases or sulphate aerosols. We do not pollute or overfish our oceans. We have made no contribution to global warming that can move the needle. But yet, we are among the main victims…on the frontline!

In the Commonwealth of Dominica, we have long pursued and respected an existence that preserves our Little Eden. The Morne Trois Pitons has been a national park for 40 years and a UNESCO World Heritage Site for 20. Our livelihoods are part of our ecosystem. This is how my people and my country earn and survive! But what is our reality at this moment? Pure Devastation!!…as Dominicans bear the brunt of climate change. I repeat - we are shouldering the consequences of the actions of others! Actions that endanger our very existence…and all for the enrichment of a few elsewhere.

The time has come for the international community to make a stand and to decide; whether it will be shoulder to shoulder with those suffering the ravages of climate change worldwide; Whether we can mitigate the consequences of unprecedented increases in sea temperatures and levels; whether to help us rebuild sustainable livelihoods; or whether the international community will merely show some pity now, and then flee….; relieved to know that this time it was not you.

The success of the COP21 in Paris is a demonstration of the collective political will of Member States to take action to combat climate change. One year on, the call for urgent action is even greater if we are to curtail the impact of climate change on us and future generations. We need all of humanity all countries - big and small; developed and developing to come together to save our planet! We must all live up to our obligations and commitments to do more!

Let us take serious action against the realities of climate change.

NATIONAL CLIMATE CHANGE POLICY AND ACTION PLAN (2019-2024) : BUILDING A CLIMATE RESILIENT DOMINICA WHILE SUSTAINING CARBON NEGATIVE DEVELOPMENT

> "*The specific needs and special circumstances of developing country Parties, especially* ***those that are particularly vulnerable to the adverse effects of climate change, and of those Parties, especially developing country Parties, that would have to bear a disproportionate or abnormal burden under the Convention, should be given full consideration.*** *"* Article 3 (2) of the United Nations Framework Convention on Climate Change (UNFCCC).

1.0. Introduction

In 1994, the Commonwealth of Dominica ratified the *United Nations Framework Convention on Climate Change* (UNFCCC) in recognition of the importance of climate change as a major environmental phenomenon with serious ramifications for all nations especially resource poor developing countries and small islands developing states (SIDS) of which Dominica is a member.

Since becoming a Party to the Convention, Dominica has, in recognition of the principles contained in Article 3 (3) of the UNFCCC, been diligent in taking "*precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects*". More specifically, Dominica continues to "*formulate, implement, publish and regularly update national ….. programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change*" (Article 4 (1) (b) of the UNFCCC.).

In 2002, Dominica was one of the first of the small islands developing States (SIDS) globally to develop and obtain Cabinet approval of their ***National Climate Change Adaptation Policy***, which defined a number of priority measures required to establish the enabling environment for effective planning for adaptation to climate change. This was a notable achievement that predated the formulation and approval of *Guidelines for National Adaptation Plans* (NAPs) adopted by the UNFCCC Conference of Parties (COP) at its seventeenth session on the 11th December 2011 (decision 5/CP.17, paragraph 6). In recognition of this pioneering work, Dominica was one of the few countries in the Caribbean region to receive funding to support the implementation of the *National Climate Change Adaptation Policy* under the Special Programme for Adaptation in the Caribbean (SPACC) (2008-2011) funded by the Global Environment Facility (GEF).

In January 2009, a report by the Climate Investment Funds (PPCR) Expert Group noted that the countries of the Caribbean are among the most vulnerable to global climate change, and while determining that no single country emerges as the most vulnerable in the region, the leading candidates would appear to be Dominica together with Guyana and Haiti. As a consequence of this assessment, Dominica was invited to participate in the Pilot Program for Climate Resilience (PPCR) which is part of the Strategic Climate Fund (SCF), a multi-donor Trust Fund within the Climate Investment Funds (CIF).

In 2011, under the PPCR program, Dominica was provided Technical Assistance (TA) to undertake the design and development of their ***Strategic Program for Climate Resilience*** (SPCR). In light of the need to develop a strategic approach to climate change management in response to UNFCCC commitments and as identified by stakeholders during the comprehensive and country-driven SPCR planning process, the TA also supported the development of Dominica's ***Low Carbon Climate Resilient Development Strategy*** that constitutes a compendium first part to the SPCR. Dominica's ***Low Carbon Climate Resilient Development Strategy***, which has been adopted by Cabinet, describes Dominica's development context and the constraints/challenges to sustainable development from climate change. It provides a review of climate change adaptation activities and how lessons learned from previous experiences are being used to foster an integrated strategic approach to address these vulnerabilities. Most importantly, Dominica's ***Low Carbon Climate Resilient Development Strategy***, which was acclaimed by the Climate Investment Funds (CIF) as a model for other small island developing States, articulates for the first time in the country, a strategic vision with clearly defined goals/activities to support the country's transformation to a low-carbon climate resilient development path within the government's national development planning process. It provides an overview of linkages to existing development plans and programs, most importantly Dominica's *Growth and Social Protection Strategy* (GSPS) and Dominica's *National Climate Change Adaptation Policy*. Dominica's ***Low Carbon Climate Resilient Development Strategy*** was one of the first *Nationally Appropriate Mitigation Actions* (NAMAs) registered by a Caribbean small island developing State.[1]

Under the framework of Dominica's ***Low-Carbon Climate Resilient Development Strategy***, the Government of Dominica is integrating green principles into national economic management and planning, and marrying environmental preservation and management into the country strategy for achieving higher levels of sustained economic growth. With people being the country's most valuable resource, Dominica's ***Low-Carbon Climate Resilient Development Strategy*** is based on the principal objectives of:

[1] As a part of the agreed outcome of negotiations pursuant to the *Bali Action Plan* concluded at UNFCCC COP 18 in Doha, developing country Parties will take *Nationally Appropriate Mitigation Actions* (NAMAs) in the context of sustainable development. NAMAs refer to any action that reduces greenhouse gas emissions in developing countries and is prepared under the umbrella of a national governmental initiative. They can be policies directed at transformational change within an economic sector, or actions across sectors for a broader national focus. NAMAs are supported and enabled by technology, financing, and capacity-building and are aimed at achieving a reduction in emissions relative to 'business as usual' emissions in 2020. At the national level, NAMAs are a formal submission by UNFCCC Parties declaring intent to mitigate greenhouse gas emissions in a manner commensurate with their capacity and in line with their national development goals. An open invitation for countries to communicate NAMAs aimed at achieving deviation from business as usual emissions is included in UNFCCC decision 1/CP.16, paragraph 50. So far, fifty-seven countries as well as the African Group have formally submitted their NAMAs. The UNFCCC Conference of Parties (COP), at its sixteenth session, decided to set up a registry to record nationally appropriate mitigation actions (NAMAs) seeking international support, to facilitate the matching of finance, technology and capacity-building support with these actions, and to recognize other NAMAs. The NAMA registry has been developed in accordance with decisions 1/CP.16, paragraph 53, and 2/CP.17, paragraph 45.

- accessing appropriate low carbon and climate resilient technologies to support Dominica's continued transformation to the Greenest Economy in the Caribbean region;
- building national capacity to support Dominica's continued transformation to a Green Economy;
- attracting a broader range of direct foreign investments in new green business opportunities;
- providing training to upgrade the skills of Dominica's workforce to fully exploit business opportunities (local and regional) in the Green Economy, thereby maximizing high-skill employment opportunities required to support the continued transformation to a Green Economy.

While pursuiing a number of projects to implement the mitigation and adaptation measures defined in the ***Low-Carbon Climate Resilient Development Strategy,*** Dominica joined with the community of like-minded nations to negotiate the *Paris Agreement* under the UNFCCC that builds upon the Convention and for the first time brought all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so. In September 2015, as part of the process leading up to the negotiation of the *Paris Agreement*, Dominica together with other Parties to the UNFCCC, formulated and communicated its *Intended Nationally Determined Contribution* (INDC), in accordance with the relevant paragraphs of UNFCCC Decisions 1/CP.19 and 1/CP.20, towards achieving the ultimate objective of the Article 2 of the Convention.

Dominica's *Intended Nationally Determined Contribution* (INDC) indicated that for the country, there is little distinction between adaptation and mitigation measures – an integrated response is being implemented to build climate resilience in vulnerable communities, while enabling Green Growth through the transition to sustainable energy technologies. Recognising Dominica's common but differentiated responsibility and limited capabilities to address climate change, Dominica committed to progressively reduce total gross greenhouse gas (GHG) emissions below 2014 levels (164.5 Ggs est.) at the following reduction rates:

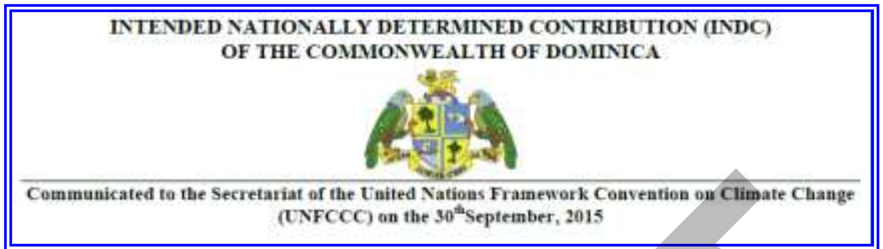
17.9% by 2020; 39.2% by 2025; and 44.7% by 2030.

By 2030, total emission reductions per sector will be as follows:
- Energy industries – 98.6% (principally from harnessing of geothermal resources);
- Transport – 16.9%;
- Manufacturing and construction – 8.8%;
- Commercial/institutional, residential, agriculture, forestry, fishing – 8.1%;
- Solid waste – 78.6%.

Benefiting from sound management practices, it was expected that Dominica forests would continue to sequester all national GHG emissions on an annual basis during the period 2020 to 2030. Additionally, the commercial development and continued harnessing of Dominica's geothermal resources will, from 2025 onwards, enable the country to export significant amounts of renewable energy (estimated to exceed 200 MWs annually) to the nearby French Territories of Martinique and Guadeloupe, thereby contributing to global efforts to reduce GHG emissions. Dominica's INDC, which was endorsed by Cabinet, was lodged as the country's *Nationally Determined Contribution* (NDC) as part of the *Paris Agreement* ratification process.[2] Dominica's *Nationally Determined Contribution* (NDC) is conditional upon receiving timely

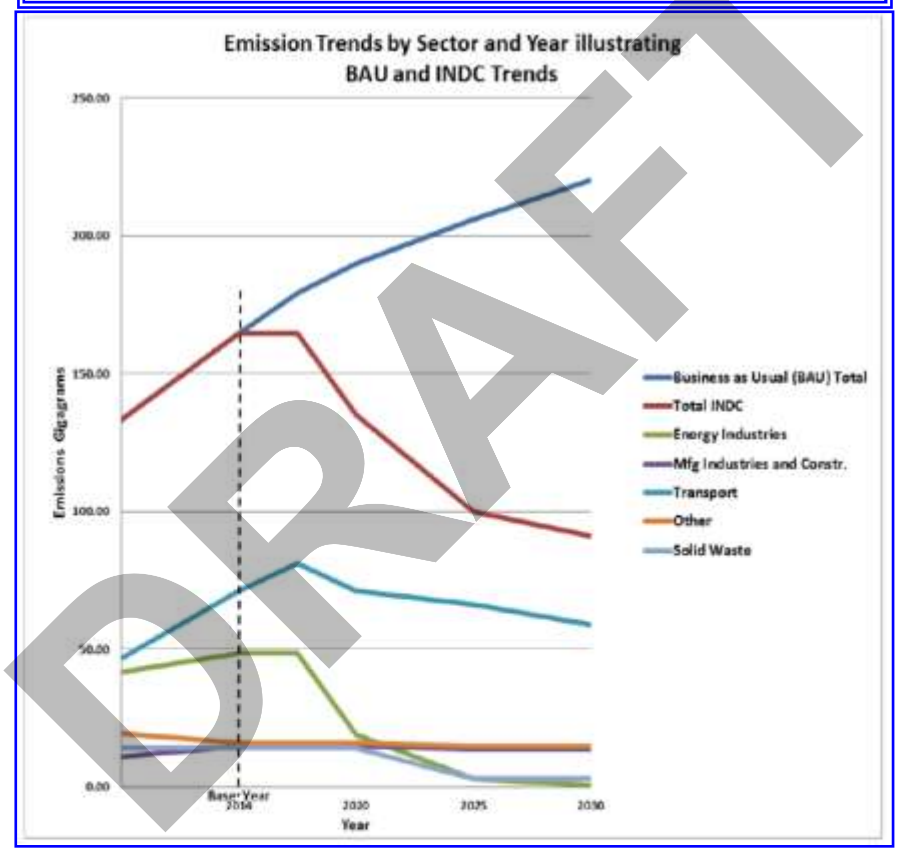
[2] The Government of Dominica signed the *Paris Agreement* on the 22nd April 2016, and lodged its instrument of ratification on the 21st September 2016.

access to international climate change financing, technology development and transfer, and capacity building support for priority adaptation and mitigation measures. Of particular importance to Dominica, the *Paris Agreement* introduced a Global Goal on Adaptation (GGA) and emphasizes the importance of fostering resilience – addressing both adaptation and loss and damage (Article 7 on adaptation provisions and obligations of conduct for countries and Article 8 on measures to address climate induced loss and damage).



INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC)
OF THE COMMONWEALTH OF DOMINICA

Communicated to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) on the 30th September, 2015



Dominica's efforts to implement commitments under the UNFCCC and the *Low-Carbon Climate Resilient Development Strategy* have received a considerable set-back as a result of two extreme events (Tropical Storm Erika in September 2015 and Hurricane Maria in August 2017 – see section 2 below) which severely tested the countries adaptation preparedness and climate resilience readiness. As a consequence, the Government of Dominica has developed this ***National Climate Change Policy and Action Plan*** which, based on lessons learned from Tropical Storm Erika and Hurricane Maria:

(a) updates the climate change adaptation priorities defined in the Dominica *National Climate Change Adaptation Policy* (2002);

(b) updates the climate change mitigation and risk management program outlined in the Dominica

Low-Carbon Climate Resilient Development Strategy (2012-2020);

(c) evaluates and determines viable greenhouse gas reduction options in keeping with *Paris Agreement* targets as provided in Dominica's *Nationally Determined Contribution* (NDC);

(d) defines urgent and priority policies and actions required to build a climate resilient nation while sustaining carbon negative development in compliance with commitments under the UNFCCC and *Paris Agreement*. [3]

This ***National Climate Change Policy and Action Plan*** has been formulated in keeping with commitments under Article 4 (1) (b) of the UNFCCC, and compliments other ongoing initiatives including the *National Resilience Development Strategy for Dominica* and the *Climate Resilience and Recovery Plan* to be formulated under the provisions of section 5 (b) of the *Climate Resilience Act 2018*. Once finalised though a public consultation process that has been supported by the Global Environment Facility (GEF), United Nations Environment, and the Green Climate Fund (GCF), it is expected that the ***National Climate Change Policy and Action Plan*** will be approved by Cabinet and will constitute Dominica's *National Adaptation Plan* (NAP) and *Nationally Determined Contribution* (NDC), and serve as the platform for the financing of priority climate resilient carbon negative measures over the next 5 years.

2.0. Vulnerability : Building Climate Resilience in the Face of Extreme Events in Dominica

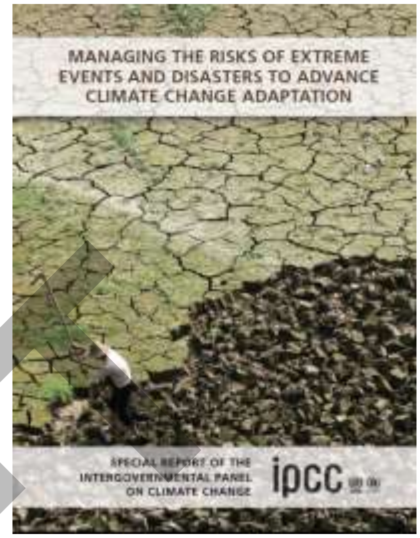
Dominica is vulnerable to numerous natural disasters arising from meteorological events (high wind, excess rainfall and hurricanes) and geophysical events (earthquake, volcano and tsunami). These recurrent events have significantly harmed both the population's socio-economic well-being and the country's general economic and fiscal stability. Particularly damaging are extreme events associated with excessive or prolonged rainfall, which provokes flooding and landslide activity. The highest elevations are located in the island's interior, and (due to orographic rainfall effects) these areas typically receive the highest rainfall. As river systems drain radially from the island's center to the coast, transit time for rainfall runoff is relatively short. This effect, coupled with the steeply sloping topography, creates the potential for flash floods.

[3] Article 4 (7) of the *Paris Agreement* and reports by the Intergovernmental Panel on Climate Change affirm that adaptation and mitigation can complement each other and together can significantly reduce risks of climate change.

With regards to physical vulnerability, steep topographic conditions and rugged interior dominate the island landscape, which has led to human settlements and physical development being highly concentrated along narrow coastal areas (particularly in the south and west). A significant proportion of Dominica's population as well as assets are therefore highly vulnerable to hurricanes as well as high-intensity rainfall, wind and storm surge events. The island's mountainous landscape presents significant engineering challenges, particularly for road construction and maintenance. In addition to the island's steep topography, underdeveloped and damaged infrastructure has been a key challenge to reducing vulnerability to extreme events. Critical public infrastructure such as roads, bridges, and water supply systems as well as health and education facilities remain vulnerable to climate change–related impacts, including flooding and landslides. This vulnerability arises in part from the failure to consider climate change and natural hazard risk in designing and constructing infrastructure, and from deferring maintenance.

Hydro-meteorological disasters have historically imposed significant costs on Dominica's economy, leading to major declines in GDP growth and general productivity. The average annual economic losses associated with extreme hydro-meteorological events are equivalent to roughly 7.4 percent of GDP. Singular events like Hurricane Dean (2007) caused extensive damage to the island, estimated at 58% of GDP, or US$162 million, with significant damage to buildings and infrastructure. More recently in 2011, record level flooding and landslides associated with heavy rain caused in excess of US$100 million in damage. In April 2013, heavy rains caused landslides, flooding and a 40-foot deep split in a section of the East Coast main road resulting in two deaths, and more recently in December 2013 heavy rains caused widespread damage to infrastructure and housing with damage estimates in the range of US$20 million. Tropical Storm Erika (2015) and Hurricane Maria (2017) together have caused additional damage amounting to in excess of US$1.85 billion which exceeds 300% of GDP (see section 2.1. and 2.2. below).

Vulnerability to climate change in Dominica, like many developing countries, is aggravated by external pressures affecting its resilience and adaptive capacity such as terms of trade, impacts of globalisation (both positive and negative), financial crises, international conflicts, external debt, and internal local conditions such as rapid population growth, incidence of poverty, political instability, unemployment, reduced social cohesion, and a widening gap between poor and rich, together with the interactions between them.



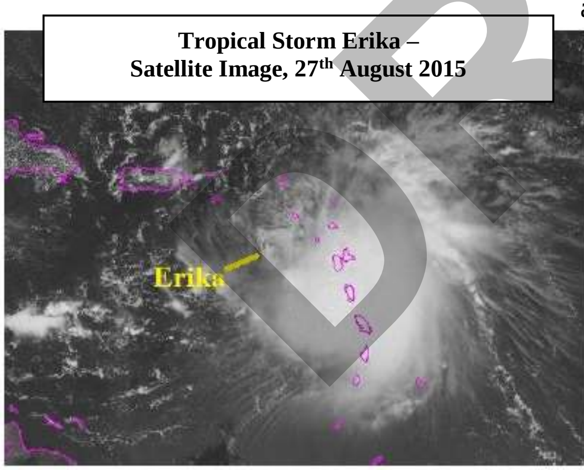
The Special Report on *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* published in 2012 by the Intergovernmental Panel on Climate Change (IPCC) reports that:

- the frequency of heavy precipitation (or the proportion of total rainfall from heavy falls) will increase in the 21st century over many areas, particularly in tropical regions;
- higher direct economic losses will result from future changes in tropical hurricane frequency and intensity.

Having suffered considerable social, environmental and economic losses due to two recent extreme events (see sections 2.1. and 2.2. below), Dominica's sustainable development aspirations require that a climate resilient carbon negative development path be pursued.

2.1. Tropical Storm Erika

Tropical Storm Erika formed in the mid-Atlantic at about 47º West longitude 15º North latitude on the 24th August 2015. It was immediately classified as a tropical storm and continued west-northwest at a speed of approximately 20 miles per hour. On the morning of the 27th August 2015, the system (storm center) arrived at the Leeward Islands with the majority of rainfall associated with the eastern side of the system. Rainfall arrived in Dominica in the morning of the 27th August 2015 producing heavy rains for approximately 9 hours. Rain gauge readings taken at Canefield Airport (on the west coast near Roseau) indicated the rain event started at approximately 7:00 a.m. local time and continued through to 6:00 p.m. As recorded at Canefield Airport, the heaviest accumulation occurred between 7:00 a.m. and 12 noon with an accumulation of approximately 200 mm (nearly 8 inches over the 5 hour period). Additional rainfall data were available from the climate station Gleau Gommier located in the mountains near the center of the island at a higher elevation. Data recorded from this station indicated that rainfall accumulation on the 27th August between 1:00 a.m. and 5:00 p.m. was 17.08 inches or 434 mm, of which 14.1 inches (359.7mm) accumulated from 4:00 a.m. to 9:00 a.m. which was higher than the Canefield Airport data. As a result of the intense rainfall in combination with steep topography and relative short distance from the center mountain ridge to the coastal areas (6 miles or so), flash flooding rapidly ensued with little warning to the population. Tropical Storm Erika was, at the time, the deadliest and most destructive natural disaster in Dominica since Hurricane David in 1979.



**Tropical Storm Erika –
Satellite Image, 27th August 2015**

The storm's asymmetric structure, coupled with the mountainous terrain of the island and ample moisture aloft, led to rainfall accumulations up to 33 in (850 mm). With grounds already saturated from antecedent rainfall, tremendous runoff quickly overwhelmed river basins and triggered catastrophic floods. Accompanying mudslides worsened the situation, temporarily damming the rivers before collapsing. On the 29th August, the Prime Minister declared 9 "special disaster areas", namely: Petite Savanne, Pichelin, Good Hope, Bath Estate (Paradise Valley), Dubique, Campbell, Coulibistrie, San Sauveur, Petite Soufriere (see map). Hundreds of homes were left uninhabitable and thousands of people were displaced; the entire town of Petite Savanne was evacuated and subsequently abandoned as a result of the storm. All told, 30 people died across the island in the nation's worst disaster since Hurricane David. The storm's devastating effects in Dominica prompted an influx of international assistance. Aid from multiple nations and intergovernmental organizations poured in to assist victims of the storm. Thousands of homes needed to be built or repaired, including 500–1,000 for the relocation of all of Petite Savanne's residents.

Flooding and landslides severely damaged transport infrastructure and substantially diminished the productive capacity of agriculture and tourism. The main airport was badly damaged. Based upon an initial assessment of impacts to each affected sector, Tropical Storm Erika resulted in total damage and loss of EC$1.3 billion (US$483 million), equivalent to approximately 90% of Dominica's Gross Domestic Product (GDP). The majority of damages were sustained in the transport sector (60 percent), followed by the housing sector (11 percent) and agriculture sector (10 percent). Out of a total population of 71,000 persons, 574 were homeless and 713 evacuated with approximately 7,229 impacted by the event in disaster declared areas.

The recovery and rehabilitation costs are substantial, putting tremendous pressure on already challenging fiscal and balance of payments positions. Recovery in Dominica was halted in September 2017 by Hurricane Maria, a Category 5 hurricane that wrought far greater devastation on the island.

2.2. Hurricane Maria

Rainfall ahead of the hurricane caused several landslides in Dominica as water levels across the island began to rise by the afternoon of the 18th September 2017. Hurricane Maria made landfall in Dominica at 21:15 AST as a Category 5 hurricane with maximum sustained winds of 160 mph (260 km/h). These winds, the most extreme to ever impact the island, battered the roof of practically every home—including the official residence of Prime Minister Roosevelt Skerrit who required rescue when his home began to flood. Downing all cellular, radio and internet services, Maria effectively cut Dominica off from the outside world; the situation there remained unclear for a couple of days after the hurricane's passage. Prime Minister Skerrit called the devastation "mind boggling" before going offline, and indicated immediate priority was to rescue survivors rather than assess damage. Initial ham radio reports from the capital of Roseau on the 19th September indicated "total devastation," with half the city flooded, cars stranded, and stretches of residential area "flattened".

The next morning, the first aerial footage of Dominica highlighted the scope of the destruction. Maria left the mountainous country blanketed in a field of debris: rows of houses along the entirety of the coastline were rendered uninhabitable, as widespread floods and landslides littered neighborhoods with the structural remnants. The hurricane also inflicted extensive damage to roads and public buildings, including schools, stores and churches, and affected all of Dominica's 71,000 residents in some form or way. The air control towers and terminal buildings of the Canefield and Douglas Charles airports were severely damaged, although the runways remained relatively intact and open to emergency landings. The disaster affected all of the island's 53 health facilities, including the badly damaged primary hospital, compromising the safety of many patients.

***Roads in the capital of Roseau area littered with structural debris, damaged vegetation and downed power poles and lines*.**

The infrastructure of Roseau was left in ruins; practically every power pole and line was downed, and the main road was reduced to fragments of flooded asphalt. The winds stripped the public library of its roof panels and demolished all but one wall of the Baptist church. To the south of Roseau, riverside flooding and numerous landslides impacted the town of Pointe Michel, destroying about 80% of its structures and causing most of the deaths in the country. Outside the capital area, the worst of the destruction was concentrated around the east coast and rural areas, where collapsed roads and bridges isolated many villages. The port and fishing town of Marigot in Saint Andrew Parish was 80% damaged. Settlements in Saint David Parish, such as Castle Bruce, Good Hope and Grand Fond, had been practically eradicated; many homes hung off cliffs or decoupled from their foundations. In Rosalie, rushing waters gushed over the village's bridge and damaged facilities in its bay area. Throughout Saint Patrick Parish, the extreme winds ripped through roofs and scorched the vegetation. Buildings in Grand Bay, the parish's main settlement, experienced total roof failure or were otherwise structurally compromised. Many houses in La Plaine caved in or slid into rivers, and its single bridge was broken.

Overall, the hurricane damaged the roofs of as much as 98% of the island's buildings, including those serving as shelters; half of the houses had their frames destroyed. Its ferocious winds defoliated nearly all vegetation, splintering or uprooting thousands of trees and decimating the island's lush rainforests.

Dominica's forests before and after Hurricane Maria

The agricultural sector, a vital source of income for the country, was completely wiped out: 100% of banana and tuber plantations was lost, as well as vast amounts of livestock and farm equipment. Direct effect of Hurricane Maria to the local agricultural economy can be categorized as the following, but not limited to:

(a) ***physical/environmental impact*** (loss of bio-diversity, loss of a critical ecosystem services, dislocation of lands, transport and sedimentation of soil material, loss of crop canopy, feeder and farm access roads, damage to government infrastructures, etc.,);

(b) ***economic impact*** (loss of foreign exchange, loss of market share, loss of income, increase in food import, increase production cost, impact on revenue, etc.,);

(c) ***socio-economic impact*** (loss of farm employment and related agricultural activities, exit from sector, migration, urbanization and changing agrarian structure, etc.,).

Hurricane Maria caused significant damages and losses to the fisheries sector in Dominica. Assessments indicate that approximately 128 vessels and 126 engines suffered damages or were lost. Fisheries cooperatives have lost their ice-making machines, fuel pumps and supplies for market vendors. Fishers have lost a large percentage of their fishing gear. The Fisheries Division in Roseau has lost its roof and all furniture and office equipment. Most of the destruction took place on the east coast, whereas the west coast was less affected. The destruction has affected the food security and livelihoods of fisher folk and those in associated sectors (e.g., market vendors, gutters, mechanics, boat builders).

Extracts from address by Dr. Hon. Roosevelt Skerrit Prime Minister of the Commonwealth of Dominica on the occasion of High-Level Conference for the Reconstruction and resilience of CARICOM Countries Affected by Hurricanes Irma and Maria convened on the 21st November 2017.

Hurricane Maria's 226% of GDP damage and loss come just two years after Tropical Storm Erika, inflicted damage and losses of 90% of our national GDP. The scale and frequency of the damages and losses means there is no commercial premium we could pay that would insure us against the magnitude of these injuries.

The science of climate change shows that the warming of the seas is leading to more rapidly intensifying and wetter storms. Consequently, no commercial insurance firm would offer the insurance we need. Insurance works best when risks are uncorrelated and random. We must now accept the fact that with climate change this is guaranteed to change. Indeed we need to worry that premiums on what they are currently prepared to insure will increase significantly; impacting the cost of recovery as many donors will insist on insurance for many things. Ultimately the ***only route available to us is to build a nation resilient to climate change rather than to insure against damages and losses caused to one that is not. That is why we are committed to creating the first climate resilient nation. It is not an ill-considered promise. It is essential to our existence. We are prepared to be the game changer! We also know that resiliency is not just about buildings. It is about sustainable livelihoods. It is about resilient networks of energy and communications. It is about resilient agriculture and irrigation systems.***

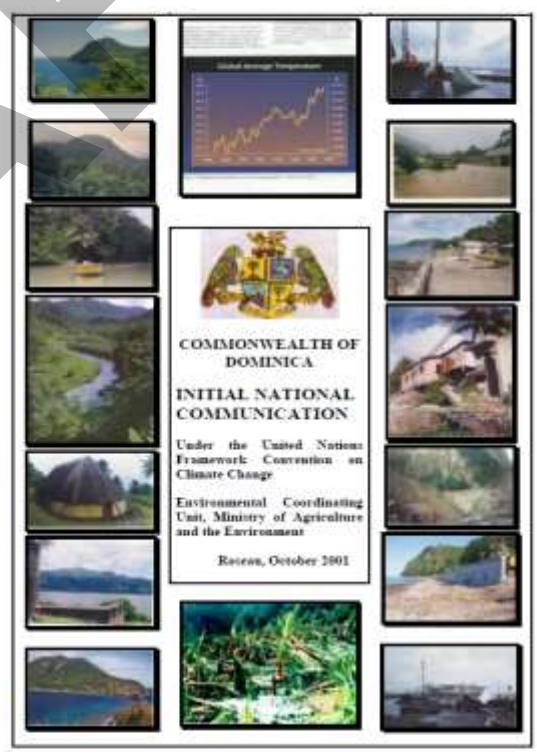
In Maria's wake, Dominica's population suffered from an island-wide water shortage due to uprooted pipes. As of October 1, there were 30 fatalities confirmed across the island with more than 50 reported missing. Tropical Storm Erika (2015) and Hurricane Maria (2017) together have caused damage amounting to in excess of US$1.85 billion which exceeds 300% of Dominica's Gross Domestic Product (GDP). Severely battered by these extreme events, ***Dominica currently ranks third on the GLOBAL CLIMATE RISK INDEX 2019*** (published December 2018).

3.0. Dominica's Climate Change Program (1998-2018)

In response to the devastation wrought by Tropical Storm Erika and Hurricane Maria, the Hon. Roosevelt Skerrit, Prime Minister of Dominica, ***committed the government to creating the first climate resilient nation***. This commitment builds upon twenty years of capacity building for climate change adaptation planning and risk management that has been undertaken in Dominica with assistance from a number of development partners in support of commitments under the UNFCCC.

3.1. *Initial National Communication* to the UNFCCC (2001)

As one of the obligations under Article 12 of the UNFCCC, Dominica committed to the production of regular National Communications to the Conference of Parties (COP) through the UNFCCC Secretariat. The first such report, the *Initial National Communication* was prepared with assistance from the Global Environment Facility (GEF) and the United Nations Development Programme (UNDP) and submitted in 2001. The INC consists of a description of Dominica's National Circumstances, a national Greenhouse Gas Inventory for 1994, an assessment of Dominica's vulnerability to the potential adverse impacts of climate change, an outline of the existing institutional framework, a description of the National Response measures that will be pursued by the Government and a listing of the Priority Actions that the Government of Dominica intends to implement in the short term to implement commitment under the UNFCCC. The country's *Initial National Communication* identifies the following sectors as being vulnerable in Dominica:



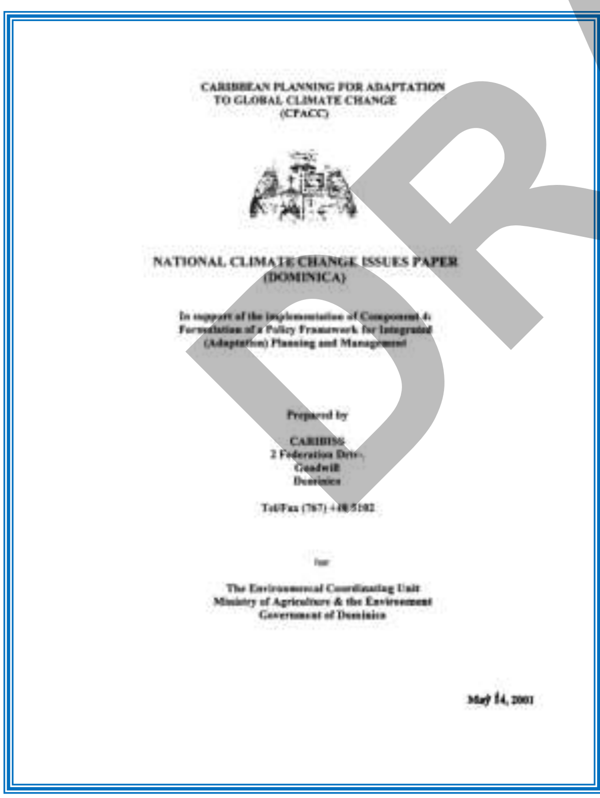
- Forestry and terrestrial resources: Possible impacts of climate change on the country's forest ecosystems include: an alteration in the range of species; reduced water flow; an increase in forest pests and disease; and reduced food availability for wildlife.
- Coastal ecosystems: A rise in mean sea level could cause a loss of beach area; rising temperatures may damage coral reefs along with the island's tourism sector and fishery; and increased mortality of mangrove forests.
- Water resources: Depending on future changes in precipitation on the island, climate change could result in flooding, landslides, reduced water for domestic use, and saline invasion of drinking water.
- Human settlements and infrastructure: Given that most of Dominica's infrastructure is located in coastal areas, more frequent extreme weather events and sea level rise could adversely impact these human settlements.

- Agriculture: Impacts could include: declines in the country's main crop, bananas, which are very sensitive to changes in precipitation; losses due to extreme weather events such as cyclones; and changes in yield due to rising temperatures and variable precipitation.
- Fisheries: The fisheries sector is vulnerable to the impacts of climate change as a result of the expected consequences of rising sea temperatures on coral reefs.
- Tourism: The impact of climate change on coastal zones, fisheries, and coral reefs could adversely affect this burgeoning industry.

The INC process enhanced the general awareness and knowledge of climate change-related issues in Dominica and strengthened the dialogue, information exchange and cooperation among all relevant stakeholders including Government, non-government, academic and private sector agencies, and civil society. The preparation of the INC was coordinated by the Environmental Coordinating Unit (ECU) which is the unit established by Cabinet Decision in 1999 with the mandate to coordinate all environmental activities in Dominica. The overall function of the ECU is to bring about more focused environmental management approaches to the solving of Dominica's environment problems, advise government of the development of more coherent environmental policies, and enhance Dominica's compliance with international treaties and conventions to which it is signatory. It also serves as the focal point for Multilateral Environmental Agreements (MEA) to which Dominica is a party.

3.2. Dominica's *National Climate Change Adaptation Policy* (2002)

Concurrently with the INC process, Dominica embarked upon the development of a ***National Climate Change Adaptation Policy*** (adopted by the Cabinet in 2002) under the Caribbean Planning for Adaptation to Climate Change (CPACC) Project (1999-2002), The CPACC project was funded by the Global Environment Facility (GEF), was implemented by the World Bank and executed by the Organisation of American States (OAS). The goal of the CPACC project was to build capacity in the Caribbean region for the adaptation to climate change impacts, particularly sea level rise. This was accomplished through the completion of vulnerability assessments, adaptation planning, and capacity building activities. Participating countries in CPACC included the majority of CARICOM members. Component 4 of the CPACC project supported the articulation of national climate change adaptation policies and implementation plans. Only Dominica and two other participating countries secured Cabinet approval for their respective ***National Climate Change Adaptation Policy.***


CARIBBEAN PLANNING FOR ADAPTATION
TO GLOBAL CLIMATE CHANGE
(CPACC)

NATIONAL CLIMATE CHANGE ISSUES PAPER
(DOMINICA)

In support of the implementation of Component 4: Formulation of a Policy Framework for Integrated (Adaptation) Planning and Management

Prepared by

CARIBISS
2 Federation Drive,
Goodwill
Dominica

Tel/Fax (767) 448 5182

for

The Environmental Coordinating Unit
Ministry of Agriculture & the Environment
Government of Dominica

May 14, 2001

Dominica's ***National Climate Change Adaptation Policy*** was developed through a broad-based national consultative process supported under the CPACC project, and built upon an Issues Paper that summarised the country's vulnerability to climate change and identified, for the first time, likely impacts from climate change on key sectors. The Issues Paper also noted that Dominica has already witnessed the impacts associated with an increase in extreme events in recent years, as summarised in the table overleaf.

Activity	Year	Impacts
Landslide (Unusually heavy rainfall) (Fond St. Jean)	1977	Significant land loss, environmental damage, 8 lives lost.
Landslide (Unusually heavy rainfall) (Bellevue Chopin)	1977	Significant land loss, environmental damage, 8 lives lost.
Hurricane (David)	1979	Extensive damage to all sectors, significant environmental damage, 39 lives lost.
Hurricane (Allen)	1980	Extensive damage to infrastructure, beaches
Landslide (Unusually heavy rainfall) (Good Hope)	1986	Significant land loss, environmental damage, 8 lives lost.
Hurricane (Luis)	1995	Extensive damage to infrastructure, beaches, loss of 1 life.
Landslide/flood (Layou)	1998	Significant land loss, environmental damage
Hurricane (Lenny)	1999	Extensive damage to infrastructure, beaches
Landslide (Unusually heavy rainfall) (Northern Communities)	1999	Significant land loss, environmental damage, 8 lives lost.

Having presented an analysis of the vulnerabilities facing key sectors from climate change, the Issues Paper provided the following summary of sectors most at risk.

Sectors	Magnitude of potential impact			Significance of sector		
	High	Medium	Low	High	Medium	Low
Agriculture	√			√		
Tourism		√		√		
Fisheries		√				√
Infrastructure	√			√		
Human Settlements		√		√		
Resilience of Natural Systems		√			√	
Biodiversity	√			√		
Coastal and marine resources	√			√		
Human Health		√		√		

The Issues Paper also noted that there was almost no capacity in Dominica to plan for and manage risks from climate change, and no government institution with a legal mandate or resources to adequately implement commitments under the UNFCCC. The Issues Paper also noted that there is no legislation specific to climate change planning and management, and recommended that this deficiency be remedied as a matter or urgency. The Issues Paper provided a number of recommendations concerning policy interventions and actions needed to address risks from climate change, which served as the basis for the development of the ***National Climate Change Adaptation Policy*** through a participatory process inclusive of all stakeholders (Government, private sector and civil society) involving four national workshops, a series of sector meetings, and an international peer review process.

The ***National Climate Change Adaptation Policy*** provides an assessment of the degree of vulnerability of Dominica to the impacts of climate change, adaptive capacity for anthropogenic climate change and proposes adaptive strategies for anticipating and ameliorating or avoiding the negative impacts of climate change. In addition it examines possible impacts on the coastal zone, forest resources, freshwater resources, human settlements and human health and tourism, agriculture, fisheries, and provides a plan of action for mitigating such impacts. The Policy identifies the role of Government as the major facilitator of implementation of the Policy directives and identifies nine priority projects among the following six priority sectors for urgent implementation: coastal and marine resources; human settlement; water resources; agriculture; forestry; and one multi-sectoral project. The National Policy provides a framework for not only advancing Dominica's capacity and capability to effectively adapt to climate change impacts, but in the wider sense contributes significantly to conservation and preservation of the islands natural resources for present and future generation of Dominicans by providing an adequate framework for building climate resilience to ensure their sustainable use, conservation, and preservation.


COMMONWEALTH OF DOMINICA
POLICY ON PLANNING FOR ADAPTATION TO CLIMATE CHANGE

PREPARED UNDER COMPONENT 4 OF THE
CARIBBEAN PLANNING FOR ADAPTATION TO CLIMATE CHANGE PROJECT
(CPACC)

Policy Framework for Integrated
(Adaptation) Planning and Management in Dominica

Prepared by
Anthony Deige
for
The Environmental Coordinating Unit
Ministry of Agriculture & the Environment
Government of the Commonwealth of Dominica

March 2002

The aim of the ***National Climate Change Adaptation Policy*** is to "foster and guide a national plan of action, formulated in a coordinated and holistic manner, to address short, medium and long term effects of climate change, ensuring to the greatest extent possible that the quality of life of the people of Dominica and opportunities for sustainable development are not compromised".

The Policy includes an action plan that defines specific activities required to plan for and manage climate change vulnerability affecting key sectors, which is summarised below.

Coastal and Marine Resources

1. Ensure the continuation, expansion and strengthening of coastal monitoring and data collection activities in order to improve decision making;
2. Undertake, a national assessment of coastal areas and resources at risk;
3. Adopt short medium and long-term measures to protect coastal lands and to increase the resilience of coastal ecosystems and resources;
4. Develop measures to restore or "replace" damaged or destroyed coastal resources (artificial reefs and wetlands);
5. Develop a comprehensive national land and natural resources management plan, which *inter alia*, incorporates climate change concerns and which based upon such concerns, makes prescriptions regarding the location of coastal developments;
6. Identify and promote alternative fishery and resource use activities (e.g. mariculture) where impacts on ecosystems and natural resources preclude the continuation of traditional activities;

7. Foster increases awareness and knowledge on the part of the general public regarding climate change impacts on the coastal and marine environment.

Agriculture

1. Provide an enabling environment for developing mechanisms for:
   - The use of agro forestry movement systems to include the establishment of buffer zones along waterways and between forests and savannahs, and reforestation programmes.
   - The implementation of soil and water conservation measures.
   - The implementation of Integrated Crop Management Systems to include the use of drought resistant varieties, systematic crop development programmes and increased efforts at agricultural diversification.
2. Establish and maintain a database network that will allow for the processing and analysis of information on the impacts of climate change on agricultural practices that will assist in informed decision-making.
3. Develop a Disaster Preparedness Strategy for the agricultural sector to address impacts over the short, medium and long term.
4. Incorporate the Disaster Preparedness Strategy for the agricultural sector into the National Disaster Preparedness Programme.
5. Adopt appropriate measures to address areas of immediate need which do not jeopardize or contradict the development of long-term, sustainable strategies for the agricultural sector. Such measures may include construction of water storage and irrigation facilities for crop production and construction of suitable housing for livestock.

6. Establish mechanisms to address agricultural activities that reduce the resilience of natural systems to adapt to climate change impacts by, amongst other matters, developing mechanisms to reduce land-based pollution on coastal systems, propagating coral artificially and procuring resources for the construction of sea defence structures.
7. Encourage collaboration between tertiary institutions and regional organizations for the conducting of more detailed research on climate change issues and their impact on agricultural activities within regional states.
8. Ensure adherence to building codes by providing mechanisms for enforcement.

Human Settlements

1. Develop or improve the basis for sound decision making by promoting and fostering the developing of capacity to undertake research into and analysis of the relevant Climate Change processes, which may affect coastal settlements - these may include, inter alia, sea level rise;
2. Undertake a comprehensive assessment of human settlement and related infrastructure at risk from the effects of Climate Change;
3. Develop a comprehensive national land use and management plan, which inter alia, incorporates Climate Change concerns and which based upon such concerns, makes prescriptions regarding the location of future settlements and urban development without compromising water supply and other such requisites for the sustainability of settlement;
4. Develop and implement a plan for the relocation or protection of settlements and infrastructure at risk from the effects of Climate Change;
5. Ensure the incorporation of Climate Change considerations into existing or proposed national emergency plan;

6. Promote the development and enforcement of a building code, which addresses Climate Change considerations including hurricane resistance; energy/heat efficiency and "flood resistance";
7. Ensure that the national infrastructure standards (jetties, roads, bridges. etc.) are adequate to withstand the effects of climate change;
8. Ensure the passage and enforcement of environmental impacts assessment (EIA) legislation and

incorporate climate change considerations into the EIA process;
9. Implement fiscal measures where appropriate to encourage the adaptation of building codes and other relevant measures;
10. Foster increased public awareness of Climate Change and its effects on human settlements.

<u>Forestry and Terrestrial Resources</u>

1. Develop or improve the basis for sound decision making by promoting and fostering the developing of capacity to undertake research into and analysis of the relevant Climate Change processes (including forecasting and data collection) on Dominica's terrestrial biodiversity;
2. Undertake measures in the short term to increase the resilience of terrestrial biodiversity - measures could include soil conservation, agro-forestry and the establishment of conservation areas;
3. Develop a comprehensive national land use and management plan, which *inter alia,* incorporates Climate Change concerns and which based upon such development without compromising water supply and other such requisites for the sustainability of developments;
4. Ensure the implementation of strategies and plans including the: *National Biodiversity Strategy and Action Plan*; the *National Report on Desertification*, and the *National Forest Action Plan*.

<u>Water Resources</u>

1. Develop or improve the basis for sound decision making by promoting and fostering the developing of capacity to undertake research into and analysis of the relevant climatic changes/processes (including forecasting and data collection) on surface and underground water resources;
2. Promote the strengthening of national water management agencies to ensure the sound management of the island's water resources;

3. Develop a long term national water management plan which incorporates and addresses climatic change concerns;
4. Undertake reforestation and other desirable watershed management practices to increase the ability of watersheds and catchments to maximize water availability, as well as to reduce soil erosion and sedimentation;
5. Assess and address needs for improved water storage and distribution infrastructure to ensure water availability during drought periods;
6. Promote initiatives to identify and, where necessary, exploit non-traditional water sources such as ground water.

Health

1. Ensure the conduct of necessary research and information gathering in order to strengthen the basis for sound decision making;
2. Formulate or improve a national health plan to ensure that appropriate short, medium and long term measures are implemented to address health related Climate Change issues;
3. Sensitise and educate the public and health personnel about Climate-Change related health matters;
4. Ensure that to the extent possible preventive measures and curative resources such as vaccines and medications available as needed.

Tourism

1. Create new or revise existing hazard maps, which will define the extent of impact prone areas and inform strategies for sustainable land use and tourism development.
2. Conduct research on the use of flexible, cost effective and easily replaceable measures for coastal protection, which would reduce vulnerability through better incorporation of the long-term environmental consequences of resource use.

Financial Sector

1. Implement fiscal and financial measures in order to achieve equitable distribution of the economic burden between stakeholders;
2. Ensure the financial sector facilitates of building codes and other standards in order to minimize risk from Climate Change;
3. Sensitise stakeholders in the financial sector about the effects and implications of Climate Change.

The ***National Climate Change Adaptation Policy*** concluded with the following Table that identifies the most critical and urgent national projects with their associated cost.

ACTIVITY/STRATEGY	**INDICATIVE *COST (US$)***
Multi-Sectoral • Development and implementation of a coordinated public education and awareness campaign on climate change, targeting all sectors and relevant stake holders. • Implement a national program for capacity building for climate change.	150,000** 200,000**
Coastal and Marine Resources • Review existing institutional and legislative framework. • Develop a holistic and integrated system for the sustainable management of all natural resources.	200,000** 75,000
Human Settlement • Development and implementation of a coordinated public education and aware-ness campaign on health matters. • Build institutional capacity for climate change responses.	100,000** 36,000,000
Water Resources • Develop and implement an integrated multi-sectoral national water resources management plan.	60,000
Agriculture • Establish a system for improved monitoring and research of conventional crop and livestock production systems and processes.	60,000
Forestry • Development and enforcement of land use policy.	70,000
TOTAL	**$36,915,000**

However, in the absence of a climate change risk assessment that identifies priority risks facing the country, and confronted by critical capacity and resource (human, technical and financial) constraints, it has not been possible for Government to effectively implement the ***National Climate Change Adaptation Policy.*** Accordingly, most of the key interventions outlined in the Policy have not to-date been accomplished. *(Note: ** Identifies priorities under the Policy that have been implemented)*

3.3. Measures to Build Capacity for Climate Change Programming

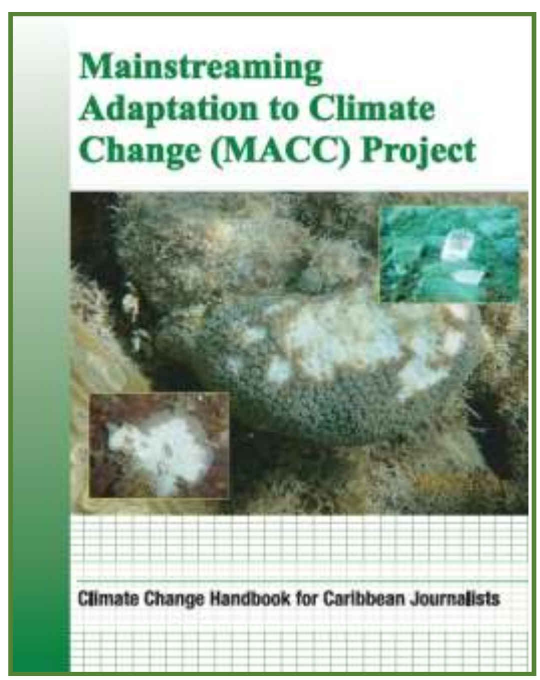
Following the publication of its *Initial National Communication*, and Cabinet approval of the ***National Climate Change Adaptation Policy***, Dominica carried out a number of important climate change capacity building activities, including the following:

- *Formal establishment of the National Climate Change Committee* (originally established under the CPACC program to guide and oversee project activities in Dominica) by decision of Cabinet in 2001;

- *Initial National Communication Phase II - Building Capacity to Respond to Climate Change Project*, endorsed by Cabinet in May 2005, was a capacity building project intended to build upon the activities completed in the context of Dominica's INC - the overall goal was to allow Dominica to extend current knowledge to facilitate the emergence of national networks and promote the integration of climate change concerns in the developing national dialogue;

- *Public Outreach on Climate Change*, including the organization of several workshops for information sharing and awareness raising on climate change;

- *Mainstreaming Adaptation to Climate Change in the Caribbean (MACC) Programme* which sought to reduce vulnerability (physical, social, economic and environmental) of Caribbean countries to the impacts of climate change - climate vulnerability risk assessment undertaken under the MACC program were in the areas of Water Resources, Tourism, Agriculture and Coastal Zone. MACC also focused on *Public Education and Outreach* (PEO) strategies as a major component of the program in Dominica;



- *National Capacity Self Assessment (NCSA)* process commenced in Dominica in January 2004 and it focused on three thematic areas, Land Degradation, Biodiversity and Climate Change. The objective of the NCSA process was to allow for a thorough assessment of the capacity needs and constraints facing national efforts to improve environmental conservation and sustainable development programmes, and to meet global environmental management obligations. The NCSA process supported the analysis of the institutional capacity framework that was initiated under the UNFCCC and the formulation of the *National Biodiversity Strategy and Action Plan* (NBSAP), and facilitated the identification of management strategies relevant to sustainable environmental development;

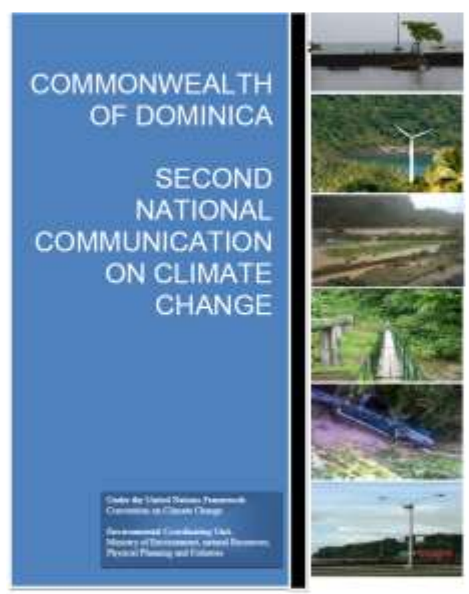
- *Accession to the Kyoto Protocol* in January 2005;

- *Special Programme for Adaptation in the Caribbean (SPACC) project* - In 2008, the Commonwealth of Dominica together with St. Lucia and St. Vincent and the Grenadines began implementation of the Special Programme for Adaptation in the Caribbean (SPACC) project entitled "Piloting an Integrated Operational Approach to Climate Change Adaptation, Biodiversity and Desertification Planning and Management". The SPACC project sought to make adaptation to climate change an integral part of a broader agenda to address major MEA within national planning processes in the participating countries;

- *National Self-Assessment* was carried out in 2010 in accordance with Global Environment Facility (GEF) Operational Procedures for the Expedited Financing of National Communications from Non-Annex I Parties (GEF/C.22/Inf.16) - the main objective was to conduct highly consultative and participatory needs assessment of activities completed or under preparation that are relevant to the Second National Communication, while identifying priorities for implementation during the SNC process;

- *Community climate change vulnerability, risk and capacity assessments* were undertaken in 2011 as a collaborative initiative between the SPACC program and the GEF-funded *Sustainable Land Management* (SLM) project – under this initiative Dominica pioneered: (a) the vulnerability mapping and "climate proofing" of National Parks Management Plans; and (b) community-based vulnerability mapping and the development, through community engagement, of community adaptation plans;

- *Dominica's Second National Communication* was submitted in 2012 and reported on the period from 2001 to 2005. Chapter 1 of the Second National Communications updated the National Circumstances since the INC, and in particular the aspects of development policies related to the major components of the climate change process. Although the baseline year for the report is 2000, Chapter 2 was devoted to Greenhouse Gases Inventories, carried out for the period 2000-2005, in accordance with the methodology recommended by the Convention Secretariat and the IPCC. This inventory was complemented by tables providing details on calculations carried out, data gaps, uncertainties, etc. Chapter 3 dealt with vulnerability to climate change and variability. The capacity for mitigating the effects of greenhouse gas (GHG) emissions related to social and economic development policies of the country was presented in Chapter 4. It was followed in



Chapter 5 with information related to the achievement of the convention objectives, and provides a detailed assessment of Dominica's ongoing efforts and requirements to efficiently implement the Convention.

3.4. Dominica's *Low Carbon Climate Resilient Development Strategy*

During the period of the preparation of the *Second National Communication*, Dominica was selected to participate in the Pilot Program for Climate Resilience (PPCR). Based on recommendations of an independent Expert Group, Dominica was selected in 2009 as one of the countries to participate in the Pilot Program for Climate Resilience (PPCR) which is part of the Strategic Climate Fund (SCF), a multi-donor Trust Fund within the Climate Investment Funds (CIF). The Caribbean PPCR has seven components: country activities in six countries (Dominica, Grenada, Haiti, Jamaica, Saint Lucia, St. Vincent and the Grenadines) and a region-wide component. The PPCR sought to provide financing through the multilateral development banks (MDBs) to support programs in the selected pilot countries. Proposals for PPCR funding were prepared jointly by the recipient country and the relevant MDBs.

The goal of the Pilot Program for Climate Resilience (PPCR) is to help countries transform to a climate resilient development path, consistent with national poverty reduction and sustainable development goals. In its nature as a pilot program and supporting learning-by-doing, PPCR implementation ultimately aims to result in an increased application of knowledge on integration of climate resilience into development. The PPCR complements, yet goes beyond, then available adaptation financing in providing finance for programmatic approaches to upstream climate resilience in development planning, core development policies, and strategies.

During 2011-2012 Dominica was provided Technical Assistance (TA) to undertake the design and development of their *Strategic Program for Climate Resilience* (SPCR). In light of the need to develop a strategic approach to climate change management as identified by stakeholders during the comprehensive and country-driven SPCR planning process, the TA also supported the development of Dominica's ***Low Carbon Climate Resilient Development Strategy*** that constitutes a compendium first part to the SPCR. Dominica's ***Low Carbon Climate Resilient Development Strategy***, which has been adopted by Cabinet in 2012, describes Dominica's development context and the constraints/challenges to sustainable development from climate change. It provides a review of climate change adaptation activities and how lessons learned from previous experiences are being used to foster an integrated strategic approach to address these vulnerabilities. Most importantly, Dominica's ***Low Carbon Climate Resilient Development Strategy*** articulates, for the first time in the country, a strategic vision with clearly defined goals/activities to support the country's transformation to a low-carbon climate resilient development path within the government's national development planning process.

Dominica's ***Low Carbon Climate Resilient Development Strategy*** provides an overview of the country circumstances, the development context and identifies climate change vulnerabilities in key sectors, for specifically vulnerable groups, for the private sector, important eco-systems and natural resources. It also provides an overview of linkages to existing development plans and programs, most importantly Dominica's *Growth and Social Protection Strategy* (GSPS) and Dominica's *National Climate Change Adaptation Policy*. Section 5 of Dominica's ***Low Carbon Climate Resilient Development Strategy*** contains a policy, legal and institutional analysis that list key agencies involved in managing climate change risks, together with the associated legal/policy framework.

A comprehensive country driven and country owned process was undertaken to develop Dominica's ***Low Carbon Climate Resilient Development Strategy***, which included the following activities that were coordinated by the National Climate Change Committee and eight Technical Working Groups:

- *Document stocktaking, review and analysis* including a critical review of Dominica's ***Climate Change Adaptation Policy and Action Plan*** (2002), and analysis of current and ongoing national development policies, programs and initiatives in particular the Government of Dominica's *Growth and Social Protection Strategy* (GSPS) which articulates a medium-term strategy for growth and poverty reduction over the next five years and sets priorities to make poverty reduction the principal focus of Government's economic and social policy;
- Broad-based stakeholder *climate change risk assessment* (including prioritization and ranking of climate change risks affecting Dominica) adapted from the risk assessment approach/methodology/guidelines developed under the Adapting to Climate Change in the Caribbean (ACCC) project and based on climate change trend analysis and projections contained in Dominica's *Initial National Communication* (INC) and *Second National Communication* (SNC) to the UNFCCC;
- Critical *review of Dominica's National Capacity Self-Assessment* (NCSA) and an *Adaptive Capacity Assessment* (assessing institutional, systematic, individual capacity) for public and private sector, vulnerable communities/sectors that served to update and validate recommendations contained in the NCSA;
- *Community Surveys* undertaken to identify climate change vulnerabilities, capacities and priority needs that built upon community vulnerability mapping and adaptive capacity assessments undertaken under Dominica's Sustainable Land Management project and Special Program on Adaptation to Climate Change (SPACC) project;
- *Identification of priority needs and investment opportunities* to facilitate Dominica's transformation to a climate-resilient development path that was undertaken during the SPCR National Consultative Workshop;
- *Cost-benefit Analysis* of proposed SPCR investment opportunities that was undertaken with technical support/methodologies provided by the Caribbean Community Climate Change Center (CCCCC) under Phase 1 of the regional track SPCR program.
- *Preparation of the SPCR* and related Investment Plan for submission to the PPCR-SC, inclusive of the development of a programme results framework with performance indicators tailored to facilitate Dominica's transformation to a climate-resilient economy with PPCR support;
- *Building capacity* to facilitate Dominica's transformation to a climate-resilient economy that addresses priority climate change risks to agriculture and food security, livelihoods, the economy, water security/quality, and supports national poverty alleviation efforts;
- *Public education and outreach* surrounding context-specific climate impacts and the SPCR program.

The Climate Change Risk Assessment undertaken by stakeholders identified the following priority climate change risks facing Dominica:

Event Risks and *Outcome Risks*	Ranking of Risks
Increase in extreme events and climate variability (Cumulative Risks) - *Physical damage to crops and agricultural access roads, impact on agricultural and fisheries productivity, increase of pests/disease, impact on livelihoods and food security*	10
Increase in extreme events -*More frequent economic setbacks, prolonged recovery periods, stress on economy (including increase in loss of life, impact on tourism arrivals, impact on agricultural production, food security, forest cover, human health and social capital), and less attractive environment for foreign investment due to cumulative destruction of critical infrastructure for tourism, manufacturing, agriculture, trade*	10
Increase in extreme events (increased intensity of hurricanes, flooding, landslides) – *Increased damage to houses, human settlements, critical infrastructure, forest resources, business and other properties*	10
Sea level rise – combined with increased incidents of storm surges - *Damage to coastal infrastructure (roads, ports, jetties, storage, processing, packing, landing sites) used for agricultural trade and access to markets*	9
Increased frequency of extreme events -*Water shortages due to increased drought and storms* (Note: includes loss to crops)	9
Sea level rise – combined with increased incidents of storm surges - *Damage to coastal tourism facilities (beaches, hotels, airports, sea ports and cruise ship/ferry terminals)* (NOTE: Includes impacts on Kalinago people and lost income to farmers)	8
Sea level rise and storm surge - *Loss of coral reefs – loss of protection to coastal areas and impact of marine ecosystem and associated effect on livelihoods and food security*	8
Climate variability -*Loss and impact on marine and terrestrial biodiversity which is key pillar for tourism*	8
Changes in rainfall intensity -*Increased coastal marine habitat degradation (including corals) and damage to fisheries infrastructure*	8
Increased climate variability -*Changes in fish and marine mammal migration patterns affecting food security and tourism*	8
Changes in rainfall patterns - *Increased incidents of landslides affecting houses, human settlements and infrastructure, and forest resources, in addition to costs for insurance and building loans*	8
Increase in extreme events –*Damage to coastal property and infrastructure due to storms surges*	7

Increase in extreme events -*Reduced availability of international donor funding due to increased demand for emergency assistance from vulnerable countries*	7
Changes in national and local temperatures regimes -*Increased damage to buildings and water cisterns from extreme dry conditions*	7
Sea level rise – combined with increased incidents of storm surges - *Increased costs for insurance, re-insurance and costs to banks providing loans for coastal infrastructure*	6
Increased climate variability - *Increased land degradation* (variation in temperature) (Note: impact on food production, water quality, health and nutrition)	6
Changes in rainfall patterns - *Impact on water quality/supply and costs of water treatment/delivery and damage to water/communication infrastructure* (NOTE: hotels and restaurants at tipping point and loss of income due to lack of water could put them out of business)	6
Increased climate variability - *Decline in tourism visitor arrivals due to more mild conditions affecting winter tourism market*	6
Sea level rise and storm surge- *Damage to coastal infrastructure from sea level rise and higher storm surges and associated impact on tourism (hotels, dive industry, yachting)* (Note: Significant cultural loss in Carib Territory and loss of beaches for recreation)	6
Increase in extreme events - *Increase cost of coastal resources management*	6
Increase in extreme events-*Damage to water resources/infrastructure and impact on water quality and costs for water supply*	6

The comprehensive assessment determined that Dominica has established a strong track record on climate change adaptation, and has made considerable progress in implementing Stage 1 adaptation measures. However, the implementation of Stage 2 and Stage 3 measures have not been possible due to serious resource (human, technical, financial) constraints. The PPCR National Adaptive Capacity Assessment identified considerable limitations in climate change risk management capacity at the systematic, institutional and individual levels, at the national, sectoral, district and local level, and within the public sector and civil society, highlighting the need for considerable capacity building. The National Adaptive Capacity Assessment confirmed the need for improved levels of earmarked financial resources for climate change risk management and resiliency building as articulated in the NCSA, and the need for improved coordination amongst key state and non state actors involved in climate change risk management. Other identified key challenges include:

- Critical infrastructure in the country is vulnerable to significant loss and damage from extreme weather events, sea level rise and storm surges;
- Lack of systems, expertise and facilities to collect, store and analyze relevant information and data on topics related to climate change;
- Inadequate knowledge and awareness of potential impact of climate change and lack of technical

skills to address them;

- Policies, laws, rules and regulations related to climate change and disaster risk reduction need strengthening and the capacity to enforce these revised regulations need enhancement; and
- Planning for coordinated response to climate change and disaster risk reduction activities need improvement.

By addressing the deficiencies identified during the SPCR priority planning process, SPCR interventions sought to support the establishment of an appropriate enabling framework to guide and facilitate Dominica's transformation to a low-carbon climate resilience development pathway that can serve as a model for other small island developing States in the region. By positioning climate change as a development issue rather than an environmental issue, Dominica's SPCR has the opportunity to demonstrate viable interventions to address climate change risks within the context of a national development framework that establishes the country firmly on the path to a Green Economy.

SPCR interventions were to be sustained in the long-term by ensuring that climate change planning/management becomes an integral part of the national development planning process under Dominica's *Growth and Social Protection Strategy* (GSPS) and ***Low Carbon Climate Resilient Development Strategy*** – the latter Strategy have been formulated under the SPCR planning process. In supporting the transition from government being solely responsible for climate change risk management to a country where this is a shared responsibility, SPCR interventions have the opportunity to demonstrate a model for transformation changes that could benefit other developing countries. Sustainability will be achieved by establishing effective partnerships with all stakeholders (public sector and civil society, technical and financial partners, local governments, vulnerable communities, grass-roots organizations) to transform Dominica to a low-carbon climate resilient country that will make a significant contribution to sustainable development in the country, and add value by ensuring that the SPCR is not a stand alone activity, but becomes a responsibility assumed by all stakeholders.

The following priority investments for support under Dominica's SPCR were identified:

Component 1 - Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development

The objective of this component was to build climate resilient communities by strengthening capacity to address climate change risks to food security associated with changing precipitation patterns. Component 1 will support the following activities:

(i) *Formulation of Water Resource Inventory* (surface and ground water resources), water balance assessment, continued monitoring of water resources, installation of hydro-met and coastal monitoring stations (including for automatic hydro-met and coastal monitoring equipment) to support establishment of community early-warning systems development (see *Component 3 (ii) below*) and formulation of Integrated Natural Resource Management Plan (*see sub-Component ii*) that will, inter alia, guide water conservation, extraction and use;

(ii) Development of Land Use Capability, and Integrated Natural Resources Management Plan and supporting legislation (as part of supporting mechanism for the National Physical Development Plan being developed with support from CDB) to regulate development in coastal and watershed areas, prevent pollution, regulate the extraction, conservation of water, and determine sustainable irrigation levels;

(iii) Establishment of food security program (to be scaled up and replicated with support under Adaptation Fund) involving:

1. design and construction of a pilot rain-fed organic greenhouse, drip irrigation, and organic food processing/storage facility utilizing renewable energy sources to demonstrate technical/financial viability to support scaling up and replication;
2. community-based pilot transplanting and restocking of climate resilient corals to demonstrate technical and financial viability in Dominica with a view to replication in other vulnerable coral reef areas.

Component 2 - Comprehensive Risk Management Framework and Sustainable Climate Change Financing.
Component 2 will support the following capacity building activities:

(i) Financing of key technical personnel needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`s ***Low Carbon Climate Resilient Development Strategy***;

(ii) design and implementation of climate change adaptation and disaster risk management education and awareness program at all levels to be coordinated by the Division of Environment, Climate Change and Development (DECCD);

(iii) community vulnerability mapping and adaptation planning undertaken for all Dominica (based on process piloted under SLM and SPACC projects) and integrated into National Physical Development Plan being developed with support from CDB – *see Component 1 (ii)*;

(iv) legal establishment of Climate Change Trust Fund in addition to US$1 million seed funding to the Climate Change Trust Fund to provide support to priority community climate change risks management measures identified through community vulnerability mapping and adaptation planning;

(iv) establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisherfolk, women and vulnerable communities in particular the Kalinago people);

(vi) establishment of climate change adaptation standards for the private sector.

Component 3 - Enhancing Infrastructure Resilience and Promotion of Sustainable Human Settlements
The objectives of this component are to establish the enabling environment whereby government, households and individuals assume the lead role in building resilient communities by addressing climate change risks to critical infrastructure. Component 3 will build climate change resilience in vulnerable communities, including through:

(i) establishment of community early warning systems based on real-time hydro-met data – *see Component 1 (i)*;

(ii) design, retrofitting/construction of at least three pilot multi-use climate resilient and energy efficient emergency shelters (one in Kalinago Territory) using appropriate traditional building methods and renewable energy sources;

(iii) design and implementation of a climate change risk management training program for Ministry of Public Works staff to climate proof the design, construction and maintenance of critical infrastructure including roads – with infrastructure climate proofing to be funded under IDA, Regional IDA and possibly IBRD loans.

Expected Outcomes from the implementation of the SPCR were to include: a) the establishment of an enabling environment to mainstream climate change risk management into national planning processes at the national, sectoral and community level and within the private sector; b) increased resilience in economic, social, infrastructural and eco-systems to climate variability and climate change through transformed social and economic development; c) climate change risks formally integrated into national physical (core) planning processes; and d) replication and knowledge sharing of Dominica SPCR lessons learned in non-PPCR CARICOM countries and SIDS.

Dominica's SPCR received strong commendation during the Independent Technical Review by an international expert retained by the Climate Investment Fund. The Independant Technical Review noted as follows:

> *"The SPCR provides a strong package of investments in climate resilience, particularly when seen in combination with parallel investments from the Adaptation Fund, IDA, and possibly IBRD. It addresses both institutional and technical capacity constraints in a range of key sectors and issues of concern. It builds upon significant previous work on adaptation in the country and the region at large. The policy imperative behind the program is very strong, based on clearly expressed high-level strategies (particularly the Low Carbon Climate Resilient Strategy) and strong political support for the climate agenda."*
>
> *"The program includes a good assessment of key climate impacts, vulnerabilities and implications (partly also based on previous work). The risk assessment and intervention prioritization methodology is strongly based on expert judgment by technical working groups, which comprise people with strong local knowledge from a range of technical backgrounds. It provides a good list of priority interventions, but could be framed more sharply in terms of its approach in dealing with climate change in the context of current variability and extremes (and the country's current adaptation deficit). This merits further attention in future capacity building, but has no strong impact on the overall program design, given that the assessment does identify a set of high-priority risks and interventions that are both climate-related and particularly relevant in the context of the current vulnerabilities and the adaptation deficit facing the country".*
>
> *"The program is tailored to the country's circumstances, and includes significant elements of institutional strengthening, which should be achievable given the high level of political ownership. Nevertheless, implementation capacity will continue to require strong support and attention, including from the World Bank and UNDP, especially given the very substantial volume of adaptation investments (also beyond the SPCR) that are being planned. In particular, the ability of the (proposed) Department of Environment, Climate Change and Development (DECCD) to demonstrate efficiency, value and effective coordination of climate change programming, and the government's commitment to ensure adequate funding, staffing and political support, will be an essential factor in the success of the SPCR and wider adaptation efforts, and should be closely followed and assessed e.g. during the mid-term review of SPCR implementation."*
>
> *"The SPCR aims to support the establishment of an appropriate enabling framework to guide and facilitate Dominica's transformation to a "low-carbon climate resilient development pathway", seeing climate risk management as a shared responsibility (among public sector and civil society,*

technical and financial partners, local governments, vulnerable communities and grass-roots organizations) rather than primarily a national government responsibility."

"The implementation arrangements depend on a new Council for Environment, Climate Change and Development (CECCD) and Department for Environment, Climate Change and Development (DECCD) (formerly the ECU), which are to be legally established under a proposed Climate Change, Environment and Development Bill, which should be passed in parliament in late 2012. ***This is clearly a critical condition for SPCR implementation.*** *It is noted that the DECCD, would initially be staffed with funding provided under the SPCR. It will be important to ensure that these positions are quickly transferred to regular core government budgets to demonstrate ownership and enhance sustainability*."

"The notion of creating an enabling framework that allows communities to better manage their own risks includes targeting especially vulnerable sectors and communities. Several of the investment areas chosen, such as food security, local early warning and shelters, and establishment of a climate trust fund and microfinance initiatives to support local adaptation, will particularly focus on poor and vulnerable communities. Effectiveness in terms of protection of livelihoods of the poor was one of the key criteria applied in the economic analysis."

Commending the Government of Dominica on a well prepared *Strategic Program for Climate Resilience* (SPCR) document, PPCR donor countries including the United Kingdom and Germany strongly supported the capacity building components and the proposal that the *Climate Change, Environment and Development Bill* be enacted prior to SPCR commencement, to demonstrate the Government of Dominica's commitment not only to the enabling framework to mainstream climate change into national planning processes, but also to ensure the adequate staffing of the Department of Environment, Climate Change and Development (DECCD) that is to be legally established under the proposed Bill.

3.5. Global Climate Change Adaptation (GCCA) Project

The GCCA project is focused on Climate Change Adaptation and Sustainable Land Management in the Eastern Caribbean including Dominica, with the OECS Commission serving as Executing Entity. The project ran from 2013-2018. The specific objective of the project is to improve the region's natural resource base resilience to the impacts of climate change, through effective and sustainable land management frameworks and practices and through specific adaptation pilot projects focused on physical infrastructure and ecosystems. In Dominica, the GCCA is supporting a physical adaptation pilot for slope and road stabilization in the Antrim Valley and Belles, in order to mitigate the effects of slippage which poses a threat to commuters and residents who live downstream and to maintain access to the main airport; as well as soil erosion management for farmers at Duck Pond and Blake's Estate.

3.6. Disaster Vulnerability Reduction Project (DVRP)

Dominica's SPCR is being implemented under the US$35 million Disaster Vulnerability Reduction Project

(DVRP) which was officially launched in September 2014. The DVRP is funded by the World Bank, International Development Association (IDA), Pilot Program for Climate Resilience (PPCR), Strategic Climate Fund (SCF) and the Government of the Commonwealth of Dominica. The total approved financing is US$39.5 million.

The DVRP Project consists of the following four components: (1) Prevention and Adaptation Investments; (2) Capacity Building and Data Development, Hazard Risk Management and Evaluation; (3) Natural Disaster Response Investments; and (4) Project Management and Implementation Support.

<u>Component 1: Prevention and Adaptation Investments (US$29.125 million – IDA (US$16 million), SCF credit (US$9 million); SCF Grant (US$3 million); Counterpart Financing (US$1.125 million)).</u> This component was designed to reduce physical vulnerability and pilot adaptive measures to build resilience to current and future hydro-meteorological shocks. Activities under this component include a suite of civil works to improve infrastructure resilience to disaster events and climate change adaptation measures. Subprojects financed under this component, through the provision of works, technical advisory services, operating costs, and acquisition of goods, include: (a) Construction of water storage and distribution infrastructure; (b) Slope stabilization interventions; (c) Climate resilient rehabilitation of primary and secondary roads and bridges along the East coast and in the South; and (d) Improved climate resilient drainage systems. Integrated hazard/climate analysis will inform engineering designs with respect to future service demands and infrastructure design life and will be built into the pre-engineering phase of each subproject.

<u>Component 2: Capacity Building and Data Development, Hazard Risk Management and Evaluation (US$7 million SCF Grant; Counterpart Financing (US$375,000)).</u> The Project supports building the capacity for analysis and assessment of risks from natural hazards and climate change, including the integration of this analysis in the development decision making process at both the project/investment level and at the national level to inform policy and investment plans. This component supports the creation of relevant core data and data collection systems as well as the integration analytical tools to permit improved decision making and engineering design for risk reduction and climate change adaptation. Core data systems to be developed under this component include: (a) creation of a high resolution digital topographic and bathymetric model for Dominica; (b) creation of a high resolution soils survey map including chemical and physical characteristics for each soil unit; (c) design and deployment of a robust hydromet network to provide high resolution hydrologic data for use in a wide range of activities to support, for example, engineering design, national land use and coastal zone planning, disaster management, resilient road construction practices and design, agricultural development and others; and (d) development of district and community level climate adaptation plans and training.

<u>Component 3: Natural Disaster Response Investments (US$1 million IDA – no SCF/PPCR funds).</u> This provisional component would allow rapid reallocation of the IDA credit, under streamlined procurement and disbursement procedures, to cover emergency response and recovery costs following an adverse natural event that causes a major disaster in Dominica. The contingent emergency component would be triggered, by an official Government of the Commonwealth of Dominica declaration of a national emergency, following an adverse natural event. Dominica may ask the Bank to re-categorize and reallocate financing

from other project components to partially cover emergency response and recovery costs. This component could also be used to channel additional funds, should they become available, in response to the emergency. Disbursements would be made either against a positive list of critical goods, both domestic and imported, and/or against the cost of procuring goods, works, consultant services, and emergency operations required to support the immediate response and recovery needs. All expenditures under this component, should it be triggered, would be in accordance with the World Bank's policy BP/OP 10.00 and would be appraised, reviewed, and found to be acceptable to the Bank before any disbursement is made. A specific Operations Manual (OM) would apply to this component, detailing financial management, procurement, safeguards, and any other necessary implementation arrangements.

<u>Component 4: Project Management and Implementation Support (US$2 million SCF Grant).</u> Activities under this component support strengthening and developing the institutional capacity for Project management, including: (a) financing the establishment of a new Project Coordination Unit (PCU) within the Ministry of Environment, including staffing, training, and operating costs; (b) preparation for designs and tender documents; (c) preparation of Project reports; (d) processing of contracts and tender evaluation; (e) coordination of participating line Ministries; (f) supervision of the quality of works; (g) training of staff in Project management and implementation support; (h) monitoring and evaluation of Project and PPCR program progress and results, and (i) related activities to support efficient Project management and implementation, through the provision of technical advisory services, training, operating costs, and acquisition of goods. The project also supports knowledge sharing and lessons learning activities at the program level and coordination with the PPCR Caribbean Regional Program in terms of knowledge management and M&R. There is a process underway at the country level supported by the CIF to align the project indicators with the PPCR core indicators and streamline M&R framework across the OECS.

The DVRP sought to contribute to vulnerability and risk reduction within Dominica through a combination of civil works, capacity building, and institutional development activities at the national and local levels. The focus of the DVRP largely moved away from the priority capacity building areas that had been identified by national stakeholders during the extensive RRCP planning process, and targeted building resilience in critical infrastructure – a strategic area of focus of the World Bank.

Despite priorities being clearly defined in the Dominica SPCR and such being approved by the PPCR Steering Committee (PPCR-SC), the DVRP supports design and construction measures to enhance resilience of selected road and drainage sub-projects, which would occur in parallel to the development of Component 2. Component 2 would have a transformative impact in the transport and other sectors by focusing on enhancing resilience of critical infrastructure and supporting improved data collection to support climate resilient construction and design standards of future investments. Improved planning to minimize climate risks will benefit from digital surveys using LiDAR technology for the entire country to identify, among others, the potential landslide areas in advance to prioritize drainage and road improvements as well as other opportunities for resiliency in other sectors, such as agriculture, water supply, and land use planning. Lessons learned will be analyzed and shared across sectors.

These activities were designed to improve national resilience to natural hazards and longer-term impacts resulting from climate change. Although broadly in line with the goal of the Dominica ***Strategic Program for Climate Resilience*** (SPCR), the DVRP does not fully implement SPCR priority resilience capacity building and risk management activities that were defined and proposed during the PPCR planning process, neither does it fully implement the thee priority component activities that were approved by national stakeholders, Cabinet and the PPCR Steering Committee (PPCR-SC) which comprise donors to the PPCR.

This change of focus not only undermines national efforts to build capacity for climate resilience, but also frustrates the priority objective of the PPCR program, namely supporting country-driven and country-owned adaptation planning.

Due to considerable changes in the scope of DVRP activities, expected outcomes for SPCR implementation are no longer possible, which has resulted in the Government of Dominica actively seeking direct access to the Green Climate Fund (GCF) in order to implement priority capacity building initiatives thereby ensuring greater country ownership and control over future climate change projects to implement commitments under the UNFCCC (see section 3.8.).

3.7. *Intended Nationally Determined Contributions* (INDC)

On the 30th September 2015, the Commonwealth of Dominica, being committed to the successful conclusion of negotiations under the Ad-Hoc Working Group on the Durban Platform for Enhanced Action (ADP) in order to adopt, at the 21st meeting of the Conference of Parties (COP21) in Paris, communicated its *Intended Nationally Determined Contribution* (INDC), in accordance with the relevant paragraphs of Decisions 1/CP.19 and 1/CP.20, towards achieving the ultimate objective of the Article 2 of the Convention. Dominica's INDC indicated that for the country, there is little distinction between adaptation and mitigation measures – an integrated response is being implemented to build climate resilience in vulnerable communities, while enabling Green Growth through the transition to sustainable energy technologies.

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

Recognising Dominica's common but differentiated responsibility and limited capabilities to address climate change, Dominica committed to progressively reduce total gross greenhouse gas (GHG) emissions below 2014 levels (164.5 Ggs est.) at the following reduction rates:

17.9% by 2020; 39.2% by 2025; and 44.7% by 2030.

By 2030, total emission reductions per sector will be as follows:
- Energy industries – 98.6% (principally from harnessing of geothermal resources);
- Transport – 16.9%;
- Manufacturing and construction – 8.8%;
- Commercial/institutional, residential, agriculture, forestry, fishing – 8.1%;
- Solid waste – 78.6%.

Benefiting from sound management practices, it was expected that Dominica forests would continue to sequester the equivalent of at least 3,600 Ggs of national GHG emissions on an annual basis during the period 2020 to 2030. Additionally, the commercial development and continued harnessing of Dominica's geothermal resources will, from 2025 onwards, enable the country to export significant amounts of renewable energy (estimated to exceed 200 MWs annually) to the nearby French Territories of Martinique and Guadeloupe, thereby contributing to global efforts to reduce GHG emissions.

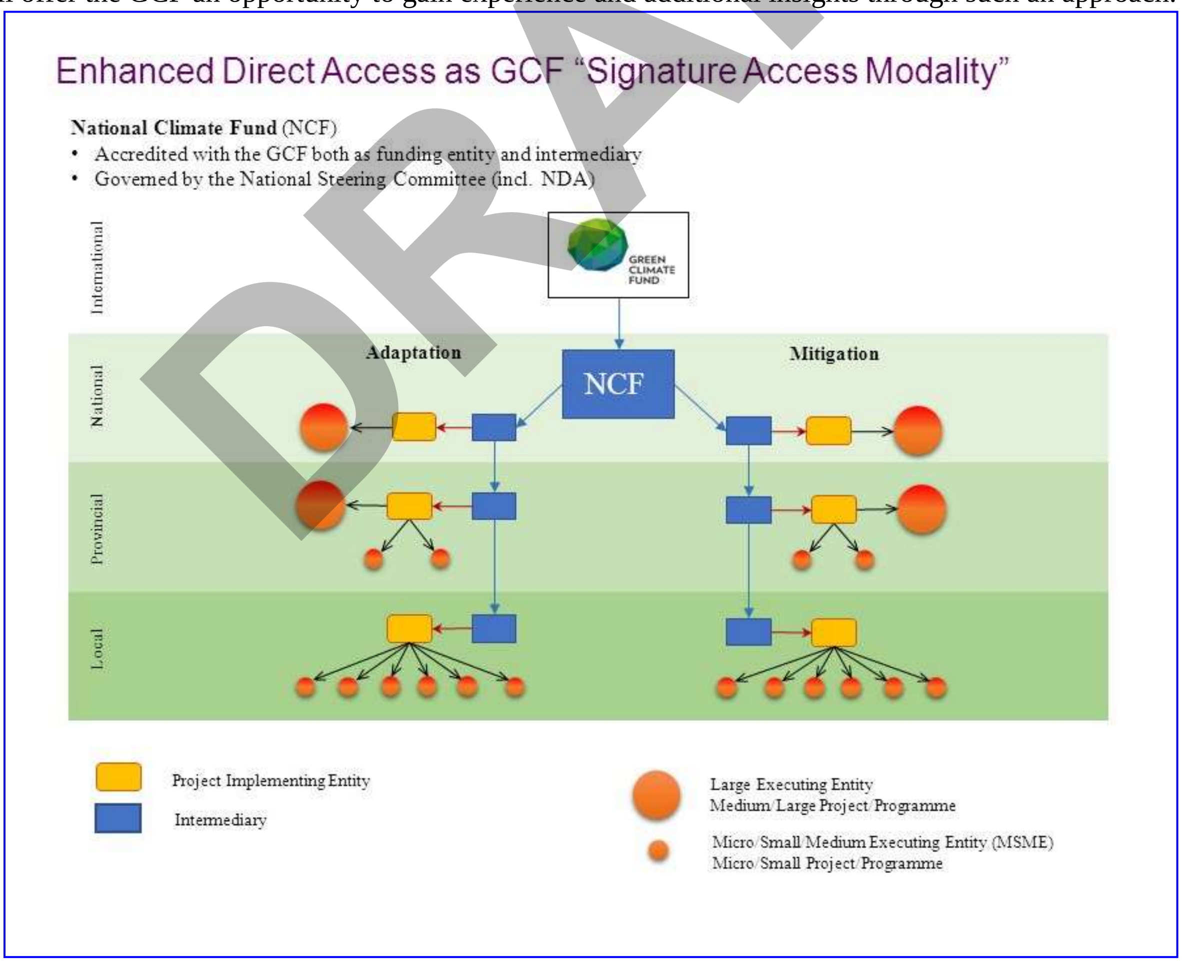
This INDC contribution is conditional upon receiving timely access to international climate change financing, technology development and transfer, and capacity building support for priority adaptation and mitigation measures. Dominica's INDC will remain provisional pending confirmation of timely access to international climate change financing, technology development and transfer, and capacity building support for priority adaptation and mitigation measures detailed in the INDC. Dependent upon COP21 outcomes, Dominica reserved the right to revise the INDC. The Government of Dominica signed the Paris Agreement on the 22nd April 2016, and lodged its instrument of ratification together with the country's *Nationally Determined Contribution* (NDC) on the 21st September 2016.

3.8. Building Capacity for Climate Resilience with Support from the Green Climate Fund (GCF).

In support of national efforts to address the deficiencies in and change of focus of the DVRP and address capacity building priorities defined by national stakeholders during the SPCR and INDC planning processes, the Government of Dominica has sought support from the Green Climate Fund (GCF) to establish two programs that target these priorities.

3.8.1. Enhanced Direct Access (EDA) Project

In 2016, the Green Climate Fund (GCF) announced a pilot initiative for Enhancing Direct Access (EDA) with the objective of the pilot to allow the GCF to effective operationalization its enhance direct access modality at the sub-national, national and regional public and private entities to the Green Climate Fund. This include devolved decision-making and stronger local multi-stakeholder engagement. The pilot phase will offer the GCF an opportunity to gain experience and additional insights through such an approach.



Led by the Government of Antigua and Barbuda, a USD 20 million Enhanced Direct Access (EDA) project was being presented to the Green Climate Fund (GCF) Board at its next meeting in the Republic of Korea in early March 2018. The project aims to build integrated resilience to climate risks of individuals and their businesses, communities and governance systems through grant and loan award mechanisms in each country that are transparently managed through decision-making by those impacted by climate change. The project is an Enhancing Direct Access pilot project to be implemented in Antigua and Barbuda, Grenada and the Commonwealth of Dominica, which was developed in response to a request for proposals issued by the Green Climate Fund in 2016.

Two out of the three participating countries suffered severe impacts last year, with Antigua and Barbuda sustaining damages and losses of about US$ 155 million due to Hurricane Irma, and the Commonwealth of Dominica is estimated to have lost US$ 1.37 billion, which is 226 percent of its Gross Domestic Product (GDP). The third country participating country, Grenada, has taken many years to recover from Hurricane Ivan which struck the island over a decade ago.

Approved by the Fund’s Board in October 2018, the Enhancing Direct Access project will transparently channel climate financing to vulnerable people and communities in the pilot countries to retrofit buildings (houses, small businesses and community buildings) using the new OECS model climate resilient building code. The project will also fund small-scale community watershed and drainage improvements to cope with flooding. The Commission of the Organization of Eastern Caribbean States (OECS) will monitor and evaluate the impact of the interventions, which will assist the participating countries to report on their *Nationally Determined Contributions* under the *Paris Agreement*.

Entitled *Integrated Physical Adaptation and Community Resilience through an Enhanced Direct Access Pilot in the Public, Private, and Civil Society Sectors of Three Eastern Caribbean Small Island Developing States*, the Enhancing Direct Access (EDA) pilot project will be implemented by the Department of Environment in Antigua and Barbuda, which was accredited to the Green Climate Fund in October 2017. The Ministry with responsibility for Environment in each of the pilot countries will serve as the Executing Entity for their country, and will benefit from capacity building in programming climate financing to vulnerable men, women and children.

The outputs of the EDA project are:

Output 1: Enhanced capacity for climate adaptation planning, implementation, and monitoring and evaluation via direct access. This will operationalize and strengthen direct access modalities in each of the small island pilot countries to strengthen financial institutions, promote openness, transparency and country ownership of climate adaptation actions across sectors and scales (national, community and individual)

Output 2: Governments implement concrete adaptation measures using ecosystem-based approaches where appropriate. This will demonstrate enhanced direct access in the public sector through an on-granting mechanism that aligns GCF-financed concrete local area adaptation projects to climate-proof ongoing investments and co-financing from the Government.

Output 3: Community resilience to climate impacts is enhanced through tangible adaptation benefits. This will demonstrate enhanced direct access for CSOs and NGOs through an on-granting mechanism for adaptation in community buildings that promotes resilience to droughts, floods and hurricanes.

Output 4: Privately owned physical assets of vulnerable populations are more resilient to climate variability and change through concessional microfinancing. This will demonstrate enhanced direct access in the private sector through a concessional on-lending revolving loans programme for adaptation in buildings (homes and small businesses).

Amongst other activities in Dominica, the EDA pilot project will support the implementation of the following priority climate resilience building measures that were identified by national stakeholders during the SPCR and INDC planning processes:

(a) Establishing the *enabling legal/institutional framework to facilitate coordination/implementation* of priority climate change measures and the mainstreaming of climate change activities into national, sectoral and community planning/development;

(b) *Creating the supportive enabling framework whereby communities and vulnerable segments of society (women, youth, elderly, people with disabilities) can manage their own climate change risks*, thereby addressing climate change impacts on vulnerable sectors (particularly agriculture, fisheries and water resources) and threats to food security, human health, poverty alleviation, sustainable livelihoods and economic growth;

(c) Establishing a *sustainable financing mechanism* to ensure timely and direct access to international climate change financing to implement priority climate change risks management measures by the private sector and vulnerable communities;

(d) Legal establishment of the Department of Climate Change, Environment and Development and the financing of key technical personnel needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`*s Low Carbon Climate Resilient Development Strategy*, and to serve as National Implementing Entity (NIE) to facilitate direct access to and management of international climate change financing under the Green Climate Fund;

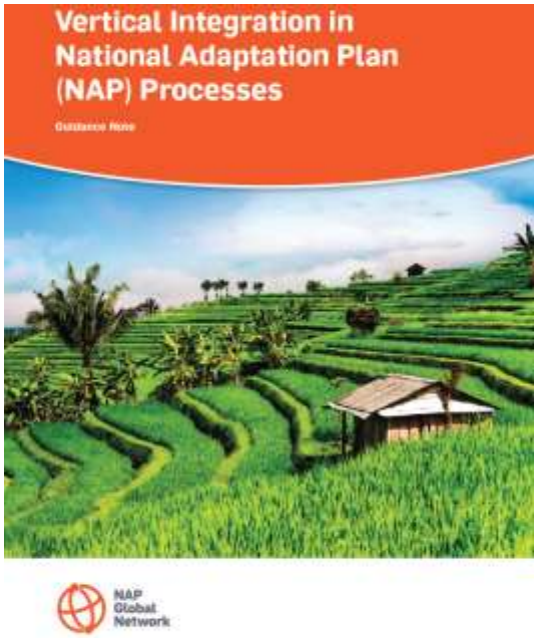
(e) Design and implementation of climate change adaptation and disaster risk management education and awareness program at all levels to be coordinated by the Department of Climate Change, Environment and Development;

(f) Legal establishment of *Climate Change Trust Fund* in addition to provision of US$6 million seed funding to the *Climate Change Trust Fund* to provide support to priority community climate change risks management measures identified through community vulnerability mapping and adaptation planning and the establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisher-folk, women and vulnerable communities in particular the Kalinago people).

3.8.2. National Adaptation Plan (NAP)

During late 2017, with support from the Department of Environment in Antigua and Barbuda, which was accredited to the Green Climate Fund in October 2017, the Government of Dominica prepared a proposal to the Green Climate Fund (GCF) to formulate a National Adaptation Plan (NAP). Antigua and Barbuda's Department of Environment has been requested by the Commonwealth of Dominica to serve as Delivery Partner for the NAP application, in furtherance of a mandate provided to Antigua and Barbuda by the OECS Ministerial Council in 2016. The Department of Environment in Antigua and Barbuda through serving as Delivery Partner for Dominica's NAP application will facilitate transfer of knowledge and lessons learned as the Commonwealth of Dominica implements a similar process of using OECS model legislation to implement the climate change multilateral

environmental agreement (MEA) commitment to undertake adaptation planning processes. This project is expected to be approved in 2018.

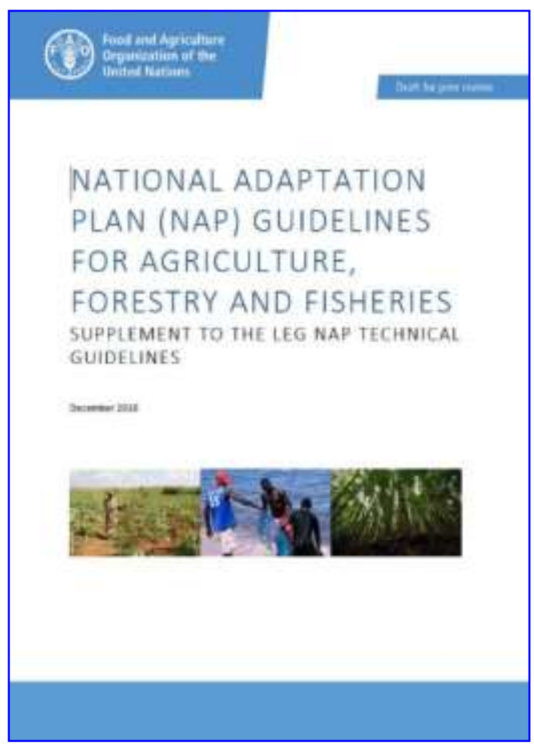


The Government and people of Dominica are receiving considerable assistance from neighbouring countries and the international community in ongoing response to Hurricane Maria, but are determined to lead these efforts to ensure that lessons learned from Hurricane Maria and Tropical Storm Erika inform and guide future reconstruction and development along a path that ensures resilience to the devastating impacts from climate change. Sensitive to the possibility of being pulled along a path that supports the agendas of well-meaning development partners rather than the needs of the country, the Government and people of Dominica are undertaking a country-owned and country driven process to develop and implement an *Action Plan for a Climate Resilient Dominica* to tackle short-term needs that will support long-term climate resilience.

The *Action Plan for a Climate Resilient Dominica* will establish a High-Level Steering Committee Co-Chaired by Prime Minister and the Minister of Health and Environment (technical lead on climate change) to provide overall guidance and support to the process, and establish a Secretariat in the Ministry of Health and Environment (jurisdictional lead for climate change and focal point) to the High-Level Steering Committee. This National Adaptation Planning (NAP) project will foster an enabling environment within legislation, institutional arrangements, and technical capacity across the public, private and NGO sectors.

The NAP project will achieve the following key outcomes:

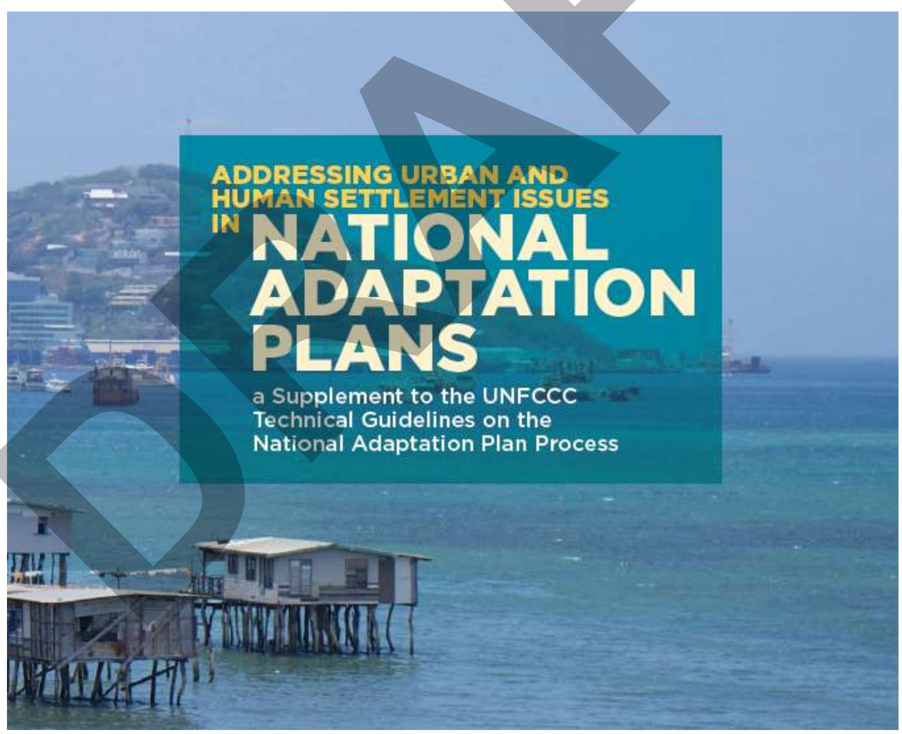
- *Legislation*: Support the advancement of the national climate change and environment law using the OECS model legislation to provide a national adaptation planning mandate and framework, and legal capacity building of the national climate change focal point;
- *Institutional arrangements*: Empowered Environmental Coordinating Unit (ECU)/Department of Climate Change, Environment and Development to coordinate the Government's policies and programs relating to climate change; high level and participatory governance bodies are constituted and convened with adequate support; climate financing architecture is vetted and strengthened;
- *Technical capacity*: Data infrastructure for adaptation and recovery are strengthened to include cloud-based storage (significant data has been lost to Hurricane Maria), and update and validation of baseline adaptation-related data;
- *Financing adaptation*: Key adaptation priorities will be identified at the national level through the NAP-supported development of up to 3 sectoral adaptation plans (e.g. Finance, Agriculture, Tourism); at the



local/community level via up to 3 local area climate resilient development plans for vulnerable communities; and at the individual/private sector level with up to 22 localised resilience action plans and investment strategies the NAP's focus on institutional capacity building.

The main impact of this project is to address key barriers to adaptation planning and implementation in Dominica. The country's bespoke experience of projects has delivered significant technical outputs and achievements; however, these project outputs are often not taken up and implemented by the Government due to capacity constraints, which has been further set back after the devastation of Hurricane Maria. The proposed NAP project will overcome this barrier by focusing on the enabling environment. The NAP project will support stakeholders to review the outputs of Dominica's various projects and donor-supported initiatives, and identify modifications and/or mainstreaming. Implementation of transformational adaptation towards the goal of climate resilient development will require large amounts of accessible and predictable resources. The NAP project will therefore enable the Commonwealth of Dominica to access scaled-up accessible and predictable financing, including through direct access modalities as a result of the NAP's focus on institutional capacity building.

This project will support and compliment Dominica in ongoing efforts to develop its Country Programme to the Green Climate Fund with support from its first "Readiness" support grant. UNDP is serving as the Delivery Partner for Dominica's first Readiness grant, to be implemented from 2018 – 2020.



4.0. Implementation of the *Low Carbon Climate Resilient Development Strategy* and *Nationally Determined Contribution.*

The following table presents a summary of activities that have been undertaken to implement the *Low Carbon Climate Resilient Development Strategy* and *Nationally Determined Contribution* (NDC), as measured against national priorities identified in those Cabinet-approved strategies. (*NOTE: ** Indicates priorities that still require resources - human, technical, financial - for implementation.)*

Priority Actions under *Low Carbon Climate Resilient Development Strategy*	**Activities Undertaken**
Mitigation Measures:	
1. Development and commercialisation of geothermal resources. i. Undertake training on geothermal energy assessment, development and technologies. ii. Develop inventory of geo-thermal resources. iii. Assess viable geo-thermal technology options. iv. Establish legislation to regulate the harnessing/export of geo-thermal energy. v. Finance design and construction of domestic geo-thermal power plant (est. 11 MW) and connection to electrical grid. vi. Establish soft financing for community and small scale private geo-thermal plants.	Activities i., iv., v. – Funding secured from Green Climate Fund (GCF) and Clean Technology Fund (CTF) for construction of 11 MW domestic Geothermal Plant and capacity building – not yet commenced. Legislation enacted and capacity building commenced with support from Government of New Zealand. Activities ii., iii., vi. - ** However, funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding for community projects to be under proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project that commenced in January 2019.
2. Harnessing of solar energy resources i. Undertake training on solar energy conversions and technologies ii. Introduce incentives for conversion to solar heating in homes and public buildings iii. Evaluate viable photo-voltaic technology options for Dominica iv. Establish feed-in tariff for solar producers	Activities i., ii., iii., iv., v. - ** Activity i. – Solar street light conversion supported by the Government of China.

v. Finance design and construction of pilot solar power facility and connection to electrical grid vi. Establish soft financing for community and small scale private solar power conversions.	<u>Activity vi.</u> Funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding for community projects to be under proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project that commenced in January 2019.
3. <u>Harnessing of wind energy resources.</u> i. Undertake training on wind energy assessments, development and technologies ii. Development of Wind Atlas for Dominica iii. Establish Feed-in tariff for wind producers iv. Finance design and construction of wind farm on east coast and connection to electrical grid v. Establish soft financing for community and small scale private wind power conversions.	<u>Activities i., iii., iv.</u> - ** <u>Activity ii</u> – Wind Atlas for Dominica developed with support from GTZ. <u>Activity v. -</u> Funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding for community projects to be under proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project that commenced in January 2019.
4. <u>Harnessing of hydro-power resources</u> i. Undertake training on hydro-power assessments, development and technologies ii. Development of inventory of hydro-energy potential in Dominica and assessment of commercial viability considering micro-hydro and run-of-river technologies iii. Establish Feed-in tariff for hydro-power producers iv. Finance pilot hydro-power plant and connection to electrical grid	<u>Activities i., ii., iii., iv</u>. - ** <u>Activity v. -</u> Funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding for community projects to be under proposed civil society project to Green Climate Fund (GCF) being

v. Establish soft financing for community and small scale hydro-power conversions.	developed under Readiness Project that commenced in January 2019.
5. Promotion of Green Communities in Support of Health/Wellness i. Undertake training on energy and greenhouse gas auditing, energy conservation and low-carbon technologies ii. Finance and commission energy/GHG audits of cities, public buildings, highway lighting iii. Establish soft financing for energy conservation and conversion to renewable energy technology including solar powered LED street lights iv. Establishment of green areas in urban development v. Undertake conversion of public buildings/infrastructure to low carbon technologies in Portsmouth vi. Establish vehicle upgrade and maintenance programs to phase in the conversion to fuel efficient and low carbon vehicles (solar powered, electrical, bio-fuel powered, hydrogen powered vehicles).	Activities iv., v., vi. - ** Activities i., ii. - ** However, funding secured from Global Environment Facility (GEF) and Caribbean Development Bank (CDB) to launch energy efficiency program – commenced in 2018. Activity iii. Funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding for energy efficiency and renewable energy projects to be under proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project that commenced in January 2019. Conversion to solar street lights supported by the Government of China.
6. Reducing greenhouse gas emissions through improved connectivity and waste management i. Undertake greenhouse as audits of waste landfills ii. Upgrade roads to improve connectivity, reduce travel time and emissions from vehicles iii. Assess feasibility of appropriate waste-to energy technologies iv. Implement pilot waste to energy project in Roseau.	Activities i., iii., iv. - ** Activity iii. Upgrade of Roseau/Portsmouth and Roseau/Douglas-Charles Airport completed with assistance from Governments of China and France.
7. Protection of carbon sinks. i. Provide training on forest/agricultural inventory procedures ii. Provide capacity building to Forestry Division to undertake forestry inventory to measure above and below ground carbon within forests and use of computer generated forest monitoring technologies iii. Undertake forest inventory	Activities i., ii., iii., iv., v., vi., vii. To be supported under REDD+ project to be implemented with assistance from FAO. Activities iv., viii.- **

iv. Determine carbon uptake of existing forest/agricultural lands and marine areas v. Assess viability of protecting additional forest/agricultural land and marine areas vi. Establish compensation framework to support protection of forest and agricultural land – particularly in buffer areas faced by encroachment or conversion vii. Prevention of de-forestation for firewood; viii. Protect new and additional carbon sinks.	No resources secured for assessment of carbon uptake by marine areas.
8. Development of biofuels to reduce petroleum imports. i. Provide training on first and second generation biofuels technologies, processes and costs ii. Assess feasibility of viable first and second generation biofuel options for Dominica iii. Establish soft financing to facilitate start-up of pilot biofuel production iv. Establish supporting legislation to facilitate introduction of biofuels for vehicles and generators	Activities i., ii., iv. - ** Activity iii. Funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding for renewable energy projects to be under proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project that commenced in January 2019.
9. Sustainable financing for low carbon technologies and energy conservation. i. Provide training on climate change financing for private sector ii. Assess viable options to finance conversion to low-carbon technologies using market based instruments (carbon levy) iii. Design architecture for Climate Change Trust Fund to finance conversion to low-carbon technologies. iv. Legally establish Climate Change Trust Fund.	Activity i. Training on climate change financing for private sector to be provided under Green Climate Fund (GCF) Readiness Project that commenced in January 2019. Activity ii. - ** Activities iii., iv. Funding for the design and to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018.

10. Development of low-carbon management services and technologies i. Design and present training programs on energy auditing, greenhouse gas auditing, energy conversions, low-carbon technologies (installation and maintenance) ii. Establish standards and certification programs for low-energy appliances/equipment, energy auditing and greenhouse gas auditing iii. Promote professional certification of low-carbon management service/technology providers.	Activities i., ii., iii. Funding secured from Global Environment Facility (GEF) to launch private sector energy efficiency program – commenced in 2018.
Adaptation Measures:	
Component 1 - Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development - Develop and implement Climate Resilient Agriculture/Fisheries and Food Security Management Program. (i) Water resource inventory and development of water resource management plan to regulate harvesting, conservation and export of water; (ii) Crop diversification program including organic production; (iii) Land suitability and capability mapping to be integrated into the National Physical Development Plans of the Physical Planning Division (supported by CDB) (iv) Promotion of improved crop varieties – e.g. drought and pest/disease resistant crops; (v) Changes in agricultural production systems – e.g. Organic, greenhouses; (vi) New and improved appropriate agricultural technologies – e.g. irrigation powered by renewable low-carbon energy; (vii) Protection of agricultural lands and fish nurseries; (viii) Improved soil and land management; (ix) Improved agricultural land use planning; (x) Agro-forestry for soil and watershed protection; (xi) Promote the sustainable utilization of non-timber forest products and sustainable wildlife farming; (xii) Increased agricultural/fishery productivity, value-added, and export; (xiii) Improved sanitary and phyto-sanitary systems;	Activities (i) to (x) and (xiii) to (xxiv) - ** Activity (xi) - Rehabilitation of Trails and Facilities within National Parks and Ecotourism Sites supported under DVRP and ecosystem resilience building supported under GEF project.

(xiv) Improved agricultural/fishery food quality, safety, standards; (xv) Self-sufficiency in food production and reversal of trend for farmers leaving the land and fisher folk leaving the sea; (xvi) Promotion of local production rather than imported produce; (xvii) Management of climate change impacts on farmer's/fisher folk health (heat stress, risks from extreme events, increase in water and vector borne disease, use of harmful chemical to control pests/diseases); (xviii) Agricultural Information Management System - Applied research, agro-met stations and information systems, education, and monitoring to determine changes in agro-biodiversity, yield, physiology, productivity, marketing, extension services, data management. (xix) Establishment of Integrated coastal and watershed management plan and supporting institutional framework to protect marine resources and biodiversity; (xx) Transplanting and restocking of climate resilient corals; (xxi) Research to determine species and site specific impacts of climate change on fisheries resources; (xxii) Aquaculture/ silviculture research and development utilising renewable energy (solar, hydro, wind) ; (xxiii) Marine product development and diversification – including alternate fishing methods/technologies; (xxiv) Institutional strengthening and climate risk capacity building within the fisheries sector (including fishing community in Kalinago territory) to facilitate shift to stakeholder management.	Activity (xii) - Amphibian Captive Breeding supported under DVRP
Component 2 - Comprehensive Risk Management Framework and Sustainable Climate Change Financing - Institutional strengthening and capacity building to effectively implement component activities. (i) Legal establishment and institutional strengthening of Division of Environment, Climate Change and Development (DECCD) to coordinate effective implementation of Dominica's Low-Carbon Climate-Resilient Development Strategy; (ii) Develop climate change risks management standards – based on international quality or risk management standards – and pilot with private sector - tied to capacity building for climate change risk assessment and management in vulnerable private sector operations.	Activities (i), (iii), (iv), (v), (vi), (vii), (viii) – Being implemented under GFC EDA project (commenced October 2018) Activity (ii) – Supported under Civil Society Component of GCF Readiness Project.

(iii) Establishment of sustainable climate change and disaster risk financing mechanisms to support urgent priority interventions, including: (iv) Climate Change Trust Fund - external to government revenue – with funds raised from market-based instruments that will not raise the local tax base (e.g. carbon levy on energy use – possibly use portion of Petro Caribe deferred payment scheme on fuels (2% interest) EC$200 million accrued over 6 years with donors providing matching funds); (v) Micro-finance and micro-insurance for farmers, fisher folk, private sector and vulnerable communities – including capacity building in financial institutions to manage climate change risks and delivery of climate change risks financing instruments – tied to climate change adaptation standards; (vi) Climate change and disaster risk management insurance for vulnerable businesses including tourism/agriculture/fisheries businesses and facilities; (vii) Climate resilience small grants facility (with a percentage set aside for Kalinago territory) to support priority climate resilience programs in vulnerable communities – supported by NGOs. (viii) US$4-9 million for micro-finance and micro-insurance for farmers, fisher folk, private sector and vulnerable communities, in particular the Kalinago people and women. (US$4 million loan).	
<u>Component 3 - Enhancing Ecosystem/Infrastructure Resilience and Promotion of Sustainable Human Settlements - Climate proofing of critical infrastructure, improving access to markets, and building climate resilient communities.</u> (i) Construction of coastal and river defences - which is also a tourism product that addresses health and recreational impacts and beach enhancement; (ii) Slope stabilization, retrofitting primary and secondary roads and bridges; (iii) Improved transportation, processing, storage of agricultural/fisheries products and improved access to markets; (iv) Retro-fitting (climate proofing) houses, roads and critical infrastructure; (v) Retro-fitting/construction of community multi-purpose emergency shelters;	<u>Activities (i), (ii), (iv),</u> - Being implemented under DVRP and with EU support under 11th EDF. <u>Activity (iii)</u> – improved roads infrastructure supported with assistance from the Governments of China and France, and under EU BAM program. <u>Activity (v)</u> – retrofitting of community clinics being undertaken by Ministry of Health <u>Activities (iv) and (vii)</u> - supported by OECS GCCA project to develop and provide training on Climate Resilient

(vi) Establishment of community-based early warning systems (including for fishing communities) and monitoring and community-based disaster management structures;	Building Codes and climate proofing of roads supported under DVRP
(vii) Implement and enforce environmental protection legislation and climate proofed building codes;	Activity (vi) – establishment of comprehensive hydro-met systems to support early warning system supported under DVRP
(viii) Effective waste and waste-water treatment management;	
(ix) Improved climate proofed drainage;	
(x) Maintenance of storm water drainage;	
(xi) Increased water storage and treatment capacity the latter using renewable energy technologies.	Activity (ix) – supported under DVRP
(xii) Establishment of Integrated Coastal Zone and Watershed Management Planning Framework (to be integrated into National Physical Development Plan, supported by CDB) including:	
(xiii) Inventory of surface and ground water resources, water balance assessment, continued monitoring of water resources, hydro-met monitoring stations (see also Component 1);	
(xiv) Update soil map and natural resource inventory;	
(xv) Community-based vulnerability mapping and adaptation planning supported by community awareness programs;	
(xvi) Central data-base to facilitate access of information to all users;	Activity (xiv) – Update of soil map supported under DVRP
(xvii) Zoning to ensure businesses are not built in vulnerable areas;	
(xviii) Land Use Zoning Plans / Land Management Plans to guide and control development in vulnerable areas	Activity (xv) – Supported under DVRP and GEF SLM projects.
(xix) Improve and implement climate proof building codes and develop effective monitoring capability to build resilience in the construction industry (and address informal buildings including through provisions attached to loans and mortgages) – backed by education and awareness at community level, legislation and effective enforcement / monitoring of the rate of coastal erosion	Activity (xix) - Supported by OECS GCCA project to develop and provide training on Climate Resilient Building Codes
(xx) Research, measurement and monitoring of coastal data (wave, current, sediment budgets, beach profiles)	
(xxi) Natural wind breaks and reduction of soil erosion through natural systems;	Activities (xx), (xxii), and (xxiv) – Supported under DVRP
(xxii) Enhance protection of river banks and other protected areas;	
(xxiii) Protection of water catchments areas.	

(xxiv) Climate change risk management capacity building in key infrastructure and water resource management agencies. (xxv)	
Priority under *Nationally Determined Contribution* (NDC)	**Activities Undertaken**
Mitigation Measures:	
1. New Domestic Geothermal Generation Plants.	Funding secured from Green Climate Fund (GCF) and Clean Technology Fund (CTF) for construction of domestic Geothermal Plant and capacity building – not yet commenced.
2. Energy Efficiency (EE) Programme.	Funding secured from Global Environment Facility (GEF) and Caribbean Development Bank (CDB) to launch energy efficiency program – commenced in 2018.
3. Solar Photovoltaic (PV) conversion program for Hotel Sector.	Funding secured from Global Environment Facility (GEF) to launch private sector energy efficiency program – commenced in 2018.
4. Solar Photovoltaic (PV) conversion program for Commercial, Institutional and Manufacturing Facilities	**
5. Off-Grid Hybrid Micro-Hydro, Wind, Solar PV, DG Back-up for Ross University	No longer a Priority – Ross University has re-located from Dominica after Hurricane Maria.
6. Replace Streetlights in Portsmouth with Off-grid Light Emitting Diode (LED) Fixtures.	Funding secured from Global Environment Facility (GEF) to launch energy efficiency program – commenced in 2018.
7. Transport Sector Emissions	**
8. Reduce Methane Emissions from Landfill	**

9. Capacity Building	Funding secured from Global Environment Facility (GEF) to launch energy efficiency program – commenced in 2018.
10. Off-Grid Hybrid Wind, Solar, Biodiesel Generator Back-up in Off-grid Mini-Grid Configuration for South-East and East Coast of Dominica.	Integral part of DOMLEC's *Recovery Plan* (December 2017) after Hurricane Maria – (status to be determined)
Adaptation Measures:	
1. Addressing climate change mitigation measures on the basis that savings in energy costs will allow Dominica to invest more in priority and much needed adaptation measures.	See above mitigation activities.
2, Establishing community off-grid mini-grid or micro-grid renewable energy electrical supply systems (backed up by emergency alternative energy systems (such bio-diesel generators, should local conditions allow for the operation to be efficiently established) in vulnerable communities on the east and south east coasts.	See above mitigation activities.
3. Establishing early warning systems, multi-use disaster shelters (powered by renewable energy and back up bio-diesel generators) and emergency preparedness training programs in vulnerable communities.	**
4. Facilitating capacity building through education, awareness and training programs on climate change risks and resiliency measures in order to strengthen capacity at the community and sectoral level, within municipalities and local authorities, and the private sector.	**
5. Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development to build climate resilient communities by strengthening capacity to address climate change risks to food security associated with changing precipitation patterns.	**
6. Establishing the enabling legal/institutional framework to facilitate coordination/implementation of priority climate change measures and the	Funding secured from Green Climate Fund (GCF) under EDA project – commenced in 2018.

mainstreaming of climate change activities into national, sectoral and community planning/development.	
7. Creating the supportive enabling framework whereby communities and vulnerable segments of society (women, youth, elderly, people with disabilities) can manage their own climate change risks, thereby addressing climate change impacts on vulnerable sectors (particularly agriculture, fisheries and water resources) and threats to food security, human health, poverty alleviation, sustainable livelihoods and economic growth.	Proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project – commenced in January 2019.
8. Establishing a sustainable financing mechanism to ensure timely and direct access to international climate change financing to implement priority climate change risks management measures by the private sector and vulnerable communities.	Funding secured from Green Climate Fund (GCF) under EDA project – commenced in 2018.
9. Legal establishment of the Department of Climate Change, Environment and Development and the financing of key technical personnel needed to ensure effective and timely implementation and coordination of the SPCR program and other climate resilient programs under Dominica`s Low Carbon Climate Resilient Development Strategy, and to serve as National Implementing Entity (NIE) to facilitate direct access to and management of international climate change financing under the Green Climate Fund.	Funding secured from Green Climate Fund (GCF) under EDA project – commenced in 2018.
10. Design and implementation of climate change adaptation and disaster risk management education and awareness program at all levels.	Part funded under DVRP.
11. Legal establishment of Climate Change Trust Fund in addition to US$5 million seed funding to the Climate Change Trust Fund to provide support to priority community climate change risks management measures identified through community vulnerability mapping and adaptation planning and the establishment of micro-finance and micro-insurance for private sector and vulnerable segments of society (farmers, fisher-folk, women and vulnerable communities in particular the Kalinago people).	Funding to legally establish the Climate Change Trust Fund secured from Green Climate Fund (GCF) under EDA project – commenced in 2018. Financing of US$5 million seed funding to be under proposed civil society project to Green Climate Fund (GCF) being developed under Readiness Project that commenced in January 2019.

5.0. Policy Objectives and Approach - Building a Climate Resilient Dominica while sustaining Carbon Negative Development

Resilience:
The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.

(Source: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Special Report of the Intergovernmental Panel on Climate Change. IPCC 2012.)

While there are several sectors and issues identified by national stakeholders during the SPCR and INDC planning processes as being important to address climate change risks in Dominica, there are a few that require priority attention if building of climate resilience is to be achieved. Several of these priorities, as identified by national stakeholders during the SPCR planning process and INDC development process, have not yet been funded or implemented under the DVRP or other programs, and yet ***possess the greatest potential to contribute to the successful transformation of the country to a climate resilient low carbon development path.***

Based on lessons learned from Tropical Storm Erika and Hurricane Maria, the National Climate Change Committee, during consultations to develop this *National Climate Change Policy and Action Plan*, ***identified the following objectives for the Policy and defined priorities for action outlined below that need to be undertaken over the next 5 years in order to establish the foundations for building a climate resilient carbon neutral Dominica.***

5.1. Objectives - Proposed Approach

The objective of this Policy is to define the priority interventions and actions required over the next 5 years ***to build resilience to current exposure to climate extremes*** (Category 5 Hurricanes, Intense Precipitation).

5.2. Priorities For Building Climate Resilience

In order to establish the foundations for building a climate resilient carbon neutral Dominica, priorities for action to be undertaken over the next 5 years are activities that will –

- ***reduce exposure and sensitivity to priority climate risks*** (see summary of risks at pages 26-27);
- ***enhance adaptive capacity***;
    - (a) within vulnerable communities and households;
    - (b) within vulnerable sectors (e.g. agriculture, fisheries, tourism);
    - (c) within key agencies/organisations (public and within civil society);
    - (d) at the national level,
- ***enhance resilience of ecosystems***, including measures that reduce stress on natural systems (forests, rivers, coastal areas);
- ***enhance resilience of homes and critical infrastructure;***
- ***have a positive impact on social capital, the quality of basic services, and natural resources that provide essential environmental services***.

5.3. Measurable Outcomes

Building resilience to current exposure to climate extremes will require that the ***following outcomes are achieved*** in the next 5 years:

(a) ***Establish & maintain the databases, information management and sharing systems and early warning mechanisms*** to facilitate informed decision-making and manage immediate risks from climate change among government, non-government stakeholders, communities, and civil society including the private sector;

(b) ***Increase access to resources*** (human, technical, financial) ***to manage immediate climate change risks*** at the national, sectoral and community levels, within civil society and amongst vulnerable members of the population;

(c) ***Strengthen capacity to manage immediate climate change risks*** at the national, sectoral and community levels, within civil society and amongst vulnerable members of the population;

(d) ***Establish priority interventions required to address immediate risks from climate change to key economic sectors*** and amongst vulnerable members of the population;

(e) ***Reduce reliance on imported fuels and ensure the sustainability of electricity supply*** (before, during and after extreme events);

(f) ***Improve coordination*** among key stakeholders to implement country-specific climate resilient programmes.

5.4. Policy Directives and Action Plan

Over the next 5 years, the Government of Dominica, working with civil society and international development partners, will mobilize the resources (human, technical, financial) to implement the following policy directives and actions –

(a) Establish &maintain the databases, information management/sharing systems and early warning mechanisms to facilitate informed decision-making and manage immediate risks from climate change among government, non-government stakeholders, communities, and civil society including the private sector.

<u>Actions</u>:

(i) Undertake site-specific vulnerability and climate change risk assessments to map (on National Land Information System) risks at the community/household levels and affecting public and private sector buildings/operations in key economic sectors;

(ii) Undertake comprehensive inventory of water resources (surface and underground), and develop/approve comprehensive water resource management plan to ensure access to water resources during and after an extreme event and to manage risks from flooding;

(iii) Establish a National Land Information System (on a computerised Geographic Information System) that includes - (A) maps showing areas prone to landslide, flooding, earthquakes, and storm surge (B) information on disaster response services/facilities, that shall be made available to the public and linked to the land registry and cadastral information system accessible to the public, developers, bankers and insurers;

(iv) Establish comprehensive national system of hydro-meteorological guages and data/information system that shall be made available to the public in real-time to support household/community early warning system;

(v) Establish and maintain comprehensive data/information management system needed for national reporting under the Rio Conventions on land use, biodiversity and climate change;

(vi) Establish community/household early warning system and community disaster management plans, and train communities/ households on disaster preparedness;

(vii) Establish, expand and adequately equip the national network of multi-use and long-term emergency multi-purpose emergency shelters powered by renewal energy (with backup solar or bio-fuel generators), with access to satellite phones and capable of dealing with special needs persons;

(viii) Establish, maintain and provide training on disaster response plans for communities, health facilities, schools, emergency services, essential services, vulnerable organizations;

(ix) Establish and maintain stockpile of emergency supplies (food, water, medicine, building materials, generators, satellite phones) at community emergency shelters, and provide training in the distribution of emergency supplies;

(x) Establish and maintain community food banks utilizing locally grown and processed produce, and establish quality assurance system to ensure that relief supplies are fit for consumption.

(b) ***Increase access to resources*** (human, technical, financial) ***to manage immediate climate change risks*** at the national, sectoral and community levels, within civil society and amongst vulnerable members of the population.

Actions:

(i) Implement the Enhanced Direct Access (EDA) project supported by the Green Climate Fund (GCF), including the legal establishment and capitalisation of the Dominica Climate Change Trust Fund;

(ii) Enact and implement the *Climate Change, Environment and Natural Resource Management Bill*, and strengthen the capacity of the Department of Environment, Climate Change and Development to be legally established under the legislation;

(iii) Establish and maintain insurance for vulnerable government buildings and essential services (electricity, water, waste management);

(iv) Establish and maintain micro-insurance and micro-finance schemes for vulnerable segments of society;

(v) Strengthen the capacity of the Office for Disaster Management (ODM), provide access to National Land Use System and computerised Geographic Information System (GIS), and strengthen capacity of Community Emergency Response Teams (CERTs) and Community Disaster Response Teams (CDRTs);

(vi) Build capacity for climate change risk management - provide human and technical resources, guidance and information at the household, business and community level on climate risk assessment and management.

(c) ***Strengthen capacity to manage immediate climate change risks*** at the national, sectoral and community levels, within civil society and amongst vulnerable members of the population.

Actions:

(i) Strengthen national capacity to manage waste after hurricanes and flooding events;

(ii) Establish and implement a post-disaster waste management policy and action plan linked to national waste to energy system;

(iii) Support the establishment of rain water harvesting/storage systems for households, government buildings and the private sector;

(iv) Develop water resource management plan to ensure the sustainable harvesting of underground water resources;

(v) Establish and maintain mini- and micro grids for vulnerable households, public buildings, and the private sector, using renewable energy with backup storage;

(vi) Establish and enforce standards for organic production, water quality, environmental management, and pollution control;

(vii) Strengthen capacity for food and water security and the provision of essential medical services at the household, business and community level;

(viii) Establish and maintain national and community stockpiles of building materials, food, water and medicines.

(d) ***Establish priority interventions required to address immediate risks from climate change to key economic sectors*** and amongst vulnerable members of the population.

Actions:

(i) *Fisheries* - develop and implement a business continuity plan for the sector (*Note – also see (g) below*);

(ii) *Agriculture* - develop and implement a business continuity plan for the sector *(Note – also see (g) below)*;

(iii) *Forestry* – complete Forest Resource Inventory and develop Forest Resource Management Plan to build ecosystem resilience and restore capacity of forest areas to serve as carbon sink;

(iv) *Tourism* – support the development of facility disaster management plans for tourism faculties/services, establish micro-finance and insurance programs for the sector, strengthen capacity to undertake climate change and disaster risk assessments, energy efficiency assessments, and the training of tourism personnel in risk management, and in the development and implementation of business continuity plans;

(v) *Small businesses* - support the development of facility disaster management plans for small businesses, establish micro-finance and insurance programs for small businesses, strengthen capacity to undertake climate change and disaster risk assessments, energy efficiency assessments, and the training of small business operators in risk management, and in the development and implementation of business continuity plans;

(vi) *Health* – undertake climate resilience risk assessment for each health facility, build capacity of health personnel to undertake energy efficiency assessments, climate change and disaster risk assessments, design and implement risk assessment management plan, and train health service personnel staff in risk management, and in the development and implementation of a business continuity plan for health services;

(vii) *Utilities* – (DOMLEC, DOWASCO, Telecoms, Waste) support in building capacity of utilities to undertake climate change and disaster risk assessments, and design/ implement risk management plans and develop/implement business continuity plans;

(viii) *Vulnerable members of the population* – establish household micro-insurance programs, and micro-finance program to support the rebuilding of homes to comply with OECS climate resilient building codes.

(e) Reduce reliance on imported fuels and ensure the sustainability of electricity supply (before, during and after extreme events).

<u>Actions:</u>

(i) Finalize and implement the renewable energy and energy efficiency program proposed under DOMLEC'S *Integrated Resource Plan* (IRP) developed after Hurricane Maria with support from the Rocky Mountain Institute, including the establishment and implementation of a nett metering policy/program;

(ii) Undertake a feasibility study for the export of geothermal energy to nearby French Territories;

(iii) Obtain technical support to negotiate and conclude power purchase agreements (PPAs) for the commercialisation of geothermal resources;

(iv) Undertake a country-wide geothermal assessment and mapping of geothermal resources to maximize the development/commercialization of community geothermal opportunities;

(v) Update the wind power map/assessment for Dominica and undertake site specific wind mapping on viable sites for 12 month period to support private sector investments in wind energy;

(vi) Explore and secure private sector financing for wind, solar, hydro and hydrogen power investments;

(vii) Investigate the potential for run of the river hydro power opportunities;

(viii) Establish the renewal energy micro grids with renewal energy backup power supplies for remote vulnerable communities proposed in the DOMLEC Post Hurricane Maria Recovery Plan (December 2017);

(ix) Operationalize the domestic geothermal power plant;

(x) Expand energy efficiency and energy conservation in offices, businesses, homes, government buildings and facilities;

(xi) Establish incentive scheme to encourage household conversion to renewal energy;

(xii) Establish and implement the energy efficiency building code;

(xiii) Establish and implement energy efficiency standards and air emission standards for vehicles and electrical generators.

(f) Improve coordination among key stakeholders to implement country-specific climate resilient programmes.

<u>Actions:</u>

(i) Enact and implement the *Climate Change, Environment and Natural Resource Management Bill;*

(ii) Strengthen the capacity of the institutions to be legally established under the *Climate Change, Environment and Natural Resource Management Bill*, including-

(A) the Council for Environment, Climate Change and Development (CECCD) to be co-chaired by the Prime Minister and the Minister responsible for Environment and Climate Resilience, Disaster management and Urban Renewal,

(B) the Department of Environment, Climate Change and Development, and

(C) the National Climate Change Committee;

(D) the Dominica Climate Change Trust Fund;

(iii) Establish a broad-based stakeholder consultation and "no objection" process for the development of projects to be funded by the Green Climate Fund (GCF).

(g) Resilience Measures for Key Sectors (Agriculture, Fisheries and Food Security) to address key impediments to building resilience, namely access to financing for recovery, insurance, critical investments.

Actions:

Develop, draft and enact new legislation in 2019 that would:

(i) require the Departments of Agriculture and Fisheries in collaboration with local farmers and fisherfolk, to ***establish an agriculture/fisheries complex*** (to serve as market, education & social centre, and tourist attraction) comprising a facility for refrigeration and display of local produce where farmers/fisherfolk can bring produce / value added products and fish catch and will be paid cash.

(ii) Legally ***establish the Dominica Agricultural and Fisheries Marketing Board*** (modelled on the former Banana Marketing Board) to administer the agricultural and fishers complex – Marketing Board to be managed by a Board of Directors with membership drawn for farmers, fisherfolk, suppliers and other people directly involved in the industry - to be private sector owned and driven.

(iii) Agricultural and Fisheries Marketing Board's mandate will be to on-sell all produce and fish bought from farmers/fisherfolk, retain small percentage and place in trust fund which is to ***fund initiatives to support the agricultural/fishing industry, food security, product development, branding, micro-insurance, micro-finance, value added product development, monitoring of standards***. Agriculture and Fisheries Marketing Board to establish sound fiduciary management framework for the Fund.

(iv) Agricultural and Fisheries Marketing Board will ***institute micro-finance and micro insurance for farmers & fisherfolk*** with premiums coming from percentage of produce sold though the agricultural complex.

(v) Agricultural and Fishereis Marketing Board would establish a roster of ***registered local farmers/fisherfolk who can sell crops at the complex and would also get benefits from the Fund*** (see above) - Membership of the Agricultural and Fisheries Marketing Board will be voluntary.

(vi) Agricultural Marketing Board will establish and ***provide training to members on risks management, quality standards, business planning***, development of value added products.

(vii) Agricultural Marketing Board will ensure food safety standards are maintained and a stock pile of food is available after a disaster.

(viii)	Agricultural Marketing Board will promote diversification, organic production and crop resilient produce.

6.0. Accountability, Responsibility, Reporting, Periodic Review and Monitoring

Effective implementation of **Dominica's *National Climate Change Policy and Action* Plan** will be coordinated by the Council for Environment, Climate Change and Development (CECCD) that is to be legally established under the proposed *Climate Change, Environment, and Natural Resource Management Bill* that is being developed through broad-based consultation and which is to be presented for enactment before the end of 2019. The Council for Environment, Climate Change and Development, to be co-chaired by the Prime Minister and the Minister responsible for Environment, Climate Resilience, Disaster Management and Urban Renewal, is a high-level coordinating body with responsibility to:

- Provide coordination, guidance and direction for the formulation and implementation of climate change-related policies;
- Provide guidance for the integration of climate change-related aspects in national policies, perspective plans and programmes;
- Take necessary measures to integrate climate change into the national development agenda;
- Initiate and coordinate activities related to additional financial and technical support to climate change-related programme and projects; and
- Initiate and coordinate measures to achieve additional benefits from climate change-related international negotiations and decisions.

The Department for Environment, Climate Change and Development (DECCD) (formerly the ECU) that is to be legally established under the proposed *Climate Change, Environment, and Natural Resource Management Bill* will function as the Secretariat of the Council, and will be tasked with the day-to-day technical coordination of **Dominica's *National Climate Change Policy and Action* Plan** in collaboration with the Ministry of Finance and other implementing agencies. DECCD will work through various line agencies and organisations at the municipal, district and community levels to deliver, monitor, and report on climate change programs under the Policy and Action Plan.

The DECCD will report to the Council for Environment, Climate Change and Development (CECCD) to provide regular reports on implementation and administration of **Dominica's *National Climate Change Policy and Action* Plan**. The National Climate Change Committee, comprised of technical experts from government, private sector, NGOs and statutory boards, and the working level focal point will provide technical input during implementation of the Policy and Action Plan from other ministries at the working level. This will ensure that non-State actors, such as civil society and private sector, are able to fully participate and are actively engaged in the implementation of **Dominica's *National Climate Change Policy and Action* Plan** thereby facilitating a significant shift in mainstreaming activities to civil society.

Like the GSPS, **Dominica's *National Climate Change Policy and Action Plan*** is a time-bound policy that will be regularly updated by the CECCD to ensure that it is kept current and revised to address changing circumstances.

Implementation of priority climate change activities identified in this Policy and Action Plan is a joint responsibility led by the Ministry of Environment, Climate Resilience, Disaster Management and Urban Renewal. The Council for Environment, Climate Change and Development (CECCD) and the Department of Climate Change, Environment and Development (currently the ECU) that are to be legally established under the proposed *Climate Change, Environment, and Natural Resource Management Bill* will be responsible for coordinating climate change programming in Dominica. The Department of Climate Change, Environment and Development is to establish and manage the National Climate Change Trust

Fund established under the *Climate Change, Environment, and Natural Resource Management Bill,* and together shall serve as one of the National Implementing Entities (NIEs) for climate change programs in Dominica. Dominica will implement the NAP, EDA and “Readiness” programs supported by the Green Climate Fund to establish the necessary legal, institutional and fiduciary management framework and accredit the Department of Climate Change, Environment and Development as one of Dominica’s National Implementing Entity (NIE) to facilitate direct access, thereby reducing dependence upon intermediary agencies for the design and implementation of priority adaptation interventions.

The Department of Climate Change, Environment and Development will report to the CECCD to provide regular reports on the implementation and administration of climate change programming in Dominica. Given the very substantial volume of climate change investments proposed and the additional institutional capacity required to undertake climate change programming, implementation capacity will be closely monitored and assessed periodically throughout implementation. The Government of Dominica is committed to providing the necessary resources to ensure the timely and successful implementation of the ***National Climate Change Policy and Action Plan***. However, In light of limited resources, the implementation of the Policy and Action Plan will be conditional upon receiving timely access to international climate change financing, technology and capacity building support for priority adaptation/mitigation measures.

ANNEX 2

Detailed Calculations (Chapter 4)

4.0. Overview

This Annex contains the detailed calculations for national inventory of greenhouse gas (GHGs) emissions from land use and carbon sinks (forest and agriculture lands) by sources and removals by sinks of greenhouse gases from Dominica for the years 2014-2017, as summarised in Chapter 4. The categories of land used for this assessment were as provided in the *IPCC Good Practice Guidance for Land Use, Land Use Change and Forestry* (LULUCF).

4.1. Forest Land Remaining Forest- Change in Carbon Stocks

In this section, the methodology for calculating "carbon stock changes and greenhouse gas emissions and removals associated with changes in biomass and soil organic carbon on the forest lands" was to be determined. It also takes into account managed forests and not natural and undisturbed forests. According to the IPCC LULUCF a manage forest/forest management is:

> *Forest management is the process of planning and implementing practices for stewardship and use of the forest aimed at fulfilling relevant ecological, economic and social functions of the forest...A managed forest is a forest subject to forest management.*

Subsequently, any forest, whether for commercial felling or any planning or management for non-commercial purposes will be construed to be a managed forest. For the purposes of this analysis, all of Dominica's forest is thus therefore considered to be a managed forest.

In calculating Forest remaining Forest greenhouse gas inventory, emission of non-CO_2 gases and estimations of carbon stock changes of the following 5 carbon pools are required: below ground biomass, dead wood litter, aboveground biomass and soil organic matter, and litter. Equation 3.2.1 below, gives in respect to changes in the above 5 carbon pools, the calculation of the annual emissions or removal from Forest remaining Forest (FF) (IPCC LULUCF Guide pg. 3.24). This Equation is a summary of several other Equations that are required.

EQUATION 3.2.1
ANNUAL EMISSIONS OR REMOVALS FROM FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF} = (\Delta C_{FF_{LB}} + \Delta C_{FF_{DOM}} + \Delta C_{FF_{Soils}})$$

The detailed calculations for this and other parts of the assessment are provided in Annex 2.

Where:

ΔC_{FF} = annual change in carbon stocks from forest land remaining forest land, tonnes C yr-1

ΔCFF_{LB} = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land; tonnes C yr-1

ΔCFF_{DOM} = annual change in carbon stocks in dead organic matter (includes dead wood and litter) in forest land remaining forest land; tonnes C yr-1

ΔCFF_{Soils} = annual change in carbon stocks in soils in forest land remaining forest land; tonnes C yr-1

Two methods can be used for calculating the carbon stock changes in biomass (ΔCFFLB), this include the default method and the stock change method. Because the stock method requires a Time 1 and Time 2 values, not available for this assesment, the default method is used, Equation 3.2.2. Also, the stock change method excludes Tier 1, which is the chosen Tier for this project.

EQUATION 3.2.2
ANNUAL CHANGE IN CARBON STOCKS IN LIVING BIOMASS
IN FOREST LAND REMAINING FOREST LAND (DEFAULT METHOD)

$$\Delta C_{FF_{LB}} = (\Delta C_{FF_G} - \Delta C_{FF_L})$$

Where:

ΔCFF_{LB} = annual change in carbon stocks in living biomass (includes above- and belowground biomass) in forest land remaining forest land, tonnes C yr-1

ΔCFF_G = annual increase in carbon stocks due to biomass growth, tonnes C yr-1

ΔCFF_L = annual decrease in carbon stocks due to biomass loss, tonnes C yr-1

Another Equation 3.2.4 is needed to calculate the growth/increase in carbon stock due to Biomass (ΔCFF_G)

EQUATION 3.2.4
ANNUAL INCREASE IN CARBON STOCKS DUE TO BIOMASS INCREMENT
IN FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF_G} = \sum_{ij} (A_{ij} \bullet G_{TOTAL_{ij}}) \bullet CF$$

Where:

ΔC_{FFG} = annual increase in carbon stocks due to biomass increment in forest land remaining forest land by forest type and climatic zone, tonnes C yr^{-1}

A*ij* = area of forest land remaining forest land, by forest type (*i* = 1 to *n*) and climatic zone (*j* = 1 to *m*), ha

$G_{TOTALij}$ = average annual increment rate in total biomass in units of dry matter, by forest type (*i* = 1 to *n*) and climatic zone (*j* = 1 to *m*), tonnes d.m. ha^{-1} yr^{-1}

CF = carbon fraction of dry matter (default = 0.5 tonnes C (tonne d.m.)-1

"A" was obtained from Remote Sensing analysis as 44,860.00 Hectares. The default value of 0.5 tonnes C (tonne d.m.)$^{-1}$ was used.

To obtain G_{total} (includes the annual increment rate of aboveground biomass (G_W) to include its belowground part, involving multiplication by the root-to shoot ratio (R)) that applies to increments component of Equation 3.2.4 above, two Equations can be used. One in situations where G_w data is available and other case where G_w isn't available instead the increment volume I_v, Basic wood density (D) and biomass expansion factors (BEF_1) are used. In the case of Dominica, Equation option A was used. G_w Data from Table 3A.1.5 for American Tropical/Subtropical, greater than 20 years' data was used, (2.0 tonnes dry matter/ha/year). Value for R was obtained from Table 3A.1.8 as Tropical/Subtropical Forest, Primary Tropical/Subtropical Forest moist forest-mean value of 0.24 tonnes dry matter/tonne dry matter.

EQUATION 3.2.5
AVERAGE ANNUAL INCREMENT IN BIOMASS

$G_{TOTAL} = G_W \bullet (1 + R)$	**(A)**	In case aboveground biomass increment (dry matter) data are used directly. Otherwise G_W is estimated using equation B or its equivalent
$G_W = I_V \bullet D \bullet BEF_1$	**(B)**	In case net volume increment data are used to estimate G_W.

Where:

G_{TOTAL} = average annual biomass increment above and belowground, tonnes d.m. ha^{-1} yr^{-1}

G_W = average annual aboveground biomass increment, tonnes d.m. ha-1 yr-1; Tables 3A.1.5 and 3A.1.6

R = root-to-shoot ratio appropriate to increments, dimensionless; Table 3A.1.8

I_V =average annual net increment in volume suitable for industrial processing, m3 ha^{-1} yr^{-1}; Table 3A.1.7

D = basic wood density, tonnes d.m. m^{-3}; Table 3A.1.9

BEF_1 = biomass expansion factor for conversion of annual net increment (including bark) to aboveground tree biomass increment, dimensionless; Table 3A.1.10

G_w from Table 3A1.5 for American Tropical/Subtropical Forests with over 20 years was 2.0, and R from Table 3A1.8 was chose as the Mean value of 0.24, value for Tropical/subtropical forests, primary tropical/subtropical moist forest.

$G_{TOTAL} = G_W \bullet (1 + R)$

G_{TOTAL} = 2.0 tonnes dry matter/ha/year * (1+0.24 tonnes dry matter)

= **2.48 tonnes^2 dry matter/ha/year**

So therefore:

$\Delta CFF_G = \Sigma_{ij} (A_{ij} \bullet G_{TOTAL\,ij}) \bullet CF$

= Σ_{ij}(44,860.00 ha * *2.48* tonnes^2 dry matter/ha/year *0.5 tonnes **C**

=55,626.40 tonnes C yr^{-1}

Values for ΔC_{FFL} (annual decrease in carbon stocks due to biomass loss, tonnes C yr^{-1}) Equation 3.2.6, are now required.

EQUATION 3.2.6
ANNUAL DECREASE IN CARBON STOCKS DUE TO BIOMASS LOSS IN FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF_L} = L_{fellings} + L_{fuelwood} + L_{other\ losses}$$

Where:

ΔCFF_L = annual decrease in carbon stocks due to biomass loss in forest land remaining forest land, tonnes C yr^{-1}

$L_{fellings}$ = annual carbon loss due to commercial fellings, tonnes C yr^{-1} (See Equation 3.2.7)

$L_{fuelwood}$ = annual carbon loss due to fuelwood gathering, tonnes C yr^{-1} (See Equation 3.2.8)

$L_{other\ losses}$ = annual other losses of carbon, tonnes C yr^{-1} (See Equation 3.2.9)

EQUATION 3.2.7
ANNUAL CARBON LOSS DUE TO COMMERCIAL FELLINGS

$$L_{fellings} = H \bullet D \bullet BEF_2 \bullet (1 - f_{BL}) \bullet CF$$

Where:

$L_{fellings}$ = annual carbon loss due to commercial fellings, tonnes C yr^{-1}

H = annually extracted volume, roundwood, $m^3\ yr^{-1}$

D = basic wood density, tonnes d.m. m^{-3}; Table 3A.1.9

BEF_2 = biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark), dimensionless; Table 3A.1.10

f_{BL} = fraction of biomass left to decay in forest (transferred to dead organic matter)

CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

BEF_2 obtained from Table 3.1.10 under tropical broadleaf forests was 3.4.

An average was calculated for D since information obtained states that forests of Dominica are made up of several different species. The most common trees were noted and an average of their basic wood density was calculated as 0.59 tonnes/m^3.

H value of 7.5 (*1000 m^3) was obtained from FAO 2015 Global Forest Resources Assessment. However, because FAO uses underbark volume (and overbark is needed for calculations), overbark volume can be estimated by dividing the underbark volume by 0.85 before using the values in Equation 3.2.7. So therefore the value of H = 7500/0.85 = 8,823.53 m^3 overbark.

F_{BL} was taken from Table 3A.11 best descriptive value was Tropical selective logging in primary forests with the value of 0.4

$L_{fellings} = H \bullet D \bullet BEF_2 \bullet (1 - f_{BL}) \bullet CF$

= 8823.53 **m^3** *0.**59 tonnes d.m. m^{-3}** * 3.4 * (1-0.4) *0.**5 tonnes C (tonne d.m.)$^{-1}$**

= 5,310.00 tonnes C yr^{-1}

EQUATION 3.2.8
ANNUAL CARBON LOSS DUE TO FUELWOOD GATHERING

$$L_{fuelwood} = FG \bullet D \bullet BEF_2 \bullet CF$$

Where:

$L_{fuelwood}$ = annual carbon loss due to fuelwood gathering, tonnes C. yr^{-1}

FG = annual volume of fuelwood gathering, m3 yr^{-1}

D = basic wood density, tonnes d.m. m^{-3}; Table 3A.1.9

BEF_2 = biomass expansion factor for converting volumes of extracted roundwood to total aboveground biomass (including bark), dimensionless; Table 3A.1.10

CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

FG was obtained from FAO 2015 Global Forest Resources Assessment as 7.52 (*1000 m^3). This value was wood for fuel, rather than specific activities and therefore it can be used.

$L_{fuelwood} = FG \bullet D \bullet BEF_2 \bullet CF$

=520 $\mathbf{m^3}$ *0.59 **tonnes d.m.** $\mathbf{m^{-3}}$ * 3.4 *0.5 **tonnes C (tonne d.m.)**$^{\mathbf{-1}}$

= 7,542.56 tonnes C. $\mathbf{yr^{-1}}$

Other losses, component from Equation 3.2. 6, due to fires, pest manifestation and windstorms are calculated using Equation 3.2.9.

EQUATION 3.2.9 ANNUAL OTHER LOSSES OF CARBON $L_{other\ losses} = A_{disturbance} \bullet B_W \bullet (1 - f_{BL}) \bullet CF$

Where:

$L_{other\ losses}$ = annual other losses of carbon, tonnes C yr^{-1}

$A_{disturbance}$ = forest areas affected by disturbances, ha yr^{-1}

B_W = average biomass stock of forest areas, tonnes d.m. ha-1; Tables 3A.1.2, 3A.1.3, and 3A.1.4

f_{BL} = fraction of biomass left to decay in forest (transferred to dead organic matter); Table 3A.1.11

CF = carbon fraction of dry matter (default = 0.5), tonnes C (tonne d.m.)$^{-1}$

Since Tier 1 is being used, f_{BL} is assumed to be 0. Other disturbances are assumed to affect the entire above ground biomass, hence total area calculated from Remote Sensing is used. B_w for Dominica came from Table 3A1.4 was 166 tonnes/ha.

$L_{other\ losses} = A_{disturbance} \bullet B_W \bullet (1 - f_{BL}) \bullet CF$

=44,860.00 ha *166 tonnes/ha *(1-0) *0.5 tonnes C (tonne d.m.)$^{-1}$

= **3,723,380.00 tonnes C yr^{-1}**

So therefore annual decrease in carbon stocks due to losses is:

$\Delta CFF_L = L_{fellings} + L_{fuelwood} + L_{other\ losses}$

=5,310.00 **tonnes C yr^{-1}** + 7,542.56 **tonnes C yr^{-1}** + 3,723,380.00 **tonnes C yr^{-1}**

= **3,736,232.56 tonnes C yr^{-1}**

The second part of Equation 3.2.1 is ΔC_{FFDOM}, the annual change in carbon stocks in dead organic matter which includes dead wood and litter. This can be calculated using Equations 3.2.10 to 3.2.13 from the IPCC Guidelines.

EQUATION 3.2.10
ANNUAL CHANGE IN CARBON STOCKS IN DEAD ORGANIC MATTER IN FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF_{DOM}} = \Delta C_{FF_{DW}} + \Delta C_{FF_{LT}}$$

Where:

ΔC_{FFDOM} = annual change in carbon stocks in dead organic matter (includes dead wood and litter) inforest land remaining forest land,

ΔC_{FFDW} = change in carbon stocks in dead wood in forest land remaining forest land, tonnes C yr^{-1}

ΔC_{FFLT} = change in carbon stocks in litter in forest land remaining forest land, tonnes C yr^{-1}

The ΔC_{FFDW} for Tier 1 instances are said to be 0. This is because The *IPCC Guidelines*, assumes that the rate in which carbon pool is transferred out of dead wood is equal to its transfer into dead wood. Therefore, the overall change is 0.

The change in carbon stocks in litter in forest land remaining forest land (ΔC_{FFLT}) can be obtained from Equation 3.2.13 below. However, the same balance as deadwood is assumed for litter also, this is because of the high level of uncertainty for Tier 1 calculations. Therefore, ΔC_{FFLT} is 0.

EQUATION 3.2.13
ANNUAL CHANGE IN CARBON STOCKS IN LITTER IN FOREST LAND REMAINING FOREST LAND

$$\Delta C_{FF_{LT}} = \Sigma_{ij} \left[(C_j - C_i) \bullet A_{ij} \right] / T_{ij}$$

where,

$$C_i = LT_{ref(i)} \bullet f_{man\ intensity(i)} \bullet f_{dist\ regime(i)}$$

$\Delta C_{FFDOM} = \Delta C_{FFDW} + \Delta C_{FF\ LT}$

= 0 + 0

=**0 tonnes C yr^{-1}**

The change in carbon stocks in the forest soils can be obtained from this Equation: $\Delta C_{FFSoils} = \Delta C_{FFMineral} + \Delta C_{FFOrganic}$. However, there is no general scientific data, but rather site specific data. Because of this uncertainty the IPCC guidance assumes that the change in carbon stock of forest soils remains constant, no default data when using Tier 1.

$\Delta C_{FFSoils} = \Delta C_{FFMineral} + \Delta C_{FFOrganic}$.

= 0

The annual emissions or removals of carbon from forest land remaining forest land based on Equation 3.2.1:

$\Delta CFF = (\Delta CFF_{LB} + \Delta CFF_{DOM} + \Delta CFF_{Soils})$

= -3,680,606.16 **tonnes C yr^{-1}** + 0 **tonnes C yr-1** +0 **tonnes C yr^{-1}**

= -3,680,606.16 **tonnes C yr^{-1}**

4.2. Forest Remaining Forest - Nitrogen Emissions

To determine the amount of N_2O emissions from the forest fertilization, Equation 3.2.18 was used. Amount of Synthetic fertilizer used in Dominica was obtained online from FAO’s http://www.fao.org/faostat/en/#data/RF website. Organic manure was estimated using number of livestock on the island values obtained from Livestock Department of the Ministry of Agriculture. The mass of organic manure was then determined by the relationship: - # of a group of animals*365 days*avg. Kilograms of feces known for that group. Table 4.6. details the estimated mass of organic manure for the various livestock species.

Table 4.6.: Organic Manure totals based on Animals.

Animal	Total Yearly feces (Gg yr^{-1})	Daily weight of feces (Gg)	No. of animals
Goats	0.25	0.000000454	1500
Pigs	6.46	0.000005897	3000
Sheep	0.99	0.000001814	1500
Cattles	11.18	0.000020412	1500
Rabbits	0.04	0.00000006	2000
Layers	2.72	0.000000095	78500
Total Organic Manure	**21.64**		

EQUATION 3.2.18
DIRECT N_2O EMISSIONS FROM FOREST FERTILISATION

$$N_2O\ direct\text{-}N_{fertiliser} = (F_{SN} + F_{ON}) \bullet EF_1$$

Where:

N_2O direct-$Fe_{rtilizer}$ = direct emissions of N_2O from forest fertilization in units of Nitrogen, Gg N

F_{SN} = annual amount of synthetic fertilizer nitrogen applied to forest soils adjusted for volatilization as NH_3 and NOx, Gg N

F_{ON} = annual amount of organic fertilizer nitrogen applied to forest soils adjusted for volatilization as NH_3 and NO_x, Gg N

EF_1 = emission factor for N_2O emissions from N inputs, kg N_2O-N / kg N input

The default emission factor (EF1) used is 1.25 % of applied N and this value is to be used when following Tier 1.

N_2O direct-$F_{ertilizer}$ = (0.0046g + 21.64Gg)*1.25%

= 0.27 Gg

EQUATION 3a.2.1
DIRECT N_2O EMISSIONS FROM DRAINED FOREST SOILS (TIER 1)

$$N_2O\ emissions_{FF} = \Sigma(A_{FF_{organic\ ijk}} \bullet EF_{FF_{drainage,organic\ ijk}}) + A_{FF_{mineral}} \bullet EF_{FF_{drainage,mineral}} \bullet 44/28 \bullet 10^{-6}$$

Where:

N_2O emissions$_{FF}$ = emission of N_2O in units of nitrogen, kg N

$AFF_{organic}$ = area of drained forest organic soils, ha

$AFF_{mineral}$ = area of drained forest mineral soils, ha

$EFFF_{drainage,\ organic}$ = emission factor for drained forest organic soils, kg N_2O-N ha^{-1} yr^{-1}

$EFFF_{drainage,\ mineral}$ = emission factor for drained forest mineral soils, kg N_2O-N ha^{-1} yr^{-1}

ijk = soil type, climate zone, intensity of drainage, etc. (depends on level of disaggregation)

To determine the N_20emission from drained forest soils, using Tier 1, Equation 3a.2.1 was used.

The total forest lands were used for $AFF_{organic}$ and $A_{FFmineral}$. $EF_{FFdrainage,organic}$ was obtained from Table 3a.2.1 as **8 ha/yr**. According to the IPCC guidance "*Emissions from drained forest mineral soils should be calculated by using separate and lower emission factors than for drained forest organic soils. Emissions from drained forest mineral soils can be assumed as about a tenth of EFdrainage for organic soils (Klemedtsson et al., 2002)"* Therefore $EF_{FFdrainage,\ mineral}$ used was **1/10 * 8 ha/yr**.

N_2O $_{emission}$sFF = $\Sigma(AFF_{organic\ IJK} * EFFF_{drainage,\ organic\ IJK}) + AFF_{mineral} * EFFF_{drainage,\ mineral} * 44/28 \bullet$ 10-6

= (44,860.00 ha * 8 ha/yr) + 44,860.00 ha * (1/10 *8) * 1.57143E^{-06}

= **358880.0564 kg N (Converted to Gg N = 0.358880056 Gg)**

EQUATION 3.2.17
DIRECT N_2O EMISSIONS FROM MANAGED FORESTS

$$N_2O\ direct\text{-}N_{FF} = (N_2O\ direct\text{-}N_{fertiliser} + N_2O\ direct\text{-}N_{drainage})$$

Where:

N_2O direct-N_{FF} = direct emissions of N_2O from managed forests in units of Nitrogen, Gg N

N_2O direct-$F_{ertilizer}$ = direct emissions of N_2O from forest fertilization in units of Nitrogen, Gg N

N_2O direct-$D_{rainage}$ = direct emissions of N_2O from drainage of wet forest soils in units of Nitrogen, Gg N

Direct N_2o emissions from managed forests was then obtained following Equation 3.2.17.

N_2O $_{direct\text{-}Nfertiliser}$ and $N_2O_{direct\text{-}Ndrainage}$ were calculated above. Therefore:

N_2O_{direct}-N_{FF} = 0.27 Gg N+ = 0.36 Gg N

= 0.63 Gg N

4.3.3. Forest Remaining Forest - Other Green House Gasses Emissions

Calculating Other Green House Gases released directing during fires are calculated using Equation 3.2.20 shown below. Using Tier 1 this Equation and corresponding values were chosen.

EQUATION 3.2.20
ESTIMATION OF GHGS DIRECTLY RELEASED IN FIRES

$$L_{fire} = A \bullet B \bullet C \bullet D \bullet 10^{-6}$$

Where:

L_{fire} = quantity of GHG released due to fire, tonnes of GHG

A = area burnt, ha

B = mass of ‘available’ fuel, kg d.m. ha^{-1}

C = combustion efficiency (or fraction of the biomass combusted), dimensionless. (See Table 3A.1.12)

D = emission factor, g (kg d.m.)$^{-1}$

The area of burnt land (A) was calculated from Remote Sensing, and would represent the occurrence during a set period. Given that the largest burnt area usually occurs on the west coast within the dry scrub forest, the optimal period for undertaken this imagery would be at the end of the dry season – July – August.

The total burnt area assessed was 242.00 ha and was not limited to only Forest land use but included all other land use types in Dominica. No, local data was available for B- mass of available fuel and C- combustion efficiency, therefore Table 3.A.1.13 was used, where the value for Primary Moist Forest was 160.4 T/ha. This gives a product of the two (B*C). Emission factor (D), for each gas was used - shown in Table 4.7. below.

Table 3.7. : GHGs and Corresponding Emission Factors

Emission Factors fuel combusted	
GHGs	G/KG
CO_2	1403
CO	67
CH_3	4
NO_x	0.5
N_2O	0.01

The values for each factor from Equation 3.2.20 was is listed in Table 4.8. below, together with the value of the amount of GHG that was released (L) from 242 hectares of burnt land during the period of review.

Table 4.8.: Calculation for L for each GHG.

L (Tonnes)=	A *	B * C *	D *	0.000001	GHGs
54.45	242	160.4	1403	0.000001	CO_2
2.60	242	160.4	67	0.000001	CO
0.16	242	160.4	4	0.000001	CH_3
0.019	242	160.4	0.5	0.000001	NO_x
0.00038	242	160.4	0.01	0.000001	N_2O

4.3.4. Cropland Remaining Cropland - Change in Carbon Stocks Emissions

The approach for calculating the change in carbon stock for this category, cropland remaining cropland is similar to that utilized for the Forest section. Equation 3.3.1 was however followed. Using Remote Sensing, a total area of 14,300.00 ha was calculated as the area under cropland land use.

EQUATION 3.3.1
ANNUAL CHANGE IN CARBON STOCKS IN CROPLAND REMAINING CROPLAND

$$\Delta C_{CC} = \Delta C_{CC_{LB}} + \Delta C_{CC_{Soils}}$$

Where:

ΔC_{CC} = annual change in carbon stocks in cropland remaining cropland, tonnes C yr^{-1}

ΔC_{CCLB} = annual change in carbon stocks in living biomass, tonnes C yr^{-1}

$\Delta C_{CCSoils}$ = annual change in carbon stocks in soils, tonnes C yr^{-1}

Following the Tier 1 Basic method for calculating the annual change in carbon stock for living biomass, the area was multiplied by the accumulation rate and losses multiplied by area was subtracted. Table 3.3.2 from the IPCC was used to obtain accumulation and losses. Using http://www.fao.org/faostat/en/#data/QC a total of 7,090 ha was obtained as the area of land harvested for 2014.

Therefore:

ΔC_{CCLB} = (area of cropland * default accumulation) – (area of land harvested * default losses)

= (14,300 ha * 10 tonnesC/yr) – (7090 ha * 50 tonnes C/yr)

=143000 tonnes C/yr^{-1} -354500 tonnes C/yr^{-1}

= -211500 tonnes C/yr^{-1}

The second part of Equation 3.3.1 is to calculate the change in carbon stocks in Soils. Equation 3.3.2 below is used.

EQUATION 3.3.2
ANNUAL CHANGE IN CARBON STOCKS IN SOILS IN CROPLAND REMAINING CROPLAND

$$\Delta C_{CC_{Soils}} = \Delta C_{CC_{Mineral}} - \Delta C_{CC_{Organic}} - \Delta C_{CC_{Lime}}$$

Where:

$\Delta C_{CCSoils}$ = annual change in carbon stocks in soils in cropland remaining cropland, tonnes C yr^{-1}

$\Delta C_{CCMineral}$ = annual change in carbon stocks in mineral soils, tonnes C yr^{-1}

$\Delta C_{CCOrganic}$= annual carbon emissions from cultivated organic soils (estimated as net annual flux), tonnes C yr^{-1}

ΔC_{CCLime} = annual C emissions from agricultural lime application, tonnes C yr^{-1}

$\Delta C_{CCMineral}$ is obtained from following Equation 3.3.3. The default values for SOC (130 tonnes C ha^{-1}), F_{LU} (0.58), F_{MG} (1.16) and F_1 (1.0) were obtained from Tables 3.3.3 and 3.3.4 in the IPCC. It was assumed that Dominica is Tropical wet climate with long term cultivation, reduced tillage and medium input. Default inventory period is 20 years. It was also assumed that conditions remained the same for SOC_0 and SOC $_{(0\text{-}T)}$.

EQUATION 3.3.3
ANNUAL CHANGE IN CARBON STOCKS IN MINERAL SOILS FOR A SINGLE CROPLAND SYSTEM

$$\Delta C_{CC_{Mineral}} = [(SOC_0 - SOC_{(0-T)}) \bullet A] / T$$

$$SOC = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I$$

Where:

$\Delta CCC_{Mineral}$ = annual change in carbon stocks in mineral soils, tonnes C yr^{-1}

SOC_0 = soil organic carbon stock in the inventory year, tonnes C ha^{-1}

$SOC_{(0\text{-}T)}$ = soil organic carbon stock T years prior to the inventory, tonnes C ha^{-1}

T = inventory time period, yr (default is 20 yr)

A = land area of each parcel, ha

SOC_{REF} = the reference carbon stock, tonnes C ha^{-1}; see Table 3.3.3

F_{LU} = stock change factor for land use or land-use change type, dimensionless; see Table 3.3.4

F_{MG} = stock change factor for management regime, dimensionless; see Table 3.3.4

F_I = stock change factor for input of organic matter, dimensionless; see Table 3.3.4

$SOC_\theta = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I$

= 130 tonnes C ha^{-1} *0.58 *1.16 *1.0

=87.464 tonnes C ha^{-1} *

$SOC_{0\text{-}T} = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I$

= 130 tonnes C ha^{-1} *0.58 *1.16 *1.0

=87.464 tonnes C ha^{-1} *

$\Delta C_{CCMineral} = [(SOC_0 – SOC_{(0-T)}) \bullet A] / T$

= (87.464 tonnes C ha^{-1}- 87.464 tonnes C ha^{-1}) *14,300.00 ha / 20 yr

=0 tonnes C yr^{-1}

To calculate the carbon emission from cultivated organic soils, Equation 3.3.5 below was used, as well as emission factors (*20.0 tonnes* C ha^{-1} yr^{-1}) from Table 3.3.5 in the IPCC. The area obtained from Remote Sensing was also used.

EQUATION 3.3.5
CO_2 EMISSIONS FROM CULTIVATED ORGANIC SOILS IN CROPLAND REMAINING CROPLAND

$$\Delta C_{CC_{Organic}} = \Sigma_c (A \bullet EF)_c$$

Where:

$\Delta C_{CCOrganic}$ = CO_2 emissions from cultivated organic soils in cropland remaining cropland, tonnes C yr^{-1}

A = land area of organic soils in climate type *c*, ha

EF = emission factor for climate type *c* (see Table 3.3.5), tonnes C ha^{-1} yr^{-1}

$\Delta C_{CCOrganic} = \Sigma c\ (A \bullet EF)\ c$

*= 14,300 ha * 20.0 tonnes* C ha^{-1} yr^{-1}

= 286,000 tonnes C yr-1

EQUATION 3.3.6
ANNUAL CARBON EMISSIONS FROM AGRICULTURAL LIME APPLICATION

$$\Delta C_{CC_{Lime}} = M_{Limestone} \bullet EF_{Limestone} + M_{Dolomite} \bullet EF_{Dolomite}$$

Where:

ΔC_{CCLime} = annual C emissions from agricultural lime application, tonnes C yr^{-1}

M = annual amount of calcic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$), tonnes yr^{-1}

EF = emission factor, tonnes C (tonnes limestone or dolomite)$^{-1}$ (These are equivalent to carbonate carbon contents of the materials (12% for $CaCO_3$, 13% for $CaMg(CO_3)_2$)).

The final part of Equation 3.3.2 is the calculation of emissions from lime in soils. Total lime for Dominica from 2013 to 2015 was obtained from Central Statistic Division as 100,038Kg. Because they did not have a yearly total, 100,038 Kg was divided by 3 to obtain a value for 2014 and then converted into tonnes: (100038/3)/1000=33.35 tonnes yr^{-1}. The data obtained from Central Statistics did not differentiate between the types of carbonates therefore only Tier 1, emission factor of 0.12 can be used to calculate the CO_2 emissions. The calculations also assume that all of the of the agri-lime imported was applied to the soil during the year in question.

ΔC_{CCLime}= M * EF

= 33.35 tonnes yr^{-1} * 0.12

=4.00152 tonnes C yr^{-1}

Equation 3.3.3 can be completed by filling in each section previously calculated.

$\Delta C_{CCSoils} = \Delta C_{CCMineral} - \Delta C_{CCOrganic} - \Delta C_{CCLime}$

= 0 - 286000 tonnes C yr^{-1}- 4.00152 tonnes C yr^{-1}

= - 286,004.0015 C yr^{-1}

Equation 3.3.1 can also be filled in:

$\Delta C_{CC} = \Delta C_{CCLB} + \Delta C_{CCSoils}$

=-211500 tonnes C/yr + -286004.0015 tonnes C yr^{-1}

= -497504.0015 tonnes C yr^{-1}

4.3.5. Cropland Remaining Cropland - Other Green House Gasses Emissions

This section was incorporated into Section 4.3.3. (Forest Remaining Forest - Other Greenhouse Gases Emissions), since the burnt area used was the estimate of all burnt land use in Dominica.

4.3.6. Grasslands Remaining Grasslands - Change in Carbon Stocks Emissions

The total area Calculated with Grasslands in Dominica, using Remote Sensing analysis was 638.00 ha. Carbon stock within grassland category is affected by several anthropogenic activities as well as natural occurrences including: wild fires and harvesting of woody biomass. Equation 3.4.1 below summarizes the calculation for the annual change in the carbon stock for grasslands remaining grasslands. This includes calculating carbon stock change in living biomass and in soils.

EQUATION 3.4.1
ANNUAL CHANGE IN CARBON STOCKS IN GRASSLAND REMAINING GRASSLAND

$$\Delta C_{GG} = \Delta C_{GG_{LB}} + \Delta C_{GG_{Soils}}$$

Where:

ΔC_{GG} = annual change in carbon stocks in grassland remaining grassland, tonnes C yr^{-1}

ΔCGG_{LB} = annual change in carbon stocks in living biomass in grassland remaining grassland, tonnes C yr^{-1}

ΔCGG_{Soils} = annual change in carbon stocks in soils in grassland remaining grassland, tonnes C yr^{-1}

In selecting Tier 1 methodological approach, no change in the carbon stock for living biomass is assumed (ΔCGG_{LB} =0). This is because not enough information is available to develop default rates to be used for Tier 1 in managements regimes that are either static or management changes that occur over time.

The carbon stock changes in soils can be calculated using Equation 3.4.7 below. This takes into account carbon stock changes for mineral soils, CO_2 emissions from organic soils and emissions of CO_2 from liming of grassland soils.

EQUATION 3.4.7
ANNUAL CHANGE IN CARBON STOCKS IN SOILS IN GRASSLAND REMAINING GRASSLAND

$$\Delta C_{GG_{Soils}} = \Delta C_{GG_{Mineral}} - \Delta C_{GG_{Organic}} - \Delta C_{GG_{Liming}}$$

Where:

$\Delta C_{GGSoils}$ =annual change in carbon stocks in soils in grassland remaining grassland, tonnes C yr^{-1}

$\Delta C_{GGMineral}$ = annual change in carbon stocks in mineral soils in grassland remaining grassland, tonnes C yr^{-1}

$\Delta C_{GGOrganic}$ = annual change in carbon stocks in organic soils in grassland remaining grassland (estimated as net annual flux), tonnes C yr^{-1}

ΔCGG_{Liming} = annual C emissions from lime application to grassland, tonnes C yr^{-1}

To calculate the change in carbon stocks in mineral soils, same equation as Equation 3.3.3 is used. SOC_{REF} remained as 130 tonnes C ha^{-1}, using Tables 3.3.4 and 3.3.5 the values for F_{LU}

(1.0), F_{MG} (0.7), and F_I (1.0) were obtained. Default time of 20 years was used. There was no changes in management of the inventory times. So SOC_0 and SOC_{0-T} were same values.

$SOC_0 = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I$

$= 130$ tonnes C ha^{-1} *1.0 * 0.7 * 1.0

= 91 tonnes C ha^{-1}

$SOC_{0-T} = SOC_{REF} \bullet F_{LU} \bullet F_{MG} \bullet F_I$

= 130 tonnes C ha^{-1} *1.0 *0.7*1.0

= 91 tonnes C ha^{-1}

$\Delta CGG_{Mineral} = [(SOC_0 - SOC_{(0-T)}) \bullet A] / T$

= (91 tonnes C ha^{-1}- 91tonnes C ha-1) *638 ha / 20 yr

=0 tonnes C yr-1

To calculate the change in carbon stock in organic soils same equation as Equation 3.3.5 above is used. EF for this section, obtained from Table 3.4.6 in the IPCC was 5.0

$\Delta CGG_{Organic} = \Sigma c\ (A \bullet EF)\ c$

= 638 ha * 5.0 tonnes C ha^{-1} yr^{-1}

= 3,190 tonnes C yr^{-1}

As mentioned in Section 2 above, lime value for 2014 was 33.346 tonnes Dominica.

$\Delta C_{CCLime} = M * EF$

= 33.35 tonnes yr^{-1} * 0.12

= 4.00152 tonnes C yr^{-1}

Therefore, the change in carbon stocks for soils

$\Delta CGG_{Soils} = \Delta CGG_{Mineral} - \Delta CGG_{Organic} - \Delta CGG_{Lime}$

= 0 - **3,190** tonnes C yr^{-1}- 4.00152 tonnes C yr^{-1}

= **-3194.00152 tonnes C yr^{-1}**

The annual change in Grasslands remaining grasslands based on Equation 3.4.1 is therefore:

$\Delta C_{GG} = \Delta CGG_{LB} + \Delta CGG_{Soils}$

= 0 + -3194.00152 tonnes C yr^{-1}

= -3194.00152 tonnes C yr^{-1}

This is considered to be an annual removal of 3,194 tonnes C yr^{-1} from Grasslands remaining Grasslands in Dominica.

4.3.7. Grasslands Remaining Grasslands - Other Green House Gasses Emissions

This section was incorporated into section 4.3.6.

4.3.8. Wetlands Remaining Wetlands - Changes in Carbon Stocks Emissions

The default method for this section focuses on wetlands drained for peat extraction. Such an activity is not done in Dominica and therefore no data on land drained or amount of peat extracted is available.

CO_2 for flooded land are calculated using Equation 3a.3.8. The E $(CO_2)_{diff}$ was obtained from Table 3a.3.5 for tropical wet climate as 0.64 kg ha^{-1} d^{-1} converted to Gg is 0.0000604 Gg CO_2 ha^{-1} day^{-1}. Area obtained from Remote Sensing is 27 ha.

EQUATION 3a.3.8

CO_2 EMISSIONS FROM FLOODED LANDS (TIER 1)

$$CO_2\ emissions_{WWflood} = P \bullet E(CO_2)_{diff} \bullet A_{flood,total\ surface}$$

Where:

$CO_2\ _{emissionsWW}$ flood = total CO_2 emissions from flooded lands, Gg CO_2 yr^{-1}

P = period, days (usually 365 for annual inventory estimates)

$E(CO_2)_{diff}$ = averaged daily diffusive emissions, Gg CO_2 ha^{-1} day^{-1}

$A_{flood,\ total\ surface}$ = total flooded surface area, including flooded land, flooded lake and flooded river surface area, ha

CO_2 $_{emissionsWW flood}$ = 365 days * 0.0000604 Gg CO_2 ha^{-1} day^{-1} * 27 ha

= 0.595242Gg CO_2 yr^{-1}

4.3.9. Wetlands Remaining Wetlands - N^2O Emissions

Calculation for N_2O emissions from flooded lands using the Tier 1 method was obtained using Equation 3a.3.10 below.

EQUATION 3a.3.10 **N_2O EMISSIONS FROM FLOODED LANDS (TIER 1)** $N_2O\ emissions_{ww\ flood} = P \bullet E(N_2O)_{diff} \bullet A_{flood,total\ surface}$

Where:

N_2O $_{emissionsWW flood}$ = total N^2O emissions from flooded land, Gg N_2O $year^{-1}$

P = period, days (usually 365 for annual inventory estimates)

$Ef(N_2O)_{diff}$ = averaged daily diffusive emissions, Gg N_2O ha^{-1} day^{-1}

$A_{flood,\ surface}$ = total flooded surface area, including flooded land, flooded lake and flooded river surface area, ha

The $Ef(N_2O)_{diff}$ (0.00000005 Gg N_2O ha^{-1} day^{-1}) was obtained from Table 3a.3.5.

The calculations are therefore:

N_2O $emissions_{ww\ flood} = P \bullet E(N_2O)_{diff} \bullet A_{flood}$, total surface

= 365 days * 0.00000000050 Gg N_2O ha^{-1} day^{-1}*27 ha

= **0.00000493 Gg N_2O $year^{-1}$**

4.3.10. Wetlands Remaining Wetlands - Other Greenhouse Gases Emissions

Calculating the CH_4 emissions is done using Equation 3a.3.9 below.

EQUATION 3a.3.9 **CH_4 EMISSIONS FROM FLOODED LANDS (TIER 1)** $CH_4\ emissions_{WWflood} = P \bullet E(CH_4)_{diff} \bullet A_{flood,total\ surface} + P \bullet E(CH_4)_{bubble} \bullet A_{flood,total\ surface}$

Where:

$CH_{4\ emissionsWW\ flood}$ = total CH_4 emissions from flooded land, Gg CH_4 yr^{-1}

P = period, days (usually 365 for annual inventory estimates)

$E(CH_4)_{diff}$ = averaged daily diffusive emissions, Gg CH_4 ha^{-1} day^{-1}

$E(CH_4)_{bubble}$ = averaged bubbles emissions, Gg CH_4 ha^{-1} day^{-1}

$A_{flood,\ total\ surface}$ = total flooded surface area, including flooded land, flooded lake and flooded river surface area, ha

$E(CH_4)_{diff}$ (0.00000064 Gg CH_4 ha^{-1} day^{-1}) and $E(CH_4)_{bubble}$ (0.00000283 Gg CH_4 ha^{-1} day^{-1}) we both obtained from Table 3a.3.5 and converted to Gg.

$CH_{4\ emissionsWW\ flood} = P \bullet E(CH_4)_{diff} \bullet A_{flood,\ total\ surface} + P \bullet E(CH_4)_{bubble} \bullet A_{flood,\ total\ surface}$

= 365 days * 0.00000064Gg CH_4 ha^{-1} day^{-1} * 27 ha + 365 days *0.00000283 Gg CH_4 ha^{-1} day^{-1} *27 ha

= 0.03419685 Gg CH4 yr^{-1}

ANNEX 3

References

1. 2017 Caribbean Economic Review. Caribbean Development Bank. Undated.

2. ACAPS Disaster Profile: Dominica, January 2018.

3. Budget 2016: Building a More Resilient Dominica. Government of Dominica. July 2016.

4. Budget 2017: Raising a Modern Prosperous Dominica. Government of Dominica. July 2017.

5. Climate and Post-shock Concessional Finance in SIDS: Contributing to Resilience of Small Island Developing States. Report to the Third International Conference on Small islands States. Undated.

6. Climate Chnage Knowledge and Practices in the OECS. OECS Survey Report - KAP Climate Change. July 2013.

7. Climate-Related Development Finance for SIDS and LDCs. Report on DAC-Senior Level Meeting side event: Breakfast Session on Climate-related Development Finance for SIDS and LDCs. OECD Headquarters, 20 October 2015.

8. Country Programming Framework for the Commonwealth of Dominica. FAO. November 2015.

9. DAC List of ODA Recipients (Effective for Reporting on 2014, 2015, 2016, and 2017 Flows). DAC. January 2018.

10. Disaster Vulnerability Reduction Project (DVRP) - Project Appraisal Document. World Bank. Undated.

11. Dominica Country Poverty Assessment, 2010. Available on: http://www.caribank.org/uploads/publications-reports/economicshttp://www.caribank.org/uploads/publications-reports/economics-statistics/country-poverty-assessment-reports/Dominica+CPA+-+Main+Report+Final+%28Submitted%29.pdfstatistics/countrypoverty-assessment-reports/Dominica+CPA+-+Main+Report+Final+%28Submitted%29.pdf

12. Dominica Climate Change, Environment and Natural Resources Management Bill, 2016. Government of Dominica. 2016.

13. Dominica's Experience Integrating Climate Change Adaptation into Policy and Legal Frameworks. Presentation to Caribbean National Adaptation Plans (NAPs) Workshop.

Georgetown, Guyana. Ministry of Health and Environment, Government of Dominica. 2 June 2017.

14. Dominica Low Carbon Climate Resilient Development Strategy. Government of Dominica. 2011.

15. Dominica National Biodiversity Strategy and Action Plan 2014-2020 (December 2013) - Ministry of Environment, Natural Resources, Physical Planning and Fisheries.

16. Dominica: Natural Disasters and Economic Development in a Small Island State. World Bank. October 2001.

17. Dominica's Report on the State of the World's Animal Genetic Resources. Government of Dominica. Undated.

18. Dominica Request for Disbursement under the Rapid Credit Facility. International Monetary Fund (IMF). November 2015.

19. Dominica Second National Communications on Climate Change. Government of Dominica. 2012.

20. Dominica Strategic Program for Climate Resilience (SPCR) 2012-2017. Government of Dominica. 2011.

21. DOMLEC 2016 Annual Report. http://www.ecseonline.com/PDF/2017/June%202017/DOMLEC%202016%20Annual%20ReportFinal.pd f

22. DOMLEC Energy Recovery Plan - Building Back Better. DOMLEC. November 2017.

23. DOMLEC Energy Recovery Plan - Resilient Microgrid Opportunities: Airport North and South. DOMLEC. Dec 16, 2017

24. DOMLEC Distributed Renewable Energy Generation Policy. DOMLEC. May 2016.

25. DOMLEC Distributed Renewable Energy Interconnection Policy. DOMLEC. 2010.

26. DOMLEC Performance Report 2016. Independent Regulatory Commission (IRC). Available on: https://www.ircdominica.org/downloads/reports-publications/

27. Draft report on the Impact of Heavy Rains on 7-18 September 2011 and 27-28 November 2011. Government of Dominica. May 2012.

28. Electricity Supply Act, No 21. of 1996. Government of Dominica.

29. Energy Snapshot Dominica. Energy Transition Initiative Islands. March 2015.

30. EO data provided via GSCDA in the framework of the Copernicus project IncREO (GA number: 312461).

31. Excerpt from Dominica's SNC http://un-gsp.org/news/dominicas-ghg-emissions-calculation-land-use-change-and-forestry-0 2012

32. GCF Funding Proposal : GEEREF NeXt - Financing of Renewable Energy ("RE") Infrastructure and Energy Efficiency ("EE") Beneficiary Projects in the Green Climate Fund ("GCF") Eligible Countries. GCF. April 2017.

33. GCF Readiness Proposal with UNDP for the Government of Dominica: NDA Strengthening and Country Programming. GCF. June 2017.

34. GEF Project Document - Low Carbon Development Path: Promoting Energy Efficient Applications and Solar Photovoltaic Technologies in Streets, Outdoor Areas and Public Buildings in Island Communities Nationwide (LCDP). Global Environment Facility (GEF). March 2016.

35. Geothermal Resources Development Act, No. 12 of 2016. Government of Dominica.

36. Global Climate Facility (GCF) Funding Proposal - Sustainable Energy Facility for the Eastern Caribbean. GCF. 2015.

37. Global Forest Resources Assessment 2015 Country Report Dominica, 2014. FAO, http://www.fao.org/faostat/en/#data/RF 2016.

38. Good Practice Guidance for Land Use, Land-Use Change and Forestry, 2003. Penman,J, et. al.,

39. Greenhouse Gas Emissions Factsheet: Eastern and Southern Caribbean Region: GHG Emissions by Sector (2011) USAID. Available on: https://www.climatelinks.org/resources/greenhousehttps://www.climatelinks.org/resources/greenhouse-gas-emissions-factsheet-eastern-and-southern-caribbean-regiongas-emissions-factsheet-eastern-and-southerncaribbean-region

40. GHG Inventory for the TNC Emissions Factor Database. Available on: http://www.ipcc-nggip.iges.or.jp/EFDB/find_ef_main.php

41. Identification of Mechanisms for Financing of Energy Efficiency and Renewable Energy Initiatives to Increase Investment in the Commonwealth of Dominica. Economic Commission for Latin America and the Caribbean (ECLAC). May 2016.

42. IMF Country Report – Dominica. IMF. July 2016.

43. IMF Country Report – Dominica. IMF. December 2017.

44. IMF Working Paper : Caribbean Energy – Macro-Related Challenges. IMF. March 2016.

45. IMF Working Paper : Financial Stability Reports in Latin America and the Caribbean. IMF. March 2017.

46. IMF Working Paper : Gone with the Wind: Estimating Hurricane and Climate Change Costs in the Caribbean. IMF. October 2016.

47. IMF Working Paper : Public Investment Scaling-up and Debt Sustainability: The Case of Energy Sector Investments in the Caribbean. IMF. June 2017.

48. Improving Hydrometeorological Data Collection Network, Data Management, and Relevant Institutional Frameworks in the Commonwealth of Dominica. DVRP/Government of Dominica. April 2015.

49. Intended Nationally Determined Contribution (INDC) of the Commonwealth Of Dominica. Government of Dominica. 30th September 2015.

50. Intergovernmental Panel on Climate Change (IPCC). Available on: http://www.ipcc.ch/organization/organization_review.shtml

51. International Trade Center Trade Map. Available on: https://www.trademap.org/

52. National Scale Landslide Susceptibility Assessment for Dominica and Saint Vincent. D.P. Zafra Ph.D., University of Twente.

53. Ozone Depleting Substances Data Center, 2018. Available on: http://ozone.unep.org/en/data-reporting/data-centre

54. Post Disaster Needs Assessment (PDNA) Hurricane Maria. Government of Dominica/ World Bank/UN/EU/OECS. 18 September 2017.

55. Rapid Damage and Impact Assessment - Tropical Storm Erika. Government of Dominica. 25th September 2015.

56. Remote Sensing Digital Image Analysis. Richards, J.A., Springer-Verlag, Berlin, p. 240, 1999.

57. Renewable Power Generation Costs in 2017. International Renewable Energy Agency (IRENA). Undated.

58. Resettlement Policy Framework - DVRP., Government of Dominica. March 2014

59. Survey of Living Conditions in the Commonwealth of Dominica: A Revision Working Paper. N. 65 Betti, G, Ballini,F. and Neri, L. (2006).

60. Technical Assistance for the Establishment of a National REDD+ Strategy Dominica – Final Report. OECS 2017.

61. The Commonwealth of Dominica: Social and Livelihoods Assessment Following Tropical Storm Erika. Government of Dominica/UNDP. Undated.

62. United Nations Framework Convention on Climate Change. (Text)

* * *