



COMMONWEALTH OF DOMINICA

Rapid Damage and Impact Assessment Tropical Storm Erika – August 27, 2015



**A Report by the
Government of the Commonwealth of Dominica**

September 25, 2015



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Global Facility for Disaster Reduction and Recovery

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COMMONWEALTH OF DOMINICA
TROPICAL STORM ERIKA – AUGUST 27, 2015
RAPID DAMAGE AND IMPACT ASSESSMENT

ACKNOWLEDGEMENTS

This Rapid Damage and Impact Assessment (RDIA) report was prepared by the Government of the Commonwealth of Dominica following the devastating impacts of Tropical Storm Erika on August 27, 2015. It was undertaken jointly with technical support from the World Bank in close conjunction with other development partners and international organizations.

The government wishes to extend its appreciation and acknowledge the numerous ministries and organizations for their support and assistance in granting access to information, providing support to the report and for their availability for discussions during the assessment. These include:

- The Office of Disaster Management
- The Ministry of Agriculture and Fisheries
- The Ministry of Education and Human Resource Development
- The Ministry of Finance
- The Ministry of Health and Environment
- The Ministry of Housing, Lands and Water Resource Management
- The Ministry of Information, Science, Telecommunications and Technology
- The Ministry of Justice, Immigration and National Security
- The Ministry of Kalinago Affairs
- The Ministry of Planning, Economic Development and Investment
- The Ministry of Public Works and Ports
- The Ministry of Social Services, Family and Gender Affairs
- The Ministry of Tourism and Urban Renewal
- The Ministry of Trade, Energy and Employment
- Government Information Service
- Dominica Water and Sewerage Authority
- Dominica Electricity Company
- DIGICEL
- LIME (Cable and Wireless)
- Disaster Vulnerability Reduction Project – Project Coordination Unit

International Partners and Organizations:

- Caribbean Disaster Emergency Management Agency (CDEMA)
- Caribbean Development Bank (CDB)
- United Nations Development Program (UNDP)
- UN Women
- UN Children's Fund (UNICEF)
- Pan-American Health Organization (PAHO)
- UN Food and Agriculture Organization (FAO)

- World Food Program (WFP)
- The International Federation of the Red Cross (IFRC)
- The Organisation of Eastern Caribbean States (OECS) Commission
- University of the West Indies (UWI)

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PREFACE

At the request of the Government of the Commonwealth of Dominica, a mission led by the World Bank conducted a rapid damage and impact assessment to estimate the scale and scope of the damage caused by Tropical Storm Erika on August 27, 2015 jointly with other development partners. Experts from international organizations, including the Caribbean Disaster Emergency Management Agency (CDEMA), Caribbean Development Bank (CDB), United Nations Development Program (UNDP), the United Nations Entity for Gender Equality and Women's Empowerment (UN Women), the UN Children's Fund (UNICEF), the Pan-American Health Organization (PAHO), the UN Food and Agriculture Organization (FAO), the World Food Program (WFP), the Red Cross, OECS Commission and the University of the West Indies (UWI) also participated in this assessment.

The objective of the assessment is to provide the Government of the Commonwealth of Dominica with a quantitative basis upon which to design and base a comprehensive reconstruction and financing strategy. From September 7-18, 2015 the team conducted a preliminary assessment of the damage caused by Tropical Storm Erika and estimated the related macroeconomic implications of the event. In addition to the rapid assessment, the team was asked to examine the impacts across sectors to be reflected in the medium to longer term reconstruction and recovery phases following the initial relief processes.

The data presented in this assessment is based on Government supplied data as of September 23, 2015. It is important to note that these estimates are preliminary due to the rapid nature of the assessment and the damage and losses might change as time progresses.

EXECUTIVE SUMMARY

On August 27, 2015 a tropical storm passed over Dominica producing extraordinary rainfall with high intensity. Owing 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.

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)¹. 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 72,340 persons, 11 persons were confirmed dead, 22 missing, 574 homeless and 713 evacuated with approximately 7,229 impacted by the event in disaster declared areas. A summary of the damage and loss by sector is detailed in Table 1. Disaster impacts have been categorized into three groups: productive sectors, infrastructure and social sectors.

Table 1: Summary of Damage and Loss by Sector (in millions)

	Sectors	Damage EC\$	Loss EC\$	Total EC\$	Damage US\$	Loss US\$	Total US\$
Productive							
	Agriculture, Fisheries and Forestry	114.22	13.11	127.33	42.46	4.87	47.33
	Tourism	52.40	31.48	83.88	19.48	11.70	31.18
	Industry & Commerce	24.56	1.50	26.06	9.13	0.56	9.69
Infrastructure							
	Water and Sanitation	46.11	6.39	52.50	17.14	2.38	19.52
	Air and Sea Ports	40.08	0.21	40.29	14.90	0.08	14.98
	Roads and bridges	643.59	129.87	773.46	239.25	48.28	287.53
	Electricity	5.89	0.88	6.77	2.19	0.33	2.52
	Telecomm	26.90	0.00	26.90	10.00	0.00	10.00
Social							
	Housing	119.80	25.86	145.66	44.53	9.61	54.15
	Education	9.55	1.20	10.75	3.55	0.45	4.00
	Health	1.73	3.50	5.23	0.64	1.30	1.94
TOTAL		1084.82	214.01	1298.83	403.28	79.56	482.84

¹ Dominica GDP (2014 - in Current US\$) \$537.8 million. World Development Indicators, The World Bank, 2015

CHAPTER ONE – INTRODUCTION AND EVENT DESCRIPTION

BACKGROUND AND INTRODUCTION

1.1 Country Profile

With a gross national income per capita of US\$10,300², Dominica is an upper-middle-income small island state, with an estimated population of 72,340 (51% men, 49% women). The country's land mass is 750 sq km consisting primarily of mountainous terrain with 90% of the country's inhabitants residing along the coastal areas. Dominica produces a narrow range of goods and services for export namely, agricultural products and educational services through the establishment of international medical schools. 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, which in addition to its export potential could lower domestic input costs.

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 indigent³ (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 disasters⁴.

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.

² Estimated 2014 GNI per capita, PPP (current international \$). World Development Indicators, The World Bank, 2015

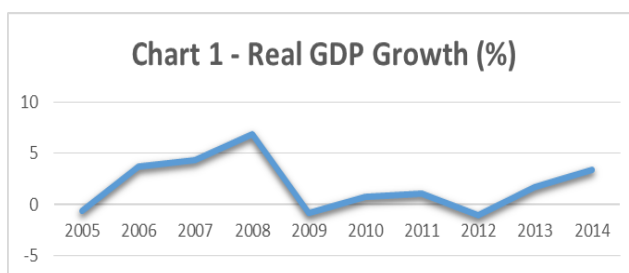
³ Indigence is defined as persons whose daily average consumption is too low to guarantee adequate nutrition to maintain good bodily health.

⁴ Dominica Country Poverty Assessment (2008-2009)

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.

1.2 Country Economic Profile

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 (see Chart 1). 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 and Omar.



Subsequently, from 2009-2013 economic performance was lackluster as the economy grappled with the effects of: (i) the Great 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, the effects of the 2013 Christmas Eve trough, 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 Government of Dominica has essentially adopted a three-pronged plan to achieve its development objective of poverty reduction. This includes: (i) creating the enabling environment for investment (ii) supporting sectoral strategies for growth in tourism, agriculture and manufacturing; and (iii) exploring direct strategies for poverty reduction through for example capital programmes with a strong growth enhancing/job creation component along with direct social assistance programmes. Importantly, within this framework, environmental sustainability and gender concerns are treated as cross-cutting themes⁵.

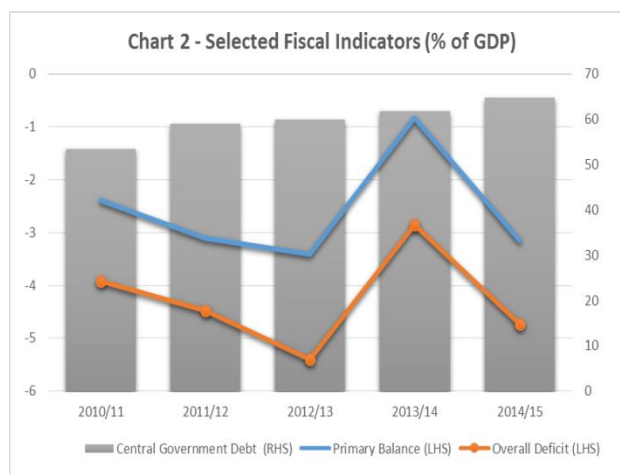
⁵ Government of Dominica's Growth and Social Protection Strategy 2014-2018

The risks to reducing poverty are significant, given existing, economic, social and environmental vulnerabilities. As previously indicated, hazard analysis and experience shows that Dominica is vulnerable to a wide range of geologic and meteorological hazards, which are likely to be exacerbated by climate change and climate variability trends, which could erode hard-won social and economic gains and would likely affect vulnerable groups disproportionately. Additionally,

notwithstanding attempts at economic diversification, the country is constrained by size, human capital endowment, limited access to finance and high input costs⁶.

Much of the financing requirement for the plan will reside with government. While the Government of the Commonwealth of

Dominica's (GoCD's) fiscal and debt indicators are more favourable than some regional counterparts, the effects of slow growth, post-disaster rehabilitation and the provision of support to vulnerable groups have put pressure on public finances (see Chart 2).



However, the country has already taken important steps in mitigating some of these risks through investments in geothermal, education and infrastructure (which will need to be strengthened going forward to incorporate enhanced resilience measures). Additionally, GoCD has managed to contract much of its debt on concessional terms, which will help to maximise fiscal space as it seeks to achieve its development objective. See Chapter 4 on Macroeconomic Impacts for more details.

1.3 Vulnerability to Disasters

Overview. 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.

Physical Vulnerability. With regards to physical vulnerability, steep topographic conditions and

⁶ A 2014 tariff survey by CARILEC places Dominica's average tariff rate at USD0.43 per kwh, the second highest of 13 English-speaking countries in the survey.

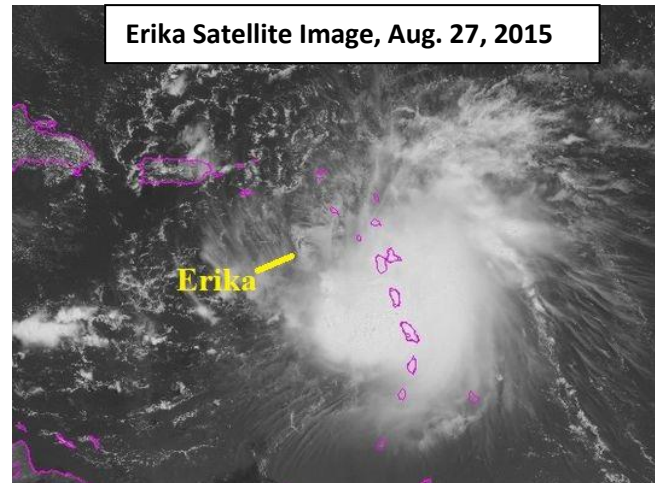
rugged interior dominate the island landscape, which has led to human settlements and physical development being highly concentrated along narrow coastal areas (particularly in the south and west). A significant proportion of Dominica's population as well as assets are therefore highly vulnerable to 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. 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.

Economic and Fiscal 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 GDP⁷. 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.

⁷ The figure is calculated for the period 1990–2012. See S. Harmeling and D. Eckstein, Global Climate Risk Index 2013 (Bonn: Germanwatch, 2012), <http://germanwatch.org/en/download/7170.pdf>.

Overview of the Storm Event

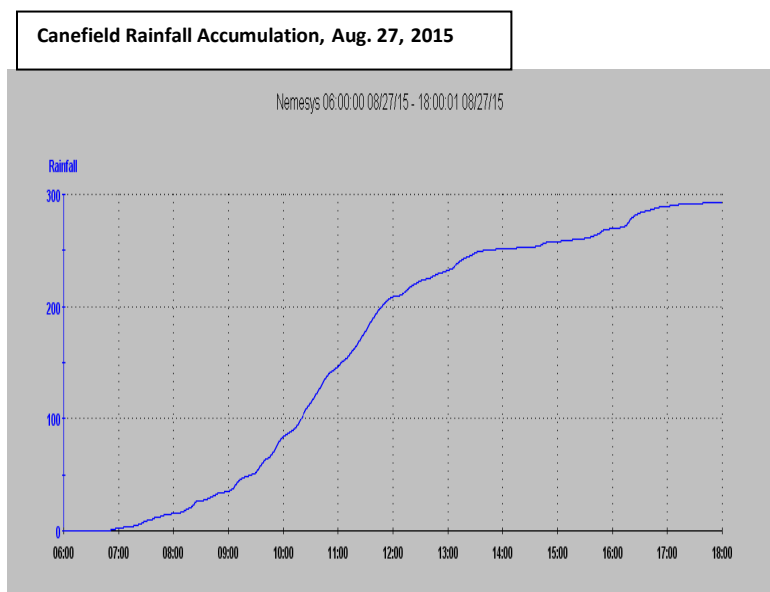
Tropical Storm Erika formed in the mid-Atlantic at about 47° West longitude 15° North latitude on August 24, 2015. It was immediately classified as a tropical storm and continued west-northwest at a speed of approximately 20 mph. On the morning of August 27, 2015, the system (storm center) arrived at the Leeward Islands with the majority of rainfall associated with the eastern side of the system. Rainfall arrived Dominica in the morning of the 27th 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).



Additional rainfall data were available from the climate station D'leau 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 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.

Impacts

Several factors contributed to the severe impacts from the storm. Flash flooding was triggered due to the accumulation of debris in river courses, effectively creating temporary stream dams which released suddenly when overwhelmed by flow accumulations. In addition, island topography coupled with short transit times from the central mountains to the coast all contributed to a major flash flood event. The combination of intense rainfall, unusual dry season and cracking of clay soils contributed to slope failures and debris generation which resulted in major damages and fatalities throughout Dominica.

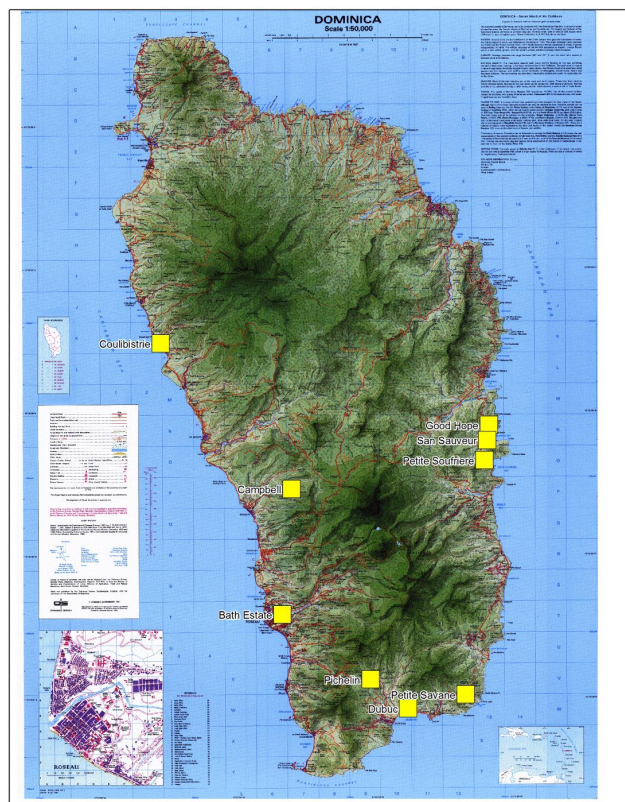


1.4 Immediate Response

The Dominica Meteorological Services and the Office of Disaster Management (ODM) through various medium kept all relevant stakeholders, media and public informed. National Emergency Planning Organization (NEPO) was activated and the acting Prime Minister Mr. Rayburn Blackmore and Ministers, Staff of the ODM and key members of NEPO kept the nation informed on safety protocols and procedures. Rainfall began subsiding at approximately 1:00 p.m on August 27. A NEPO meeting was convened at 1.30 pm Thursday at the Police Headquarters where initial reports were received and decisions were taken for search and rescue and response to affected areas. Initial efforts focused on creating emergency access to areas cut off by the storm (landslides and bridge collapse).

On August 29, 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 1). Overall, more than 7,200 people were directly affected by the disaster. Teams conducting Damage Assessment and Needs Analysis (DANA) were dispatched on August 29. The Government of Dominica established an account at the Eastern Caribbean Central Bank to receive contributions in support of its recovery and reconstruction efforts following the passage of Tropical Storm Erika.

Map 1 - Areas Declared Special Disaster Zones



1.4.1 Request for Assistance and International Response

The Regional Response Mechanism (RRM), coordinated by the Caribbean Disaster Emergency Management Agency (CDEMA) through its Regional Coordination Centre in Barbados, was activated on August 27 through September 6. The RRM is an arrangement for the coordination of disaster response among CDEMA Participating States, and Regional and International Agencies. In early September, military vessels and helicopters from Venezuela, The Netherlands, and the UK arrived in Dominica to assist with search and rescue, medical and infrastructure support and damage assessment. Helicopters sent from France and Trinidad and Tobago assisted with airlifting persons in critical conditions from affected areas and delivery relief items. Additional vessels and officers were sent by St. Lucia, Barbados, Antigua and Barbuda, British Virgin Islands, Cuba, US Virgin Islands, Montserrat, Grenada, St. Kitts and Nevis, to provide transportation of humanitarian assistance and persons in the affected areas.

The European Union Humanitarian Aid and Civil Protection Department (ECHO) provided EUR 300,000 in emergency humanitarian funding through the Pan American Health Organisation (PAHO). The emergency aid provided by the EU targeted: restoring access to essential health services and medical care capacity (including psycho-social support); providing safe drinking water, and ensuring proper hygiene, sanitation and waste management; and implementing crucial disease prevention activities.

The US Government provided an emergency grant of US\$50,000 in humanitarian assistance through the International Federation of the Red Cross (IFRC). The Caribbean Development Bank (CDB) made available an Emergency Relief Grant of US\$200,000 is to be administered through CDEMA. The Caribbean Institute for Meteorology and Hydrology (CIMH) deployed meteorological equipment and two technical personnel to facilitate the re-operationalization of both airports. Technical and logistical assistance to enhance response capacity of the Government of Dominica were provided by: International Telecommunication Union (ITU), UNFPA, UNICEF, UNDP, PAHO, and UN Women.

CHAPTER TWO – THE RAPID DAMAGE AND IMPACT ASSESSMENT APPROACH

2.1 THE RAPID DAMAGE ASSESSMENT APPROACH

To conduct the assessment, the Government coordinated an interagency team comprised of national government authorities and representatives from the World Bank, UNICEF, WFP, FAO, PAHO, UN-Women, University of West Indies and the Caribbean Development Bank to take stock of and tabulate damage and loss, visit affected areas, gather information and analyze the results to inform the recovery strategy.

The information in this RDIA report reflects the results of the assessment and information available as of September 23, 2015.

ASSESSMENT TIMEFRAME

Time Period	Activity
August 28	GoCD request for technical assistance
September 7-16	RDIA data collection in coordination with the GoCD and the World Bank technical team
September 7	RDIA methodology technical workshop.
September 15	Preliminary presentation of findings to Ministry of Finance
September 12 – 23	Preparation of the Draft Assessment Report
September 24	High-level presentation to the GoCD for endorsement
September 25	Finalization of the Report

RDIA Training. A one hour technical workshop focusing on the methodology of the assessment was held on Monday September 7, 2015 and chaired by the Ministry of Finance. The RDIA builds on the Damage and Loss Assessment (DaLA) methodology developed by UN ECLAC (see box below) and expands it with quantitative data on social sector and livelihood impacts. Twenty eight experts attended representing Ministries and organizations from impacted sectors, which include: the Ministry of Finance, the Ministry of Agriculture and Fisheries, the Ministry of Education and Human Resource Development, the Ministry of Health and Environment, the Ministry of Housing, Lands and Water Resource Management, the Ministry of Public Works and

Ports, the Ministry of Social Services, Family and Gender Affairs, the Ministry of Tourism and Urban Renewal and Dominica Water and Sewerage Authority.

The session outlined the data collection methodology to facilitate the Rapid Damage and Impact Assessment. The training focused on assessments in four main sectors: social, productive, infrastructure, and crosscutting sectors.

2.2 ASSESSMENT SCOPE

The Damage and Loss Assessment Methodology

The DaLA methodology uses the country's system of national accounts and involves all macroeconomic sectors including productive (agriculture, tourism, commerce, and industries), infrastructure (transportation, electricity, and water supply, telecommunications, and sanitation), social (housing, education, and health), as well as crosscutting issues (e.g. the environment and gender). Under the methodology's conceptual framework, the following *disaster effects* are measured during the assessment:

***Damage** is defined as the monetary value of physical, durable assets that may be fully or partially destroyed due to the natural disaster, expressed in terms of the replacement value of the assets assuming the same characteristics that they had prior to the disaster.*

***Losses** are changes in the normal flows of the economy that may arise in all sectors of economic and social activity due to the external shock brought about by the disaster, and that may continue until full economic recovery and reconstruction has been achieved, and are expressed in current values.*

Figure 1: Damage and Loss Assessment Methodology

This assessment covers the damages and losses caused by Tropical Storm Erika and the associated floods and landslides that occurred during that period. The main assessment of the damage and loss were conducted island-wide taking into account data from all districts. The following sectors have been included in the assessment: i) Transportation; ii) Water and Sanitation; iii) Telecommunications; iv) Agriculture; v) Tourism; vi) Commerce; vii) Housing; viii) Education; ix) Electricity; and x) Health.

2.3 ASSESSMENT METHODOLOGY

While the main focus of the assessment has been to estimate the damages to physical assets and the corresponding losses, this Rapid Damage Impact Assessment is broadly based on the

Damage and Loss Assessment (DaLA) methodology developed by the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC) in the early 1970s and further updated and expanded by the World Bank's Global Facility for Disaster Risk Reduction (GFDRR)⁸.

To the extent possible, the team applied the DaLA assessment approach with some deviations owing to the timing of the assessment. This report provides, based on the available information, an approximation of damages to assets and loss to the economic flows, and provides some inputs to assist in summarizing total macroeconomic impacts.

Wherever possible, the reconstruction needs are computed and expressed as the financing requirement for restoring damages with a “Build Back Better” factor for quality improvements, resilience and risk reduction.

2.4 LIMITATIONS AND CAVEATS

The findings presented in the RDIA, which was conducted from September 7-18, 2015, are intended to quantify the impacts of the August 27 flood event and provide recommendations to increase the country's disaster resilience. The data in this report is derived from figures provided by the government and incorporated into the analysis by the sector teams following discussions with government officials and on the basis of strategic interviews, expert opinions, feasibility considerations and other implementation considerations.

Since some of the assessments and specific sectoral analyses are ongoing, the figures presented in this report should be considered as the best estimate possible given available data and time constraints. Furthermore, given the short time available for this Rapid Damage Impact Assessment, and the focus of local authorities on rapid emergency response in terms of reconstruction needs, this report has attempted to include the disaster's impact on cross-cutting areas such as Gender, Environment and Social Protection to the extent possible. In addition, while an approximation of loss to the economic flows have been presented, albeit partially, based on available information, the possible macroeconomic performance modifications, including possible slowdown of gross domestic production, deterioration of the balance of payments and of fiscal sector position, and increase in inflation arising from the losses in production have not been fully accounted for.

Therefore, the damage and loss figures presented in this Report should not be considered definitive, but rather a preliminary understanding of the disaster's impact, to guide the recovery and reconstruction efforts.

⁸ GFDRR, *Guidance Notes for Damage, Loss and Needs Assessment*, vol. 1, *How to Conduct a Damage, Loss and Needs Assessment*; vol. 2, *How to Estimate Sectoral Damage and Loss*; vol. 3, *How to Estimate Post-disaster Needs for Economic Recovery and Reconstruction* (Washington, DC: World Bank, 2010); and vol. 4, *How to Estimate Disaster Impact at Macroeconomic and at Personal Levels* (Washington, DC: World Bank, forthcoming)

CHAPTER THREE – DAMAGE AND LOSS BY SECTOR

DAMAGE AND LOSS BY SECTOR

SUMMARY. According to a summary of the data reported from each affected sector, Tropical Storm Erika resulted in an estimated total damage and loss of **EC\$1.3 billion (US\$483 million)**, equivalent to **90%** of Dominica’s Gross Domestic Product (GDP). The majority of damages were sustained in the transport sector (60 percent), followed by housing sector (11 percent) and agriculture sector (10 percent). The table below summarizes the damage and loss by sector.

Table 3: Summary of Damage and Loss by Sector (in millions)

	Sectors	Damage EC\$	Loss EC\$	Total EC\$	Damage US\$	Loss US\$	Total US\$
Productive							
	Agriculture, Fisheries and Forestry	114.22	13.11	127.33	42.46	4.87	47.33
	Tourism	52.40	31.48	83.88	19.48	11.70	31.18
	Industry & Commerce	24.56	1.50	26.06	9.13	0.56	9.69
Infrastructure							
	Water and Sanitation	46.11	6.39	52.50	17.14	2.38	19.52
	Air and Sea Ports	40.08	0.21	40.29	14.90	0.08	14.98
	Roads and bridges	643.59	129.87	773.46	239.25	48.28	287.53
	Electricity	5.89	0.88	6.77	2.19	0.33	2.52
	Telecomm	26.90	0.00	26.90	10.00	0.00	10.00
Social							
	Housing	119.80	25.86	145.66	44.53	9.61	54.15
	Education	9.55	1.20	10.75	3.55	0.45	4.00
	Health	1.73	3.50	5.23	0.64	1.30	1.94
TOTAL		1084.82	214.01	1298.83	403.28	79.56	482.84

Reconstruction cost estimates. The RDIA has determined that a total of EC\$1,084,818,469 damages were incurred during TS Erika resulting in EC\$214,011,231 losses. The reconstruction is – in principle – based on the assessment of damages, which are based on current replacement and/or repair costs using 2015 prices. In addition to the current replacement cost, additional costs are accounted for feasibility studies, engineering design and supervision of works related to engineering works. For the purpose of determining the public liability for reconstruction, a net present value budget of EC\$1,023,527,611 in 2015 prices is required to reconstruct and ‘build back better’. This estimate excludes private liabilities but includes a comprehensive housing development programme for approximately 560 new homes estimated at EC\$128,784,053⁹.

⁹ Costs include land acquisition, access to water and sanitation, electricity, access and standard housing units.

3.1 INFRASTRUCTURE SECTORS

3.1.1 Transportation - Roads & Bridges

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
643.59	129.87	773.46	239.25	48.28	287.53

**values in millions*

Background. The 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. In 2009, a road condition assessment was conducted based on road roughness indices. The results showed that about 24% of the main roads and 90% of the secondary, urban and feeder roads were categorized as in poor or bad conditions. This had implications in terms of higher vehicle operating costs and negative effects on tourism and agriculture. The Ministry of Public Works has developed a comprehensive 10 years road sector program to improve the condition of 100% of all type of roads in the country to satisfactory condition by 2020. Tropical storm Erika has caused extensive damages and losses in the transport sector and the result is a major setback to the ambitious infrastructure rehabilitation program of the government.

Impact of Disaster. The floods and landslides triggered by tropical storm Erika destroyed and damaged extensive parts of the transportation network in the country. From the initial rapid damage assessment approximately 17% of roads and 6% of bridges are fully damaged. In addition, 24% of roads and 44% of bridges are 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 remain sections of roads that will require significantly longer time to repair and reconstruct. The west coast road has been severely damaged with multiple segments cut due to landslides and bridge failures (e.g. Macoucherie, Batali, 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. The situation remains critical in the Loubiere-Pichelin-Dubique-Bagatelle and Roseau-Pont Casse-La Plaine-Boetica Gorges, along Roseau Valley corridors and some feeder roads. In some sections such the Boetica Gorge the entire road and embankment of more than 10,000 cubic meter were washed away. Restoring connectivity in some areas such as Petite Savanne will be difficult in the short or medium term and will require significant investment.

Financial (Damages and Losses). *The total damages and losses to the transport sector (roads and bridges) and additional needs are estimated to be EC\$773.46 million (US\$287.53 million). Damages to roads and bridges are estimated to be EC\$434 million (\$US161 million) and EC\$ 150 million (\$US56 million), respectively. Damages to road slide slopes are estimated to be EC\$58 million (\$US22 million). In addition, losses due to increase in vehicle operating cost, increase in travel time, clean up, and temporary works are estimated to be EC\$41.7 million (\$US 15.5 million). Reconstruction needs to improve the resilience of new and existing infrastructure including bridge condition investigations, design and supervision of new works are estimated to cost an additional EC\$88 million (US\$33 million).*

Figure 1 (a) Drone view of collapsed road at Boetica’s Gorge (depth 25m, length 50m) and (b) Batali Bridge, West Coast Road



Table 1: Roads and Bridges – Damage, Losses and Reconstruction Needs¹⁰

Description	Damage (EC\$)	Loss (EC\$)
Bridge reconstruction	41.02	
Bridge repair	109.08	
Roads reconstruction	233.45	
Roads repair	200.55	
Slope stabilization	58.41	
Vehicles damaged	1.08	
Time and vehicle operating cost		12.49
Temporary work and clean up		29.2
New design and supervision		58.41
Improved resilience		29.2
Bridge Inspection		0.56
Total	643.59	129.87

¹⁰ All estimation used market value of reconstruction per unit measurement. In addition, value of time, vehicle operating cost, and additional provision to increase the resilience of infrastructure were included in the analysis. The damage and loss assessment does not include the impact of transport interruption on tourism, commerce, agriculture and other industries.

Infrastructure Sector Recommendations

Immediate Actions:

To avoid additional casualties:

- Appropriate signage in dangerous areas
- Inform people about unstable and landslide prone section of the roadway
- Inform people to take caution when crossing rivers, especially in rainy days
- Proactively close traffic in dangerous sections of roads when heavy rains are expected
- Regularly monitor partially damaged bridges that are open to circulation
- Urgently clean up rivers, bridges, culverts etc. to avoid further flooding
- Safely trigger active landslides (blocks, trees, unstable materials, etc.),

To avoid further damages to road and bridge assets:

- Undertake urgent abutment reconstruction, foundation stabilization and approach protection of partially damaged or undermined bridges
- Undertake a comprehensive and detailed landslide assessments, apply speed restriction and traffic restriction to avoid total collapse
- Clean up rivers, drainage systems and restore hydraulic capacity of bridges by removing blocks, trees or materials

Short Term Actions to Restore Access and Support Recovery.

Repairs on the west coast road (Roseau to Portsmouth)

- Construct low cost river crossings using pipes (e.g. in Macoucherie, Batali, Pointe Ronde)
- Prepare construction sites and install temporary bridges at minimal cost (e.g. at Batali and Pointe Ronde)
- Rehabilitate damaged critical points

Actions on the rest of the network

- Clean up remaining landslides
- Conduct light road and bridge repairs, install temporary crossings, place blocks or gabion cages to stabilize walls
- Improve bridge approaches to restore connectivity
- Conduct temporary stabilization works of undermined road sections
- Perform a comprehensive and detailed assessment of the bridge and road assets

Long Term Reconstruction Strategies and Recommendations:

- To enhance the resilience of the road network to natural disasters and climate change prepare technical guidelines for
 - Hydraulic capacity analysis
 - River bank protection
 - Landslide stabilization and mitigation measures
 - Coastal protection
 - Prioritization process of investments based on cost benefits analysis
- Conduct preliminary technical studies, prepare design and bidding documents for repair and reconstruction of partially and fully damaged sections.
- Conduct river training work near major bridges
- Perform a comprehensive and detailed vulnerability assessment of the road network to natural disaster and climate change and prepare a multiyear investment mitigation action plan.

3.1.2 Transportation - Airports and Sea Ports

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
40.07	0.215	40.29	14.90	0.079	14.98

**values in millions*

Airport

Background. Douglas-Charles Airport is the main gateway to Dominica with the rest of the world, and is also the main gateway for stayover tourism, which comprises 93% of the roughly US\$ 130 million revenues from the tourism industry. It follows that the operational condition of the airport is of utmost importance for the economy of Dominica. Fortunately the outage of the airport occurred in the slowest part of the year. The damages were extensive – though the airport has been reopened in record speed, significant capital needs to be invested in order to make it truly functional as an efficient gateway serving roughly 140 thousand passengers a year. With all ground-level kept electrical equipment such as conveyor belts, x-ray machines, walk-through security scanners, runway and approach lighting, and communications equipment having been destroyed, the airport currently operates in a very limited capacity, allowing only daytime flights in good visibility, and having long queues for baggage and passenger security screening. Throughput at the airport will need to be increased in order to serve the upcoming tourism season effectively.

Impact of Disaster. Both Canefield Airport and Douglas-Charles International Airport were flooded, however, the substantial damages occurred at Douglas-Charles due to the flooding and the accompanying mud deposits. The river by the airport most likely became clogged by debris further upstream, and as this 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 (*see Figure 2 and Figure 3*).

Financial (Damages and Losses). *The total damages and losses to the transport sector (airports and seaports) are estimated to be EC\$40,289,890 (US\$14, 977,654).* Damage calculations are based on figures provided by the Dominican Sea and Air Ports Authority. Calculations of financial losses for the airport are based on the income statement for the year 2014/15 ending June 2013, adjusted for monthly seasonality based on passenger arrivals and departures for the same period.

Overall estimates of the damages, which are still preliminary estimates, are in the range of US\$ 15 million. Fortunately, there appears to be no structural damage to any buildings, and the cleanup effort of removing debris, along with repairing and replacing the most essential equipment, has been very rapid, with non-scheduled relief flights already using the airport, and scheduled services resuming on September 18. Two aircraft were observed destroyed beyond repair: A Beechcraft Debonair and a Cessna Skyhawk 172, losses that could be valued at EC\$538,000 (US\$200,000). In addition, damages of EC\$1,345,000 (US\$500,000) on airline-owned ground equipment were reported.

The list of items damaged is quite long. In effect, all ground based electronics were destroyed. This includes ground lighting, runway approach lights, the precision approach slope indicator, all portable communications equipment (the chargers were on the ground floor), x-ray machines (one for passenger screening, one for luggage screening), uninterruptible power supplies, baggage scales and handling system, PA systems, CCT, air conditioning systems, and much else. Not destroyed because of their higher locations was the distance measuring equipment (DME) and the non-directional beacon (NDB).

Table 2: Preliminary List of Infrastructure Damages at Douglas-Charles Airport

Description	Estimated Damages	Preliminary Damage Estimates
		EC\$
CCTV	30%	152,700
Security Access Control	70%	129,500
Public Address System	70%	57,400
Baggage Handling System	100%	597,000
Air Conditioning	75%	54,000
Furnishings	90%	453,600
Air traffic control, Nav aids, Met	60%	1,597,800
Building (Terminal, Maintenance, Concessionary)	60%	7,200,000
UPS MGE Galaxy 5000	35%	752,890
UPS for Nav aids, HS6040-2 Dual View X-ray	100%	120,000
Inspection for hand luggage	100%	375,000
Cargo shed	30%	300,000
Subtotal	60%	11,789,890
Pavements		28,500,000
Total		40,289,890

Figure 2: Though cleaned up externally, penetration of water and soil destroyed this and all other luggage scales.



Figure 3: All luggage handling equipment, such as this x-ray machine and luggage conveyer, were rendered inoperable.



In addition to electrical equipment, both fire engines became inoperative, the terrain inspection vehicle was destroyed (as were multiple other vehicles), a generator for aircraft powering became inoperative, the MET station for weather observation and reporting was destroyed, and much of the apron surface was damaged. In addition, the very beginning of runway 60 received some damage to its surface (*see Figure and Figure 5*). 7,000 meters of fencing will require replacing.

Figure 4: A large part of the apron has been washed away.



Figure 5: Damage to the runway surface at the end of runway 60.



Airport revenues for the fiscal year 2014-2015 were EC\$1,990,600 (US\$740,000). Using matching traffic data, a season-adjusted monthly revenue stream can be established, along with a daily stream using the number of days per month. Assuming 5 days of loss of operations in August, and 15 days in September, the total amount of losses can be estimated to be EC\$215,200 (US\$80,000). However, losses by the airlines directly servicing the airport far exceed those incurred by the airport, with an estimate of US\$ 14.5 million. Losses to airlines serving Dominica indirectly, such as British Airways and Virgin Atlantic, are difficult to establish, however, with a round trip airfare of US\$ 2,270 (Gatwick – Antigua, British Airways), and

visitor loss from the UK estimated at 1,202, a reasonable estimated would be EC 7.3 million (US\$ 2.7 million).

LIAT has resumed operations out of Douglas-Charles airport since September 18, and Seaborne Airlines since September 23rd. However, significant cost are spent daily on extra security personnel guarding missing sections of the perimeter fence and performing screening functions that used to be completed electronically (x-ray equipment and walk-through scanners). During daytime 25 extra security staff are needed, and at night 12.

Cross-cutting Themes. Every airport is dependent on access, and the main road leading to the airport has received some damage. To bring the airport fully into service again, the road linking the airport needs to be fully restored, which involved the removal of a high number of mud slides, the repair of the road by a bridge, and the restoration of one lane of the road at a location where it has collapsed. Tourism and air transport are deeply interlinked. Without air access, hotels cannot engage their markets, and without demand for Dominica's tourism, the airport's passenger volume will suffer. It is therefore essential that as the airport redevelops, tourism's infrastructure is also brought back on line (*Also see section on Tourism*).

Airport Sector Recommendations. The airport is being recovered at a rapid pace, with the runway having been cleared, the terminal appearing clean, and some essential equipment such as one fire engine and one generator having become operational. The airport right now can only allow daytime VFR operations, which is a severe handicap. In addition, passenger and luggage screening has to be done manually, and security guards are needed where the fence is missing.

Priority one in aviation is always safety, followed immediately by security. Therefore, a prioritized list would go as follows:

- Both fire engines and other emergency equipment need to be fully operational
- The perimeter fence needs to be rebuilt
- Runway lighting, approach lighting, and a PAPI should be on the airfield
 - While the airport is still operating under VFR, a much less costly visual approach slope indicator (VASI) could be installed
- All tower related equipment (ground to air communications, ground to ground communications, for example) needs to be operational.

In order to make the airfield fully marketable again, a very high priority would be x-ray screening and walk-through scanning equipment.

Of a very high, but longer term priority, the rock and soil based dam that has been repaired needs to be replaced with a much more substantial installation, and the river may need to be straightened through extensive earthworks on the opposite shore. The most important aspect of building the airport back better is to manage the risks concerning the river, and to build better

embankments and dams which take adequately into account occurrence of extreme events with a view to climate change.

The airport is progressing very rapidly towards limited commercial operations, however, procurement and replacement of critical equipment may still take one or two months.

Collapse of Barrage which Caused Inundation of the Airport



There are short-term, intermediate term, and longer term steps that should be taken in order to keep Dominica connected.

Short term recommendations

- Immediate replacement of damaged electrical equipment and electronics. This would include all security installations (CCTV, entry systems, x-ray machines, scanners), luggage handling (conveyor belts, scales), computers, and both ground to ground and ground to air communications equipment. Landing lights and precision approach lighting are essential to bringing the airport into full operational mode again.
- Immediate repair of physical infrastructure, including the end of runway 60, the washed away portions of the apron, the drive-up and car parking areas affected, and the security fence.
- Immediate repair of any emergency response infrastructure (fire engines, ambulances) that are currently not operating.

- The earthen dam may not be strong enough to hold back another rain storm, and the airport therefore still remains vulnerable. Reinforcements of the dam with more permanent materials such as concrete should be a top priority.

Intermediate term recommendations

- A feasibility study should be developed, evaluating:
 - (a) the probabilities and risks facing the airport and their mitigation by, for example, building river defenses, and;
 - (b) Identification of potential future sites for constructing a new, safer airport.

Long term recommendations

- Implementation of the findings of the feasibility study be they extensive fortifications of the current airport, or the building of a newer facility with higher capacities on a more secure site.

Sea Ports

TS Erika caused no damages to the port at Woodridge Bay, the main container port of Dominica. The ferry terminal was flooded, however the cleanup was accomplished in a single day. There may be some damages to the passenger screening equipment which are in the process of being evaluated.

3.1.3 Water and Sanitation

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
39.06	6.16	45.22	14.52	2.29	16.81

**values in millions*

Background. The DOWASCO service system comprises 42 service areas serviced by 44 abstraction points (*Figure 6*) the majority of which are stream extraction systems. Prior to the storm, DOWASCO was supplying 98.5% of the population with treated piped water. System production is approximately 10 million gal/day. 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 waste 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 its water resources.

Impact of Disaster. Damages in the water sector are significant and widespread with most of the damages 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. Damages to sewer systems were to transmission lines (3) and outfalls (2).

During the storm, flash flood damages to transmission infrastructure were largely concentrated at bridge crossings. Much of the transmission system is underground however, 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 damages to intakes and transmission line damage (*Figure 6*). 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.

In some areas, where intakes could not be reestablished, portable extraction/treatment units have been installed for temporary supply. Apart from the issue of extraction, transmission remains

problematic for some areas. Where lines were attached to bridges, and the bridges were destroyed, service restoration has been hampered. At this writing, several communities continue to rely on bottled or trucked water and 75% of the system has been restored to service.

As emergency response measures have been focused on getting water supply to the community, temporary measures have been taken which continue to leave the system in an extremely vulnerable condition. While the impact is currently unknown, heavy rains on Friday, 12th September took at least 2 abstraction points out of service.

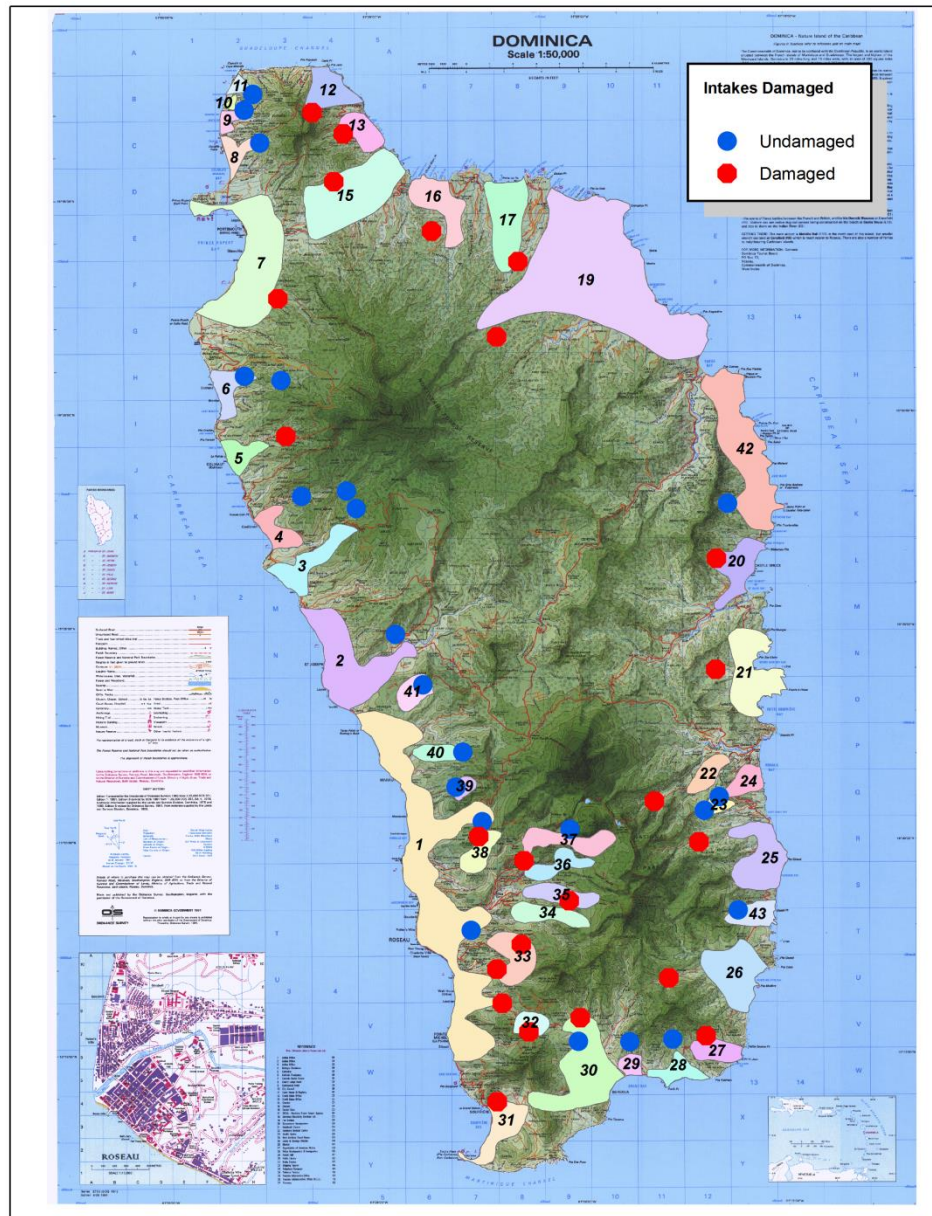
Financial (Damages and Losses). *The total damages and losses to the water sector are estimated to be EC\$45,221,590 (US\$16,811,000).* It cannot be overemphasized that these figures are expected to climb as the Hurricane Season progresses, given the network is fragile and vulnerable.

Damages presented in this report (*Table 3*) relate to the costs associated with infrastructure damages and the requirements for their reconstruction and rehabilitation. With respect to the water sector, losses relate to emergency temporary repairs, emergency response to water shortages (trucking water) and lost revenue currently being experienced. These are focused on DOWASCO expenditures. Not captured in this section are losses relating to the public health impacts of interruptions in the potable water supply. Most significant will be the increase in cases of gastric disease associated with consuming contaminated water and lost employment opportunity faced by care givers. Recent monitoring indicates this is on the rise with the aged and very young segments of the population at increased risk. This will be captured in the public health section of the report.

Table 3 - Summary of Damages and Losses, Water Sector

Damages		EC\$
Damages to Production and transmission facilities		\$36,925,630
Damages to Sewer lines		\$2,138,550
	Total Damages	\$39,064,180
Losses (<i>Aggregated losses not including lost revenue</i>)		
Emergency repairs, time and materials		\$6,157,410
	Total Losses	\$6,157,410
	Total Damages and Losses	\$45,221,590

Figure 6 - DOWASCO Service Areas and Intake Status



Water and Sanitation Sector Recommendations.

Medium- Long Term Actions

- As transmission lines are often installed external to bridges, consider liaising with Ministry of Works, on the design of new bridge infrastructure to include protected utility corridors in the bridge design rather than hanging transmission lines externally.
- Consider the application of stream bed infiltration galleries (if possible) in lieu of surface water abstraction systems to reduce exposure to heavy debris during flooding events.

- Review current locations of abstraction points to identify if less vulnerable locations can be utilized to lessen the impact of flood debris and battering from main channel flows (e.g. upstream locations, stream side diversion designs)
- Consider weir designs that facilitate sediment removal such as de-sedimentation structures, sloped designs or other approaches that reduce sediment build-up or promote rapid excavation after an event.

3.1.4 Environmental Health

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
7.04	0.24	7.28	2.62	0.08	2.71

*values in millions

Background. 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.

Environmental health 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.

Vector and waterborne disease. For vector control, environmental health assesses and provides treatment for the control of insects (mosquitoes, flies), rodent control and other activities to reduce human exposure to potential disease transmission. Vector borne disease is a major concern for Dominica as Dengue Fever is endemic to the island with high epidemic potential. The recent outbreak of Chikungunya (CHIKV) demonstrated the vulnerability of the population to vector borne disease. The disease, spread by the yellow fever mosquito (*Aedes aegypti*) and was introduced to Dominica in early 2014. Within 9 months, an estimated 70% of the population was infected. This is the same mosquito that transmits Dengue virus.

Water borne disease is related to general sanitation. Consumption of water contaminated with sanitary waste is the primary mechanism for the spread of disease such as gastroenteritis, typhoid, salmonellosis in the public health setting. Leptospirosis (*Leptospira sp.*) is known in Dominica and is spread through contact with contaminated soils and water. Common reservoirs for the bacteria are domestic livestock (cattle, pigs, horses etc.), dogs, rats and other mammals. The Environmental Health Unit monitors water quality and disease outbreaks and responds to control outbreaks providing analytical and control services.

Solid Waste. The Environmental Health Unit is the primary solid waste manager for the country. Waste collections are weekly or bi-weekly depending on the service area. The unit maintains 2 collection vehicles which travel from the community pickup locations to the sanitary landfill. The island has no transfer stations. Private contractors supplement the service, particularly in the

hotel and industrial sectors. Metal recovery and recycling is practiced to the extent possible. Medical waste is managed by incineration. Environmental Health is responsible for the incinerator facility located at the hospital, however the unit is currently offline. Medical waste is currently being landfilled in a special designated area.

Sanitation. The unit manages and maintains a number of public sanitation facilities throughout the island. Thirteen facilities (serving 885 persons) throughout the island are reported to be out of service due to damages. They also monitor the condition and status of private wastewater systems, generally a combination of septic systems and pit latrines. There is currently a national program in place to ultimately eliminate the use of pit latrines.

Impact of Disaster. Solid waste, vector propagation and contaminated water are the three areas of primary environmental health impact. On the public side, solid waste generation has increased significantly as affected persons continue their cleanup and recovery efforts. Lack of public water and damage to sanitation facilities has resulted in an increased exposure to contaminated water with corresponding increases in gastroenteritis. The general post flooding environment has created conditions favorable for the widespread propagation of pests and vectors, particularly associated with the accumulation of solid waste and standing water.

Financial (Damages and Losses). *The total damages and losses to the Environmental Health sector are estimated to be EC\$7,279,523 (US\$2,706,142).* Damages (Table 4) reported by environmental health relate primarily to equipment damages and damage to public sanitary facilities as well as to the leachate collection system. This includes the need to replace collection vehicles and container systems and rehabilitate waste management infrastructure.

Losses are evolving as the emergency response phase continues. Losses cited in the table are partial, incomplete and likely quite low given the potential for public disease impacts. They relate primarily to the need for emergency acquisition of vector control supplies and response materials. Losses in time and materials will continue to accrue, particularly as contractors are engaged to support cleanup activities. Additional losses will be accrued as enhanced laboratory surveillance is conducted to manage the emergency.

Finally and perhaps most importantly, losses due to increase in disease prevalence will accrue as health conditions have deteriorated. As of 10th September, surveillance reports indicate that cases of gastroenteritis were rapidly rising. Losses due to Vector Borne Disease (Dengue) cannot be accounted for at this time owing to the incubation time required which varies from 4-15 days. The incubation period for leptospirosis is 7 – 12 days.

Table 4: Summary of Damages and Losses, Environmental Health

Damages		EC\$
Repair public sanitary facilities		\$220,000
Specialized waste collection vehicles and containers		\$3,250,850
Biomedical waste transport vehicle		\$215,200
Landfill excavator		\$640,220
Metal compactor		\$1,345,000
Medical waste incinerator		\$807,000
Landfill drainage repair		\$198,021
Landfill road repair		\$99,010
Leachate pond repair		\$269,000
	Total Damages	\$7,044,301
Losses (Vector control only)		
Consumable supplies (pesticide, fuel etc.)		\$95,284
Vehicle (fogging application)		\$100,000
Field equipment (foggers, safety equipment)		\$39,938
	Total Losses	\$235,222 (vector control only)
	Total Damages and Losses	\$7,279,523

Environmental Health Sector Recommendations

Short-term Actions:

- Work with ODM, local governments and DOWASCO to consider prepositioning vector control and drinking water treatment supplies at strategic locations as part of the disaster preparedness program.

Medium-term Actions:

- Consider the use of waste transfer stations around the island and analyze the use of these stations for both improved solid waste management and as staging areas for post-disaster waste storage when transportation is interdicted.
- Consider improvements to public sanitary facilities that include onsite water storage to maintain facility operations when public water is disrupted.

3.1.5 Telecommunications

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
26.90	NA	26.90	10.00	NA	10.00

**values in millions*

Background. Dominica's telecom system is privately owned and operated by four separate corporations: LIME, Digicel, Marpin 2K4, and Wikibuli. The backbone of the communications network is based on submarine cables entering Dominica at landing points in Roseau and Canefield. Distribution throughout the island is handled by a ring of fibre-optic cable following the primary coastal road using both underground and overhead cables which use poles and trenches shared with other telecom and utility companies. In addition to the cables, LIME and Digicel operate a number of cellular sites. Smaller companies are Marpin 2k4 which operates cable television, internet and phone services and Wikibuli which provides business communication services.

Impact of Disaster. Damages to the telecoms sector were primarily incurred due breaks in the fibre optic cable lines resulting in interruptions of internet, cellular, cable and phone services to all areas outside of Roseau. Breaks in lines were caused by bridge failures, scouring of trenches located adjacent to roads and utility poles destroyed by landslides. Failure of microwave towers also occurred in areas of severe landslides and flooding. Damage to infrastructure located below ground were much more substantial than above ground. Cellular services were restored by LIME and Digicel by September 3rd to 98% of their network. Permanent repair of fibre-optic infrastructure and last kilometer links is estimated to take several months. Due to dangers to staff, all of the providers have opted not to restore service in the worst affected areas.

Financial (Damages and Losses). *The total damages and losses to the Telecommunications sector are estimated to be EC\$26,900,000 (US\$10,000,000).* Details of lost revenue and number of customers were not made available by the various companies. Estimated damage figures for infrastructure were provided with estimated losses.

Telecommunications Sector Recommendations. Communications with communities during, and immediately after the disaster, were severely disrupted. An emergency wireless communications system should be set up and maintained by the GoCD in partnership with the major telecommunications companies. Volunteers should be trained in the operation of this system during a disaster. Further private sector and Government specific recommendations are outlined below.

Recommendations for the Private Sector:

- Three days after the disaster, generators at some of Digicel's sites ran out of fuel and could not be resupplied. This led to further network outages. All sites should be inspected to ensure that they have adequate backup fuel supplies and properly serviced backup equipment. Some of these sites also house seismic and hydro-meteorological equipment. Backups should be functioning for these critical sensors.
- Locations of equipment should be assessed for their vulnerability to hazards. Design of new bridge and road infrastructure should take into consideration the reduction of hazards to telecommunications equipment. For example, conduits for housing cables should be installed within a bridge rather than exposed on the side where they can be damaged by water flow and debris.
- A review should be conducted of call/data handling procedures in the event of a disaster. Measures need to be put in place to ensure first responders and disaster response personnel have priority access to networks.

Recommendations for Government:

- The existing emergency radio communications network needs to be reviewed and upgraded. Some communities could not be contacted for days, nor could they be accessed on land. The Emergency Operations Centre (EOC) receives situation reports from its volunteers and first responders on the ground through a radio base station. Where possible, every community should be equipped with a radio and a volunteer trained in its use.
- The existing voice radio network should be upgraded to carry broadband data through a mesh network connecting crucial parts of the country. Satellite phones are also an option which could be used to transmit data alongside terrestrial radio.
- Standard incident reporting procedures need to be adopted and enforced during a disaster. The EOC should be the information and communications focal point of the government during and immediately after the disaster. Telecommunications companies should be required to make regular daily reports to the EOC as they assess and repair damages. The EOC should provide a standard template for reporting which is linked to an emergency management information system.
- Government should upgrade all existing hydro-meteorological and seismic monitoring stations to automatically report through either radio or satellite. Information from stations should be available in real time and not be entirely reliant on wired communications.

3.1.6 Electricity

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
5.89	0.88	6.77	2.19	0.33	2.52

**values in millions*

Background. Dominica Electricity Services Limited (DOMLEC) is the sole commercial generator, transmitter, distributor, and seller of electrical energy in Dominica. It serves a customer base of residential, commercial, and industrial users for its operated hydropower stations as well as diesel powered generator, with a standby facility at Soufriere.

The present generation facilities in Dominica consist of:

- Three cascading run-of-the-river hydro plants (Laudat, Trafalgar and Padu) on the Roseau River with an installed capacity of 6.6MW and an available capacity of 6.16MW.
- The Fond Cole Power Station close to Roseau with a mix of medium and high speed units (nine in total) with an installed capacity 13.27MW and an available capacity of 12.35MW.
- The Sugar Loaf Power Station in the Portsmouth area with five high speed units with an installed capacity of 6.83MW and an available capacity of 6.43MW.

These units supply the island via eight 11,000 volt (11kilovolts) distribution feeders. The two diesel generation centers are tied together by the Portsmouth Feeder (PMF), but can also be tied together through two alternate routes utilizing the East Coast Feeder (ECF) and the Sugar Loaf West Feeder (SWF).

The hydro generating plants are linked to each other and the Fond Cole diesel station as follows:

- Laudat to Trafalgar by a dedicated interconnector line called the LTI.
- Trafalgar is also connected to Padu through a dedicated interconnector line called the TPI, and Trafalgar is also linked to the Fond Cole diesel station by a dedicated interconnector called the TFI.
- Padu is also linked to the Fond Cole diesel station by a dedicated interconnector called the PFI.

In addition, another 15MW of installed capacity (known at this time) exist through self-generators.

Impact of Disaster. Following the heavy rains, outages were experienced across the island to which DOMLEC dispatched emergency response crews to restore services where possible. Immediately after the incident, areas without Power were upper Trafalgar, Wotten Waven, Parts

of Bellevue, Pichelin, Grand Bay, Montine, Tete Morne, Dubique, Stowe, Bagatelle, Fond St. Jean, Petite Savanne, Delices, Soufriere, Gallion, Scottshead, Macoucherie, Salisbury, Coulibistrie, parts of Colihaut, Clarke Hall, Layou Valley, Checkhall Valley, Canefield Industrial Estate, Penrice, Campbell, Melville Hall, Marigot, Antrisle, Atkinson, Kalinago Territory, Concorde, Dix Pas, Tronto, Morpo, Good Hope, Sans Sauveur, Petite Soufriere, Rosalie, Riviere Cyrique, La Plaine, Morne Jaune, Boetica, Pont Casse, Fond Melle. On August 29, 2015, areas restored were Fond Canie, Lower Trafalgar, Bayak, Shawford, Cocoa Bottom in Canefield, Sultan, Pont Casse, Fond Melle.

Service to the following areas has been restored on the East Coast on Sunday September 6 - Wakaman, Bellefie, Richmond, Magini, Mahaut River, Gaulette River, Carib Territory, Sim Sim, Salybia, St. Cyr, Sineku, Crayfish River, Bataca, Concord, Atkinson, Entwistle, Pagua Bay, Hatten Garden, North End, Central Concord.

Financial (Damages and Losses). *The total damages and losses to the Electricity sector are estimated to be EC\$6,772,825 (US\$2,517,779).* Overall, the power supply sector did not experience major damage to its infrastructure except for intakes and pipelines in the hydro-power generating system EC\$5,289,000 (US\$1,966,171) and the transmission / distribution grid EC\$600,000 (US\$223,049). Losses for 2015 are estimated at EC\$883,825 (US\$328,559) for higher production cost. In addition, DOMLEC project reduced revenues due to lower GDP in forthcoming years. DOMLEC has estimated its damages and commenced with the reconstruction of its damaged infrastructure. In terms of water supply reliability for driving its hydropower generating units, an assessment of siltation of water intakes may be required

Table 5: Summary of Damages and Losses, Electricity

Damages		EC\$
Power Plants		\$5,239,000
Transmission System		\$600,000
	Total Damages	\$5,889,000
Losses in post disaster electricity demand		\$883,825
	Total Damages and Losses	\$6,772,825

Electricity Sector Recommendations:

- Consider conducting a comprehensive risk assessment with respect to landslide and flood risks for DOMLEC infrastructure
- Consider an assessment of the resilience of DOMLEC's Supervisory control and Data Acquisition system to ascertain control over its power generating capability at all times
- Consider slope stabilization and flood impact proofing of DOMLEC infrastructure if and as needed

3.2 PRODUCTIVE SECTORS

3.2.1 Agriculture, Forestry and Fisheries

AGRICULTURE

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
109.7	13.12	122.8	40.79	4.87	45.66

**values in millions*

Background. The Agricultural Sector is a significant contributor to the economy of Dominica. Agricultural contributes approximately 17%, or USD\$93.4M to the country's GDP. The agriculture sector is a major source of jobs 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. A variety of crops are grown but root crops and ground provisions are among the highest in agricultural importance. Bay oil production is regarded as second followed by banana and plantain. Other important crops include citrus, avocado, coconut, passion fruit and vegetables.

Livestock is a minor but important contributor to the sector. Poultry, cattle, goats, sheep, and pork are grown primarily for local consumption. In terms of agricultural importance, laying hens for egg production are considered number one, followed by pork production and finally ruminants. Over the past two decades, there has been much attention paid to the agricultural sector. GoCD together with international partners have invested significantly in the sector to promote production and manage pests and disease.

Impact of Disaster. 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 in and the bay leaf crop Petite Savanne.

Other severe impacts were realized with erosion and landslides blocking interior farm-to-market roads. As tertiary roads, they have yet to be addressed in the emergency response and await the availability of resources once primary and secondary roads are opened to traffic. As such, numerous farmers are either denied access to their fields and livestock or are denied access to markets. Finally, arable lands have been destroyed either through landslide, erosion or rock and debris deposition. The impacts of this will be most severe where individual landowners have lost

a significant portion of their arable plot requiring them to purchase new lands or abandon agriculture.

Financial (Damages and Losses). *The total damages and losses to the Agriculture sector are estimated to be EC\$122,832,078 (US\$40,789,110).* Damages and losses are extensive in areas hardest hit by flooding and landslide. As with other infrastructure sectors, this is a rapid assessment and damages and losses are expected to climb as the hurricane season progresses. Damages presented for this sector (*Table 6*) relate to the costs associated with infrastructure damages, loss of land, livestock and are based on the requirements for their reconstruction and rehabilitation or replacement at market value. Agricultural losses reflect the impact of Tropical Storm Erika on the ability to realize a harvest in accordance with projected production for this year, inability to harvest at the appropriate time and increased expenditures for land preparation and re-treatment as required.

Table 6: *Summary of Damages and Losses, Agricultural Sector*

Damages		EC\$
Destruction of agricultural lands		\$29,000,000
Damages Irrigation and drainage systems		\$1,900,000
Agricultural machinery and equipment		\$4,200,769
Damage to storage and farm related buildings		\$3,047,000
Plantation and production facilities damaged or destroyed		\$13,034,736
Livestock killed		\$851,000
Damage to road infrastructure		\$57,650,000
	Total Damages	\$109,722,705
Losses (Aggregated losses)		
Losses due to production changes		\$13,034,736
Losses due to increased production costs		\$74,637
	Total Losses	\$13,109,373
	Total Damages and Losses	\$122,832,078

Agriculture Sector Recommendations.

Medium-long term actions:

- Review with ODM, coops and farming community the locations of critical facilities (e.g. collection and storage facilities, processing facilities etc.) to optimize locations that reduce vulnerability.
- Review damages to tertiary roads and explore options with Ministry of Agriculture and Ministry of Works to harden infrastructure and consider engaging the users in drainage and erosion control on a routine basis. As national resources are limited, engaging the users would be a logical approach to improving resilience.

FORESTRY

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
1.546	NA	1.546	0.575	NA	0.575

**values in millions*

Background. Within the forestry subsector, activities include forest resource management, protected areas management, and the management and operation of natural sites and parks. With respect to commercial forestry, there is some agro forestry but the majority of product is used locally. Management of protected areas for habitat and watershed protection represents the majority of forestry activities in Dominica. As a subsector, activities within forestry maintain and manage the ecological services provided by the natural habitats which serve other sectors particularly drinking water through watershed management and transport through vegetative land slope stabilization. The sub-sector contributes to tourism by providing visitor sites and trails and manages the protection of endangered species on the island.

As a percentage of area, approximately 60% of Dominica is forested with 21.7% of the land area relegated to protected status. This includes Morne Trois Pitons National Park which was designated a UNESCO World Heritage site in 1998.

Impact of Disaster. Large landslides have taken sections of access road, tree cover, and landslide, flooding and erosion have damaged various facilities throughout the forest/park system. Extensive damages are evident in the following areas: Mosquito Mountain, Morne Diablotin, Carholm Heights, Scotts Head/Soufriere, Petit Savanne, Delices, Bagatelle, Heights of Sympa/Woodford Hill, Fond Pie, Morne Rachette, Heights of Salisbury and Colihaut, Morne Trois Pitons, Fond Touve, Stewart Hall Water Catchment, Castle Bruce and Fond Melle. The distribution of damages was not sufficient to impact resources on a broad ecological level and no critical ecosystems or critical habitats have been lost.

Financial (Damages and Losses). *The total damages and losses to the Forestry sector are estimated to be EC\$1,546,960 (US\$575,078).* Damages to forestry are primarily associated with landslide. Landslide is the predominate source of damage and losses in the sector and with respect to forestry is captured largely in cleanup and reforestation costs. Other losses accrue from stream damage due to high debris accumulations and sedimentation. It is noteworthy that fishing for crayfish is a cottage industry and has been significantly affected by changes in stream habitats.

Table 7: Summary of Damages and Losses, Forestry Subsector

Damages		EC\$
Lost land (30Ha)		\$600,000
Damage to forest roads		\$150,000
Reforestation of lost forest cover		\$56,960
Park infrastructure, trails and visitor facilities		\$740,000
	Total Damages	\$1,546,960
Losses (Aggregated losses)		
Losses in ecological services		Reflected in Water sector production changes and increased landslip in infrastructure sectors
Lost revenue from visitor access limitations		Reflected in tourism sector
	Total Losses	Refer to other sectors
	Total Damages and Losses	\$1,546,960 (Damages only)

Forestry Sector Recommendations

The Forestry Department generally manages protected areas and visitor facilities within the protected areas system. Additionally, they have an ongoing program to manage forest reserves and promote reforestation activities where appropriate. While landslip is an unavoidable occurrence given the islands physiography, certain activities can contribute to the stability of land areas and island ecological integrity.

Short Term

- Conduct an inventory of affected areas and determine whether reforestation would be effective as a soil stabilization measure.
- Examine associated infrastructure to determine whether storm related impacts have placed facilities at greater risk and develop plans to mitigate risks identified.

- Review critical habitats for wildlife species particularly those considered endangered to ensure that no significant habitat disruptions have occurred.

Mid to long term

- Develop a detailed mapping of forest resources/forest cover, implementing a classification scheme that defines forest types based on their biological characteristics. This will provide a basis for informed reforestation activities that preserves the ecological characteristics of islands habitats and improve resilience of forest management investments.

FISHERIES

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
2.949	NA	NA	1.096	NA	NA

**values in millions*

Background. 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 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 presented in *Map 2*. The fisheries monitors fishing activities through 15 fisheries enumeration districts (*Map 2*). 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.

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.

Impact of Disaster. 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. 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 have been covered in sediments which will alter the ecology of some fishing areas.

Financial (Damages and Losses). *The total damages and losses to the Fisheries sector are estimated to be EC\$2,949,324 (US\$1,096,403).* With respect to the overall damages and losses suffered on a national scale, the fisheries subsector is a very minor contributor, however owing to the nature of the subsector, losses and damages can be catastrophic to livelihoods and families involved. As such, the direct impacts to those involved in the sector are disproportionately severe compared to other sectors. Losses and damages are still being tabulated at this writing however, preliminary estimates have been provided by the Fisheries Department. These are presented in *Table 8*. While damages have been tabulated, losses have not. These will be 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”. Finally, losses will be incurred awaiting equipment replacement and rehabilitation of critical infrastructure and facilities.

Table 8: Summary of Damages and Losses, Fisheries Subsector

Damages	EC\$
Fishing pots	\$101,400
Engines	\$1,132,700
Boats	\$4,200,769
Fishing Tackle	\$44,806
Nets	\$39,000
Navigation & Safety	\$3,475
Containers/Coolers	\$24,180
Sheds	\$15,000
Fish attraction devices (FAD)	\$3,000
Misc Damages	\$96,763
Total Damages	\$2,949,324
Losses (Aggregated losses)	
Losses due to reduced catch from fishing grounds damage and Ghost pots.	Not available
Losses due to equipment and facilities replacement schedule	Not available
Total Losses	Not available

Recommendations for the Fisheries Sector

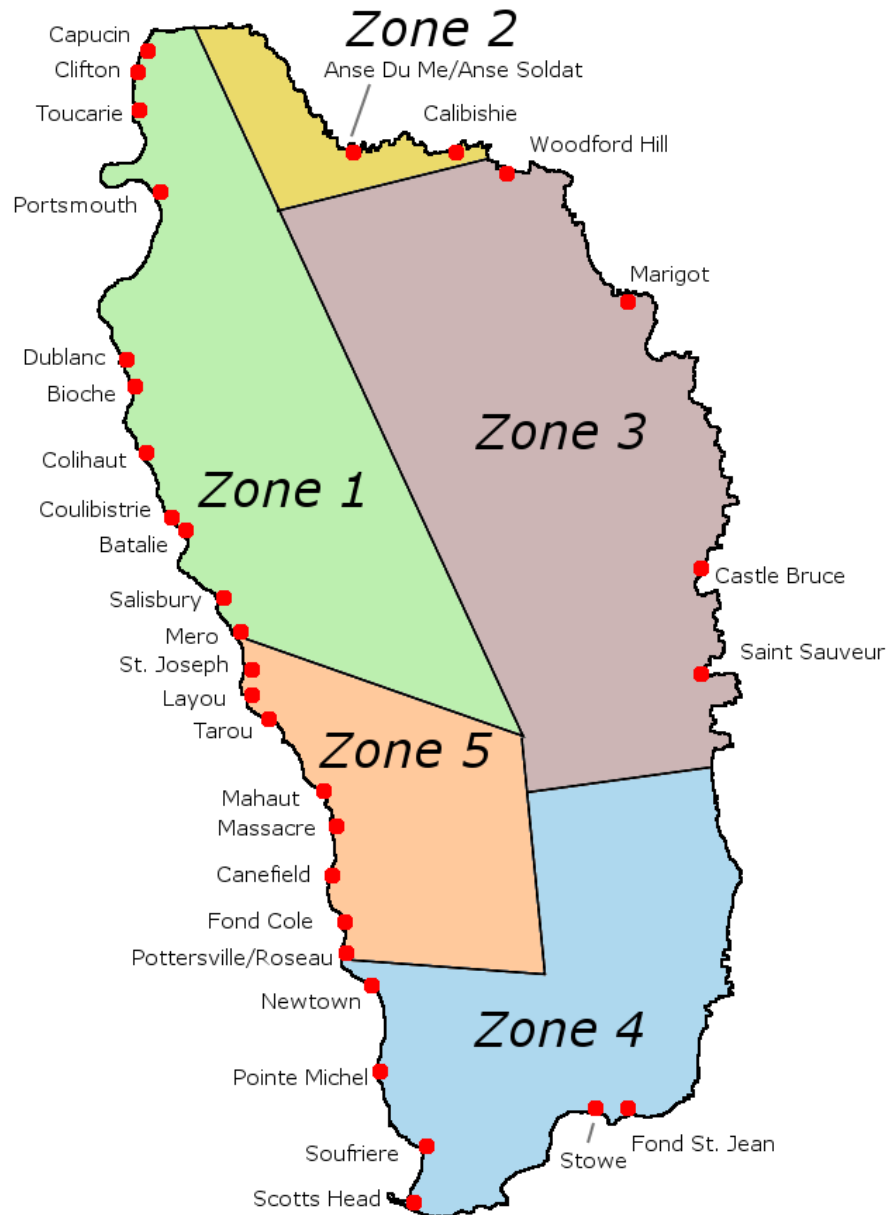
Short-term Actions

- Engage the diving community in the search and removal of abandoned traps to reduce the impacts of Ghost Fishing.

Medium to long term Actions

- Assess and identify safe harbor locations for water craft and fishing gear when floods are expected and work with fisher folk to help plan to protect their assets during an event.
- Review, in light of this disaster, weaknesses in the fisheries cold-chain (e.g. ice, refrigerators, etc) and identify where improvements may be made to rapidly restore these services.

Map 2 - Location of Fisheries Communities



3.2.2 Tourism

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
52.40	31.49	83.88	19.48	11.70	31.18

**values in millions*

Background. The tourism sector in Dominica comprises mainly of stay-over tourists and cruise ship arrivals. Though cruise ship arrivals outnumber stay-over visitors nearly four to one, 93% of tourism (roughly US\$ 124 million) revenue is generated by the roughly 80,000 stay-over visitors, while only a minor amount (US\$ 9 million) comes from the nearly 290 thousand cruise arrivals. The average expenditure per stay-over visitor has been roughly US\$ 1,500, while all other visitors, the bulk of which are cruise passengers, spend roughly US\$ 30 per visitor. 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 of and availability attractions outside hotels. The cruise industry also depends heavily on attractions: Cruise ship operators have their own arrangement in packaging excursion 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. Fortunately this gives the tourism sector a window in time to recover the most important assets before the height of the season begins.

Impact of Disaster. The private sector reports that out of 95 hotels, 31 (33%) have reported being affected by TS Erika, and 7 could not be reached. Of the 31 affected, 20 are nonetheless operating. It is known that 11 hotels have ceased operating, and two additional 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 has been a reduction of 8% in room capacity, from 976 rooms to 900, amongst those hotels which have been contacted. Water damage is 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 by TS Erika, of which 7 are operational. Of 28 tour operators, 7 are reported as affected, and 2 could not be reached or could not assess their damages yet. 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.

Financial (Damages and Losses). *The total damages and losses to the Tourism sector are estimated to be EC\$83,891,200 (US\$31,186,320).* Calculations of damages are based on reports provided by the Discover Dominica Authority and the Dominica Hotel & Tourism Association. Losses are calculated with visitor figures published by the Eastern Caribbean Central Bank for 2014 and 2015, with the baseline projected at an annual growth rate of 2%. Stay-over visitor revenue is assumed to be 93% of total tourism revenue. The estimation for stay-over losses includes 14 days of airport closure, with the expected re-opening date of Tuesday, September 15.

Tourism sector damages total around EC\$52,401,200 (US\$19,480,000), with hotels being hit the hardest with EC\$40,350,000 (US\$15,000,000) in damages, of which the Jungle Bay Resort accounts for slightly over EC\$26,900,000 (US\$ 10 million). The damages can be summarized as follows:

Table 9: Preliminary Pricing of Damages in the Tourism Sector

Damages		EC\$
Hotel losses		\$40,350,000
Sites & Attractions and Community Tourism Facilities		\$4,384,700
Other		\$7,666,500
Losses		\$31,490,000
	Total Damages and Losses	\$83,891,200

The effect of the damages is wider ranging. Though with a loss of an estimated 20% in tour attractions, there is expected to be a reduction in cruise calls and visitors, lasting most likely through December and January as capacity is being restored. In addition, access for overnight visitors has been nearly impossible since the closure of Douglas-Charles Airport. The commercial losses for September 2015 may reach as high as EC\$9,146,000 (US\$3, 400,000).

The hotel room stock has been reduced by 8% to 92% of original capacity. This capacity will not be fully restored within a short period because of the complete destruction of one hotel. An implied assumption, therefore, is that within the next six months hotel capacity will be restored to only 96% of pre-Erika.

In addition, the cruise industry is deeply affected by on-island attractions, which have been estimated to have dropped to 80% of previous capacity. These attractions may also factor as areas of demand for hotel stay-overs.

Seasonal visitor and spending figures of September 2014, grown at an annual growth rate of 2%, were extended over 9 months as the baseline. Using these figures it can be estimated that the operational losses facing the tourism sector will be in the EC\$31,490,000 (US\$11,706,320) range.

Cross-cutting Themes. The damage and even destruction of some hotels most likely shares the same common themes as the housing sector overall: zoning to avoid watersheds and flood areas, as well better construction standards. There must be a tradeoff between the physical appeal of a site and the danger that the site thus presents. One of the impacts of the downturn in tourism will be unemployment, with employees of the one permanently shut down hotel now finding themselves out of work. In the case of the Jungle Bay Resort and Spa, 65 people are now out of work.

Tourism Sector Recommendations. The storm hit the island in its slowest tourism period, so there will be time to bring some attractions on line again before peak season. The hotel room stock will not be up to 100%, since two properties were fully destroyed, however, 95% capacity should be achievable.

Both stay-over tourism and cruise ship tourism depend on attractions. It would therefore appear that a number one short-term priority, beyond making hotels and resorts usable and enjoyable, would be to restore attractions and their accessibility as quickly as possible. This would include both government owned and managed attractions such as trails and access to water falls, as well as private operations such as dive centers and others.

Long term reconstruction recommendations:

- The location of hotel sites must be more carefully considered and controlled by zoning. The recommendation falls in line with the issues facing the housing sector overall.
- Similar to the housing sector, building construction standards may need to be improved.
- Dominica is an island facing several natural disaster risks, including volcanic eruption. Emergency preparedness and planning is therefore essential. This would suggest the need for a comprehensive plan for evacuation of hotels, tailored to the uniqueness of each property's location.

3.2.3 Industry and Commerce

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
24.56	1.50	26.06	9.13	0.56	9.69

**values in millions*

Impact of Disaster

The Ministry of Commerce together with the Ministry of Trade collaborated to get an appreciation of the extent of damage experienced by the commercial sector – particularly companies engaged in the export trade. Dominica has 71 businesses engaged in the export trade, with only 5 businesses indicating negative impact from the tropical storm.

Damage and Losses

Commerce. The Ministry of Commerce conducted a rapid assessment analysis of commercial sector players, the main findings are:

- 34.5% or 19 of the targeted businesses with a combined employment of over 1,000 employees were directly impacted, resulting in damage and losses amounting to EC\$24,151,268.75 after the passage of the storm.
- 25% or 14 assessed businesses reported damages to their premises in the amount of \$9,201,400
- 16% or 9 of the assessed businesses reported stock damage of \$5,263,625.01
- 3 businesses reported damage to office furniture in the amount of \$468,439

Industry. The island's sole bay oil manufacturing facility was completely destroyed, while the two main rum producers: Belfast Estates Ltd. and Shillingford Estates Ltd sustained damages to property, furniture, equipment, loss of stock, and loss of sales, totaling EC\$1,600,000 and EC\$5,030,268.72 respectively. Data from other businesses and factories was not available to be included in this Report.

Recommendations

Short Term

- Coordinate recovery planning with the private sector (industry) with a view to create jobs.
- Promote the dissemination of hazard maps and risk analysis with small and medium enterprises to create awareness of hazard risk and preparedness planning

Long Term

- Promote the updating the “business continuity plans” in the factories.
- Review hazard insurance options for small and medium enterprises.

3.3 SOCIAL SECTOR

3.3.1 Education

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
9.55	1.20	10.75	3.55	0.45	3.995

**values in millions*

Background. The Government of Dominica places high priority on the education sector, with the major thrust during the last decade being directed towards the universalisation of the access to secondary level education. The figure for total recurrent expenditure on education for 2013/2014 was ECD\$59,748,346 (USD\$2,300,000) being 16.1% of overall national recurrent expenditure for that year. Through a school bus service, school feeding programme, school books rental, an educational loan programme together amongst other initiatives, the government has focused support towards students from the lower socio-economic groups to continue their education. The Education Act 11 of 1997 governs the education system and mandates compulsory education for all children between the ages of 5-16. According to the Education Digest prepared by the Ministry of Education and Human Resource Development covering the academic year 2013/2014, there were 60 primary schools and 15 secondary schools administratively divided into 4 geographic zones. Also included are 73 pre-schools (many housed within primary schools) and 1 tertiary education institution that fall under the responsibility of the ministry. Prior to Erika school drop-out rates were at 0.25% of those enrolled at the primary level and 6.6% of those enrolled at the secondary level. Graduation rate at the secondary level for 2014 was 79.2% (61% passing five or more subjects at CSEC the Regional Exam Board certification qualification) with the balance expected to repeat their final year. With 23 schools impacted, 13 damaged including 2 totally destroyed, and the start of the 2015/2016 school year delayed, the gains achieved in previous years are under significant risk.

Impact of Disaster. With the sudden, unexpected impact of Tropical Storm Erika, the education sector took a direct hit, seriously affecting the vast majority of Dominica's primary, secondary schools as well as community recreational facilities. Of 75 schools, 23 have been directly impacted of which 13 experienced structural damage including 2 totally destroyed, spread between 8 parishes. It is estimated that approximately 3,420 primary and secondary children have been directly affected out of a total school population of 7,695 primary and 5,561 secondary students. The original school opening date of 1st September 2015 has been pushed back to 14th September 2015 but only for schools that were not damaged, used as shelters and have water supply (approximately 60% of schools).

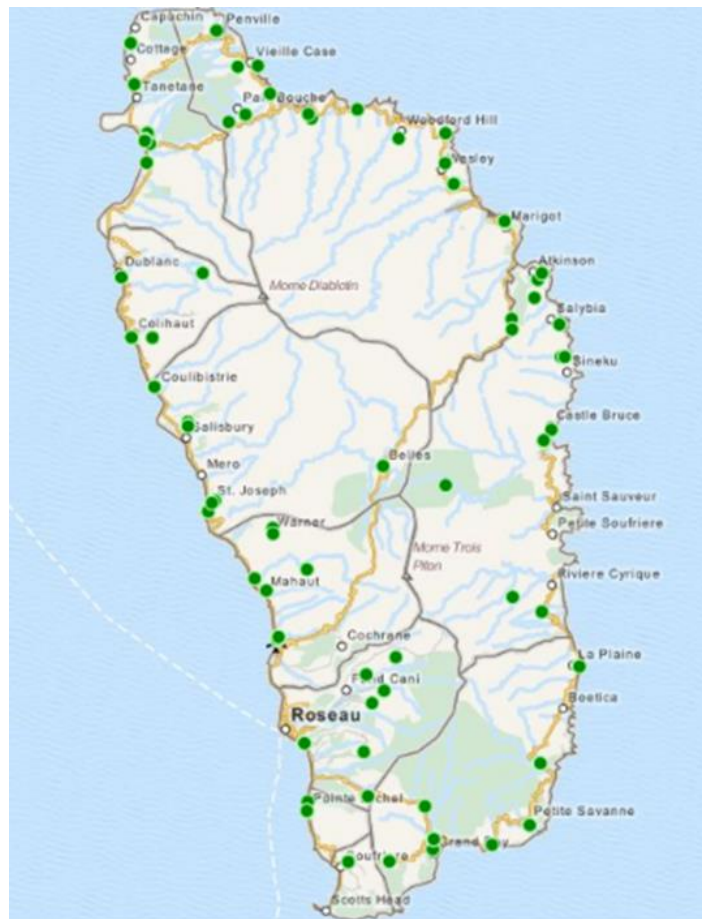
Three schools are currently being used as shelters with seven community recreational areas having been damaged, with a further community recreational area used as a temporary helicopter

landing site and for storage of emergency response equipment. Beyond the initial trauma caused to the school population and damage to infrastructure caused by Erika, the longer term disruption to the education system and preparation schedules for children's performance within national and regional curricula, will be significant while not easily quantifiable in financial terms.

Table 10: 2014/15 Basic Education Data

Student enrollment				Teaching force		
Primary	Male	Female	Total	Primary:		% age
Public	2,627	2,135	4,762	No. Trained	357	66
Assisted	826	1,165	1,991	No. Untrained	183	34
Private	423	399	822	TOTAL	540	100
TOTAL	3,912	3,783	7,695			
				Secondary	2013/14	
Secondary	Male	Female	Total	Graduates	No.	% of Staff
Public	2,241	1,589	3,830	Trained	102	19.8
Assisted	537	1,088	1,625	Untrained	73	14.1
Private	53	53	106	Non Graduates		
TOTAL	2,831	2,730	5,561	Trained	137	26.5
				Untrained	204	39.5
				TOTAL	516	100

Map 3: Location of Schools



Financial (Damages and Losses). *The total damages and losses to the Education sector are estimated to be EC\$10,747,895 (US\$3,995,500).* Repairs, rehabilitation and rebuilding costs have been estimated at USD\$3,435,000 with non-structural repair costs estimated at USD\$465,500. The below table summarises the quantifiable losses experienced by Dominica’s education system due to Erika. What though is less quantifiable at this stage are the costs caused by the disruption of the educational year for individual students and the nation as a whole.

Table 11: Education Sector Damages and Losses

Item	EC\$
Repairs, rehabilitation and rebuilding (including BBB)	9,549,500
Non- structural costs (including school cleaning, re-equipping, pyscho-social support, water provision)	1,198,395
Total Costs	10,747,895

While initial damage and loss assessments to rehabilitate, reconstruct and re-open the most affected schools have been undertaken, an in-depth systematic study needs to be designed and implemented with a fundamental objective to “Build Back Better” (BBB). Prior to this though, the priority is to re-commence education for all of Dominica’s children with the key actions being to deep clean all affected schools to adequate hygienic standards, provision of water tanks with regular supply for schools still without, and re-equip schools with education materials including furniture which was lost during the extensive flooding. Essential psychosocial support outreach programmes for traumatised children (“Return to Happiness” initiative), who in some cases lost family members and witnessed the destruction of their homes, have already begun and need to be sustained. Children also need to be provided with necessary school gear and back-to-school kits to support their speedy return to normal school routines. Students enrolled at damaged and destroyed schools will need to be transported to other schools on a temporary basis where shift systems will need to be implemented to enable as many children as possible to continue their education. The non-structural costs outlined above including training for teachers and NGO partners along with the required capacity development for the implementation of existing education sector preparedness and response plans such as “Return to Happiness”, have an estimated cost of EC\$1,250,850 (US\$465,000).

Cross-Cutting Themes. Most teachers in Dominica are women with a figure of 87% in primary and 73% in secondary. There will not be a significant loss of jobs or income due to the delay in opening because the Ministry will continue to pay salaries and has organized for a shift-school system for the majority of those schools that cannot be opened as yet or have been destroyed. Also the Ministry attempted to support teacher placement at schools close to their homes or identified needs as much as possible. While this was possible prior to Erika, the damage caused to the road network and disruption to transportation services, will have had a significantly negative effect on this. A recommendation is to cost the viability of distance learning options, but this is heavily dependent on the telecommunications capacity which took a big hit with many cables carrying telephone and internet across the island brought down by landslides. With

schools being used as shelters, Build Back Better methodologies should include structural capacity to allow for ease of gender segregation for washroom and sanitation facilities that ensure adequate facility provision in safe environments. Climate change will cause more events such as Erika, therefore education sector planning needs to fully mesh with the social protection sector to ensure safe environments for children and women in Disaster Risk Management preparedness methodologies that lead to effective response mechanisms.

Education Sector Recommendations. The key objective for the reconstruction of the education sector is to enable children to recommence their education in safe and supportive environments at the earliest opportunity. This must be facilitated through support to the Ministry of Education and the Ministry of Social Services, Family and Gender Affairs to implement an effective response and recovery programme for both the education and child protection sectors. Mobilisation of funds for critical immediate actions such as cleaning, re-location, psycho-social support, re-equipping and safe water provision must be facilitated through the re-allocation of existing funds in the education sector and emergency response interventions covered under preparedness plans within collaborative partnerships with agencies such as UNICEF and local and international NGOs. Medium and longer term interventions including reconstruction and structural rehabilitation including Build Back Better, will require significant resource mobilisation in collaboration with the donor community.

Short Term Priority Actions:

- Identify alternative locations for students enrolled at the 2 destroyed and 5 schools in which structural damage prevents commencement of education in safe hygienic environments for an extended period. Provide transportation for students and teachers to access alternative sites, in addition to provision of school meals for children in schools far from their homes
- Provide water tanks, cast concrete stands and pipe fittings to enable storage and provision of adequate volumes of safe water to the 23 schools that have their normal piped water supply disrupted.
- Provide appropriate basic education, early learning and recreational materials for displaced schools and all those which had lost materials due to flood damage; including special measures for children needing help to re-engage in education.
- For the 23 impacted schools, ensure all buildings and immediate compounds have been completely cleared of debris and silt, and have been thoroughly cleaned and disinfected. For the 3 schools used as shelters, monitor the environmental and hygienic status of buildings and compounds, and ensure plans in place to enable commencement of education rapidly once evacuees leave.

- Work with Child Protection to address violence in and around learning spaces and schools, especially the 3 currently used as shelters, with a focus on the most vulnerable
- Take an inter-sectoral approach to the provision of support in temporary learning spaces and child-friendly spaces by mobilizing available psychosocial support for teachers and students through the 'Return to Happiness' programme
- Assess the extent to which teachers have been affected – and categorise the loss among the 165 teachers so far identified – and make specific efforts to ensure their full 'rehabilitation' to be able to effectively carry out their duties
- Conduct comprehensive condition assessment of schools in affected areas including risk assessments relating to flood and landslide risks
- Conduct comprehensive water shed studies to provide enhanced information on risk profiles for schools

Medium-term response and long term recovery:

- Ensure that the rehabilitation and reconstruction of schools and recreational facilities are in accordance with established standards for child-friendly and structurally resilient designs- "Build Back Better".
- Integrate immediate emergency response with long-term vision and recovery planning within the education system
- Consider river engineering works to reduce flood risk exposure of schools at risk
- Advocate for and support the redevelopment of schools according to safe, inclusive, equitable and child-friendly models including bathing and washing facilities for those likely to be used as shelters.
- Build capacity of the education cluster for better response, including coordination of support to education sector as this has been shown that the existing capacity is not sufficient to move with the necessary speed to coordinate efficient response.

3.3.2 Health

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
1.73	3.50	5.23	0.64	1.30	1.94

**values in millions*

Background. 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 August 27, 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. The Ministry of Health set up its Emergency Operations Center – the Health EOC, in order to organize, coordinate and inform on its response to the event. Information from the Health EOC also informed policy makers so that appropriate emergency actions could be taken where health matters were concerned.

Impact of Disaster. 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. It must also be noted that contact by cellular or landline phones was not possible for some time and information on status of facilities was not available. 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 has highlighted that some health facilities are vulnerable to flooding which means that at the time of a similar event when they are most needed are not operational. The drainage at the Roseau and Fond Cole Health Centers must be addressed to reduce the risk. A hydrological survey must be carried out on the water courses that are close to our health facilities. This will guide us on the mitigation measures that will be required for facilities including Coulibistrie, Pichelin, Massacre, Dublanc, etc. Facilities such as Mahaut and Newtown must be relocated. Water of all facilities must be increased and improved as a matter of urgency. Also important to the Vulnerability Reduction Strategy, accessibility immediately after the event and the focus on Build Back Better, many of the facilities must now be equipped with standby generators,

increased storage capacity (some climate controlled –Refrigeration) in order to increase the quantity of supplies there.

The prevention of outbreaks is a major area for maintenance of health care services with massive efforts needed in health education especially for the prevention of water-borne diseases such as gastroenteritis. Vector-borne diseases such as dengue and leptospirosis are major concerns and enhanced efforts on vector control as well as solid and liquid waste disposal are critical for minimizing the health impact of this weather event. While many of these prevention efforts are planned at central level, implementation at the local level through the primary health care system is critical to success.

Financial (Damages and Losses). *The total damages and losses to the Health Sector are estimated to be EC\$5,229,682 (US\$1,944,120).* The summary table below provides a breakdown of estimated damage and losses.

Table 12: *Summary of Damages and Losses, Health Sector*

Damages		EC\$
Facilities fully destroyed		\$5,239,000
Facilities partially destroyed		\$25,000
Equipment, furniture, medications destroyed		\$1,102,900
	Total Damages	\$1,727,900
Treatment of injured		\$2,154,556
Vector control, surveillance, information campaigns		\$260,187
Demolition and rubble removal		\$24,500
	Total Losses	3,501,782
	Total Damages and Losses	\$5,229,682

Cross-cutting Themes. The link between poverty and health is well recognized – poverty is associated with poor health outcomes. It is therefore important that high quality primary health care services remain accessible and affordable for all Dominicans. A key step in this direction is the reconstruction of all facilities that have been damaged or lost in locations that make the facilities readily accessible. This will include health facilities for the residents of Petite Savanne who have been evacuated from their village and will be relocated to a new site.

- **Environmental:** The location and construction of health facilities should be such that negative impact on the environment will be minimal while providing safe, ergonomically sound environment for staff and patients. This should include the

harvesting of rain water to minimize run-off, and establish redundant water supply, use of green energy and the safe management of solid and liquid waste generated by the facility.

- Risk Reduction/climate adaptation: A review of all health care facilities needs to be undertaken to assess their vulnerability to natural disasters – hurricanes and floods in particular. Design and re-design needs to minimize the impact from these events and allow for the continued functioning of the facility as soon as possible following the event.
- Others: Communication system is one major area for improvement for the health sector. Following this weather event there was no communication with some health facilities for several hours and even days. Initial communications were via social media which evolved into a major means for communication. Equipping facilities with radios and the provision of the appropriate training will be key.

Health Sector Recommendations

As stated earlier, recommendations for reconstruction will focus on reducing vulnerability, increasing accessibility immediately after the event and, ‘build back better’ i.e ensuring that facilities that are reconstructed are done to standards that exceed what existed prior to TS Erika. Therefore the following actions must be considered as [part of](#) an appropriate response.

Short-term Actions:

- Install additional Water tanks to ensure at least 3 days of water storage capacity to continue services at the facility.
- Provide standby Generators and at least 3 days fuel storage capacity, protected against floodwaters.
- Refrigeration Equipment for vaccines and other medicines.
- Assessment of all electrical wiring at flooded facilities and the replacement of any damaged wiring, electrical outlets and fixtures.
- Replacement of damaged external doors to the facilities with solid wooden or steel doors connected with 3 hinges per door.

Medium-term actions:

- Retaining walls, with suitable drainage behind walls, to help mitigate failure of unstable soils and slopes around the perimeter of the health facilities
- Installation of storm water drainage and adequate storage capacity or detention ponds to channel rainfall runoff away from health facilities and foundations of the buildings. The detention ponds will serve to control the flow of runoff to prevent excessive erosion and flooding downstream.

- Stabilise and secure access road to health facilities by using concrete paved access ramps and roads instead of asphalt, which bleeds and pits with excessive rainfall; grading slopes for proper rainfall runoff and installing appropriate drainage.
- Installation of rainwater roof catchment system. This should include gutters, downpipes and water tanks to capture rainfall off roof. This will serve to provide water to the health facility in the event that water lines are broken and national pipe-borne water supply is in future floods.

Long-term actions:

- Relocation of some facilities such as Mahaut and Newtown health centres away from the high risk flood zones in which they are currently located.
- Upgrade of the Marigot and Portsmouth Hospitals to strengthen the resilience of these facilities against future hazards including floods, hurricanes. Strengthening of the roof and external windows and doors, as well as the boundary fences and installation of retaining walls. Soil and slope stabilization may also be required, which may include, but not be limited to the use of soil anchors and installation of geotextiles. In certain select locations, flood barriers may also be required to prevent ingress of waters into these facilities.

3.3.3 Housing

Damages (EC\$)	Losses (EC\$)	Total (EC\$)	Damages (US\$)	Losses (US\$)	Total (US\$)
119.8	25.9	145.6	44.5	9.6	54.1

**values in millions*

Background. According to Dominica's 2011 Population and Housing Census Report, the total population of Dominica numbered 71,293. The total population comprises 36,411 males and 34,882 living in 26,085 households. Dwelling units are built mainly of wood, concrete, a combination of wood and concrete, or plywood. It is estimated that that 7,229 persons are affected in the disaster declared areas. As of September 6, 2015, the following housing related impact has been confirmed by CDEMA: Homeless: 574; Evacuated: 713; Provided with shelter: 411.

Impact of Disaster. The preliminary assessment of housing stock was conducted by the Ministry of Housing in conjunction with Local Government and has initially concentrated on the Disaster Areas of 1. Bath Estate (Paradise Valley) 2. Dubique 3. Petite Savanne 4. Campbell 5. Coulibistrie 6. Pichelin 7. Petite Soufriere 8. Good Hope 9. San Sauveur where the highest concentration of impact per housing stock has been confirmed. An island-wide rapid assessment is still ongoing although hampered by access to professional engineering services to conduct thorough landslide risk assessments, flood risk assessments as well as structural impact assessments.

Financial (Damages and Losses). *The total damages and losses to the Housing sector are estimated to be EC\$145,659,315 (US\$54,148,444).* The total damage to the housing stock is estimated to be EC\$119,799,000 (US\$44,534,944). Losses for cost of demolition and rubble removal and a temporary housing scheme are estimated at EC\$25,860,315 (US\$9,613,500). As of September 6, 2015, the preliminary damage assessment of the Housing Stock indicates that 430 houses damaged or destroyed of which the majority are in Petite Savanne and the remainder across the country. Considering that the entire housing stock has not been assessed by professional structural engineers, it is estimated that the number of destroyed houses is very likely to increase. Therefore, a number of 478 houses is anticipated for this rapid damage and loss assessment with a write-off value of EC\$95,700,000 reconstruction cost.

In addition to the confirmed damages, a significant number of houses are considered to be unsafe for continued habitation. These are primarily located in the disaster Areas but will also include housing stock across the country. The exact number of houses unsafe for returning inhabitants needs to be assessed by risk management specialists with particular focus on flood risk assessment and landslide risk assessments. For this rapid damage and loss assessment, it is

considered that ca. 87 houses are at risk. This would constitute a write-off value of EC\$17,400,000 (reconstruction cost).

A permanent resettlement programme for destroyed and “at risk” housing units is estimated to cost EC\$143,996,004 including a Build Back Better component. This estimate includes land acquisition, access and utilities connection.

If a relocation program is implemented with government assistance, it should make use of a standard housing design in low risk areas for landslides and flooding and should 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 home.



Houses in Colihaut (Credits: International Organizations for Migrations)

Table 13: Summary of Damages and Losses, Housing Sector

Damages		EC\$
Conformed Houses Fully Destroyed in disaster Areas		\$87,000,000
b) Additional Houses Destroyed Island-wide		\$8,700,000
Houses at risk		\$17,400,000
Household Goods		\$6,699,000
	Total Damages	\$119,799,000
Temporary Housing Scheme		\$18,254,340
Demolition and rubble removal		\$7,605,975
	Total Losses	\$25,860,315
	Total Damages and Losses	145,659,315

Housing Sector Recommendations

Short-term actions

- Develop a strategy for addressing the loss of housing stock whilst considering options for implementing a temporary housing programme for homeless people and people currently residing in shelters
- Develop and conduct a Building Assessment Programme to develop a prioritized approach to Building Back Better new Housing stock
- Develop a building programme and financing strategy for replenishing the diminished housing stock
- Enhance sex and age disaggregated data for HOH who have lost houses in order to inform relocation lists;
- Identify houses that were rented vs mortgaged.
- Conduct comprehensive condition assessment of housing stock in affected areas including risk assessments relating to flood and landslide risks
- Conduct comprehensive water shed studies to provide enhanced information on risk profiles for housing stock

Medium-term actions

- Consider options and implement a temporary housing programme for people who were evacuated from the disaster areas or lost their home due to storm impact and found refuge with families in non-affected areas.
- Consider river engineering works to reduce flood risk exposure of housing stock at risk
- Develop a risk-based approach to housing and residential/urban planning based on best practice building asset management principles (building inventories, condition assessments, inspection programmes, building permitting, etc)
- Adopt and enforce building code for Dominica that adequately addresses requirements for resilient housing for hurricanes, flood and landslide risks.
- Commence with the implementation of a building programme to replenish the housing stock

Long-term actions

- Implement a long term asset maintenance strategy and system for existing and new houses and buildings if they remain in public ownership
- Engage women and youth in non-traditional rebuilding relocation efforts through training programmes linked to social protection (see social protection section).

CHAPTER FOUR – THE MACROECONOMIC IMPACT

THE MACROECONOMIC IMPACT

Summary of Economic Damage

Based upon an initial assessment of impacts to each affected sector, Tropical Storm Erika resulted in total damage and loss of EC\$1.30 billion (US\$483 million), equivalent to over 90 percent of Dominica's gross domestic product (GDP).¹¹ The majority of damages and losses were sustained in the transport sector (60 percent), followed by the housing sector (11 percent) and agriculture, fisheries, and forest (10 percent), as summarized in Tables 1 and 2 and explained in the preceding sections. Damages and losses are also the equivalent of 270 percent of 2014's exports, 195 percent of imports, and 615 percent of gross fixed capital formation. Damages to durable assets alone total more than five years of normal investment spending. Expected impact on 2015 and 2016 GDP is more modest, since reconstruction activities will make up for lost economic activity due to the TS. For 2015, instead of GDP growth of about two percent, the net impact of economic losses and recovery is estimated to support growth at 2.6 percent. For 2016, the same estimation approach yields GDP growth reflecting a strong and rapid recovery, although dependent on financing availability and sufficient absorptive capacity, such that growth could easily exceed eight percent. As reconstruction begins to wane (in 18 months to 2 years), GDP is likely to return to a somewhat lower path than before the disaster. These figures highlight the challenges facing public finances and the external sector.

The Situation Before the Storm

With a gross national income per capita of US\$10,300¹², Dominica is an upper-middle-income small island state, with an estimated population of 72,340. In 2014, Dominica registered strong growth, following a more modest expansion in 2013 (undermined by a previous tropical storm). Growth projections for 2015 before TS Erika were around two percent.¹³

Growth and Inflation. There was a return to growth and improvement in external conditions in 2014. Economic activity expanded by an estimated four percent in 2014, according to government figures, spurred by growth in public administration, education, wholesale and retail trade, and construction following the tropical storm that devastated the country in December 2013. The expansion was bolstered also by recovery of the tourism sector, which has been hampered by insufficient infrastructure and petty crime in recent years. Carnival stay-overs increased by 30 percent, and the World Music Creole Festival achieved year-on-year attendance

¹¹ Dominica's GDP in 2014 (in current EC\$) was \$1415.3 million or (in current US\$) 526.1 million. From ECCB.

¹² Estimated 2014 GNI per capita, PPP (current international \$). World Development Indicators, The World Bank, 2015

¹³ Data for this section comes from the Dominica Budget Statement of July 2015; ECCB data from September 2015, and various World Bank and IMF data.

growth of 8.3 percent from the US and 7.3 percent from the UK. However, agricultural production fell because of the prolonged adverse effects of the Black Sigatoka disease, which eradicated half the country's banana production between 2011 and 2013 and led to a suspension of Dominican banana exports to the UK, a major market for the fruit. Consumer prices rose modestly, by 1.8 percent during 2014, reflecting a slight increase in fuel prices before the sharp declines in international oil prices during the last quarter of the year.

Fiscal Account and Debt. The fiscal deficit is estimated to have improved in FY 2013/2014, with the primary balance standing at about one percent of GDP. This improvement was secured despite the phase-out of budgetary support from the European Union (EU) and was partly driven by the continued non-tax revenues from the Economic Citizenship Program. Despite a draw-down of central government deposits in the banking system, net public debt declined to 65 percent of GDP in FY2013/2014, about four percentage points lower than the previous year. These patterns continued into the subsequent fiscal year of FY 2014/15, especially on the expenditure side. However, tax revenues and revenues from the sale of assets dipped, and revenue overall came in about five percent lower. The resulting primary balance was 3.4 percent of GDP, and public debt rose to 68 percent of GDP.

Money and Financial Sector Developments. NPLs increased to 13.9 percent of loans outstanding in December 2013, but this ratio remains below the ECCU average of 18.3 percent. Credit growth to the private sector continued to decline, by 0.9 percent from January to October 2014, following a year-on- year contraction of 0.7 percent in 2013.

External Sector. The current account deficit remained constant in 2014, at about 13 percent of GDP, driven principally by lower oil and commodity prices which offset imports related to FDI. The current account deficit was financed mostly from FDI inflows and capital grants, which accounted for 5.7 percent and 4.5 percent of GDP, respectively, in 2014. Dominica's point-to-point REER appreciated by 5.8 percent to 98.2 at end-December 2014.

Outlook for 2015 and 2016 prior to TS Erika. Even before the Tropical Storm of August 2015, the economic outlook for Dominica was mixed. GDP growth was projected at 2.0 to 2.5 percent for 2015. A recovery of the tourism sector was expected, to be supported by the recent increase in the availability of hotel space, the accommodation of night landings at the Douglas Charles airport, the increased capacity of up to 15,000 seats per year via Winair, and the ECP mandate to attract investments in tourism-related infrastructure. Growth over the medium-term was also expected to be bolstered by the completion in 2016 of a geothermal electricity plant, which was expected to reduce electricity costs by 40 percent and reduce Dominica's high fuel import bill. The agricultural sector was projected to continue to decline by about 1 percent per year, as plans to replace the banana plants infected by fungal disease with French imports and effect improvements in irrigation systems will not show benefits soon. The Ministry of Agriculture intends also to explore the prospects of other commodities, such as white potatoes, and farm tourism. Inflation is projected to increase only slightly, to 1.3 percent by 2017, due to a gradual recovery in primary commodity prices. The fiscal deficit is projected to remain steady over the

next three years. Nevertheless, financing was expected to be adequate to support investments planned at the time, particularly in the tourism and mining sectors. Public debt was expected to remain around 75 percent of GDP. The current account deficit was projected to rise from a projected 13 percent of GDP in 2015 for the next few years, as FDI-linked imports were projected to jump, but then to moderate in later years, in part due to reduced fuel imports as a result of the geothermal initiative. The major risk facing the economic outlook was seen as the uncertain pace of recovery in the agricultural sector from the devastating effects of the Sigatoka disease and the tropical storm of 2013. In addition, maintaining fiscal discipline was seen as an ongoing priority. FDI inflows associated with mining, ongoing hotel projects, and the creation of executive office space were expected to continue to be a major source of financing.

Projections of the Impact of TS Erika on Macroeconomic Variables

This assessment of the macroeconomic effects of Tropical Storm Erika on Dominica's economic performance for 2015 and following years makes use of the damage and loss assessment completed for sectors and summarized above. The analysis aims to address the questions of how the losses created by the TS will affect the economy and how much money the government needs to finance reconstruction costs and how quickly such financing can be obtained within the framework of sustainable fiscal policy. It focuses on the impact on growth, the fiscal deficit and public debt, and the current account deficit. Because of multiple sources of uncertainty, scenarios are presented to allow for differing assumptions about the economy's capacity to absorb external resources and its project delivery capacity. Considering multiple scenarios is one way to proceed with such an assessment despite the lack of data on economic activity after the TS. This assessment can and should be updated as new economic data is reported.

As discussed in detail above, Tropical Storm Erika brought flash flooding and landslides to Dominica, affecting most parts of the island. Roads, housing, and the tourism sector suffered the most harm in terms of losses and disruptions to normal economic activity while roads, housing, and agriculture are assessed to have suffered the most damage to physical assets. Tourist arrivals will drop quickly, since the tourist season is imminent, but if reconstruction is timely, tourism should return to close to pre-disaster levels by the winter of 2016/17. Cruise ship arrivals should follow the same path as tourism overall.

Output Impacts of Losses. The estimates of losses that emerged from the sector assessments are incorporated into projections of GDP (*see Table 13 and Table 14*). The pattern of expected lost activity (or additional recovery activity) over time was calculated, and import content was estimated and omitted from GDP (so that the losses, which are more closely related to output would more closely resemble value-added).¹⁴ GDP growth for 2015 is projected to be 0.8

¹⁴ Because no input-output table was available and because this assessment is a rapid exercise, the exact sectors that will benefit or lose from losses registered in a single sector is not exact. In particular, much of the repair and cleanup activity may be properly recorded in the construction sector, while here it is noted in the original sector of impact as recovery activities in that sector.

percent rather than 1.9 percent higher than 2014 (in real terms). Hotels and trade are hit hard by the temporary drop in tourism. Growth for 2016 is projected to rebound sharply as losses (negative flows) recede and positive flows continue, in particular clean-up activities.

Table 13. Growth of GDP by Sector Before and After Losses from Tropical Storm Erika, 2014-17

	2014	2015		2016		2017	
		<i>Pre TS</i>	<i>Post TS</i>	<i>Pre TS</i>	<i>Post TS</i>	<i>Pre TS</i>	<i>Post TS</i>
Agriculture, forestry, fishing	-0.2%	1.4%	-0.8%	3.3%	1.1%	3.4%	
Mining	-4.8%	2.0%	2.0%	3.0%	3.0%	3.0%	
Manufacturing and utilities	2.7%	1.7%	5.6%	2.1%	2.0%	2.1%	
Construction	10.2%	2.0%	62.9%	2.0%	68.2%	2.0%	
Wholesale and retail trade	4.5%	3.6%	-9.3%	2.5%	2.9%	2.5%	
Restaurants and hotels	14.5%	1.3%	-32.1%	2.7%	46.5%	2.7%	
Transport, storage and communications	-0.8%	0.6%	0.5%	2.3%	2.4%	2.3%	
Financial intermediation	4.9%	1.8%	1.8%	1.8%	1.8%	1.8%	
Real estate and business services	0.5%	0.5%	0.5%	0.6%	0.6%	0.6%	
Public administration and defense	11.9%	2.9%	2.9%	2.0%	2.0%	2.0%	
Education, health and other services	5.3%	3.1%	5.0%	2.2%	0.6%	2.4%	
GDP	4.0%	1.9%	2.6%	2.3%	7.8%	2.2%	4.0%

Notes: 2015-2017 are projections. Change in GDP as real growth rates using 2015 prices in EC\$. Post-TS projections incorporate information about sectoral losses (changes in flows) estimated by World Bank team. Sectoral damages (to assets) are not included. Note that some changes in flows are positive since emergency activities supplement other economic activity. Estimated import content of flows is subtracted from totals before applying to sectoral output.

Source: CSO, Dominica and ECCB; World Bank calculations.

Fiscal Impact of Losses. Far more problematic than the impact of losses on Dominica's output and income are their likely fiscal impacts. Dominica was already facing fiscal challenges before the disaster imposed even greater pressures on government spending. The government was considering various fiscal adjustment possibilities sufficient to attain a debt target of 60 percent of GDP by 2030. Adjustment on both revenues and current expenditures would be needed, while preserving needed infrastructure spending. Such a path had little leeway to address the aftermath of a disaster. Even a conservative estimate of the impact of losses on fiscal variables pushes the overall deficit above nine percent of GDP in FY15/16. These impacts come from the additional public expenditure necessary for activities such as cleanup, emergency repairs, temporary shelter, and treatment of the sick and injured. Rebuilding physical assets (damages) are not included and are addressed below.

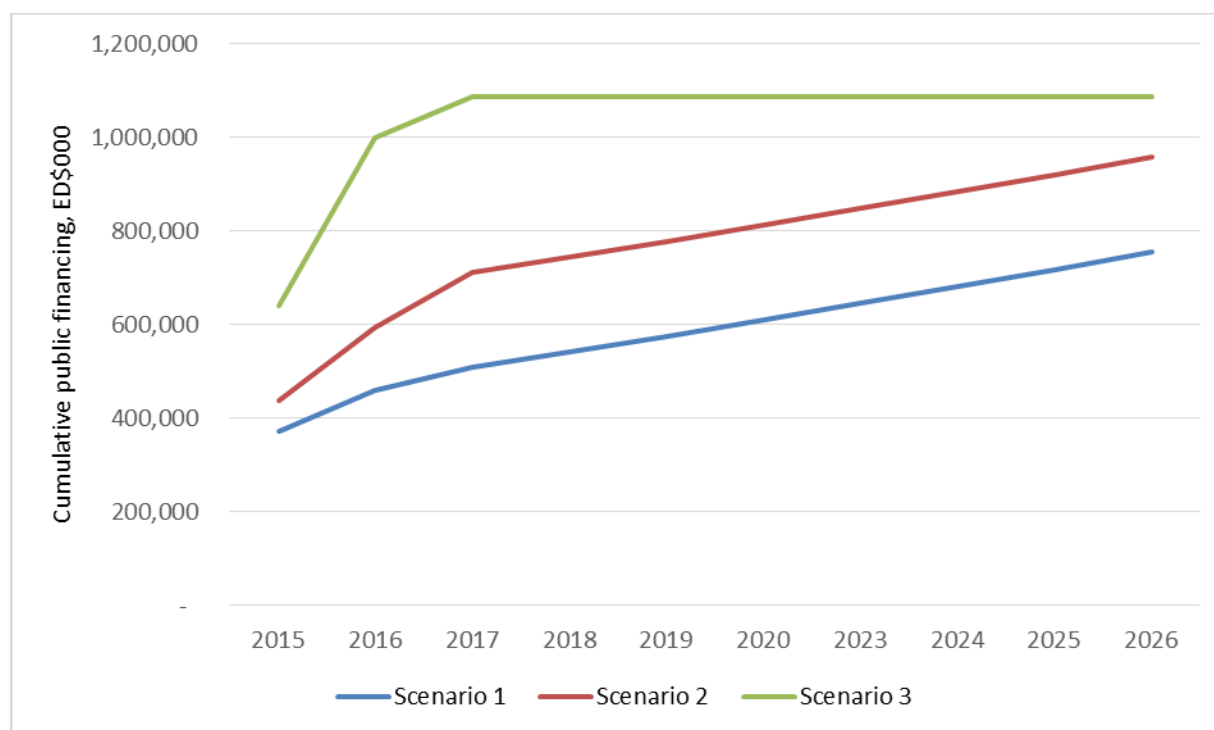
Table 14. Fiscal Variables Before and After Losses from Tropical Storm Erika, as Shares of GDP, FY2014-17

	2014/15	2015/16		2016/17		2017/18	
<i>as % GDP</i>		<i>Pre TS</i>	<i>Post TS</i>	<i>Pre TS</i>	<i>Post TS</i>	<i>Pre TS</i>	<i>Post TS</i>
Revenue	26.5%	29.3%	29.2%	29.5%	29.4%	29.2%	
Grants	2.0%	3.2%	3.1%	3.2%	3.2%	3.2%	
Expenditure	31.5%	32.8%	40.4%	33.4%	32.9%	33.0%	
Current expenditure	24.6%	23.9%	31.8%	24.3%	23.9%	24.1%	
Capital expenditure	6.8%	9.0%	8.7%	9.1%	9.0%	9.0%	
Overall balance	-5.0%	-6.7%	-11.2%	-7.1%	-6.7%	-7.0%	
Primary balance	-3.4%	-4.5%	-9.1%	-4.8%	-4.6%	-4.7%	

Economic Impact of Damages. The second and larger impact of TS Erika was damages to physical assets that were partially or fully destroyed. The total damages across sectors was estimated at EC\$1,213 million or more than six years of normal investment spending. These damages were concentrated in roads and bridges, and the public sector bears the responsibility for repair and rebuilding. Recovery in transport is, of course, a precondition for the recovery of the economy overall. Overall, about 80 percent of the damages to capital will fall to the public sector for recovery. If all damaged or destroyed assets were replaced or rebuilt, including recommended improvements, and all assets for which the government is responsible were financed by debt, the costs would double Dominica's public debt, already at 70 percent of GDP in FY2014/15, to more than 160 percent of GDP in FY2015/16. This debt already carries a low interest rate. Thus, the pace of recovery will need to be modulated to access to grant financing and a modest amount of highly-concessional debt so as to maintain macroeconomic stability over the next few years.

Fiscal and Debt Scenarios. To understand better the constraints facing the government in financing disaster recovery, three scenarios are applied. The first scenario assumes that no additional grant financing becomes available and that the ratio of public debt to GDP cannot exceed 100. At this pace of financing, after five years, about half of the damages to assets have been covered. The second scenario assumes USD25 million in grants for the next three years and that public debt to GDP does not exceed 100. In this case, about 70 percent of damages are financed after five years. The third scenario assumes USD100 million in grants for the next three years. Under this final scenario, the needed financing for damage recovery is covered by the end of FY 2017/18.

Figure 7. Public Financing Scenarios for Damages, in EC\$000



Notes: All scenarios limit public debt to 100% of GDP. Scenario 1 assumes no new grant financing. Scenario 2 assumes USD25 million per year for 3 years. Scenario 3 assumes USD100 million per year for 3 years.

New Public Borrowing. While desirable, obtaining financing in the form of grants to cover 100 percent of reconstruction needs may not be feasible. The scenarios above, it should be noted, do include new borrowing: all three scenarios include new loans of USD 140 million in FY 2015/16 followed by new borrowing of USD 20 to 30 million per year in subsequent years. It must be noted that these calculations consider only broad parameters regarding public borrowing, and the impacts of adding financing at concessional terms (in particular, IDA) on the debt profile of the country will need to be assessed more thoroughly using the IMF's DSA framework.

CHAPTER FIVE – CROSS CUTTING THEMES

SOCIAL PROTECTION

Thirteen percent (13%) of households (28) in Petite Savanne were on some form of public assistance. Information regarding the number of households in Dubique on public assistance is not available because it is aggregated with a neighbouring community.

There are nine different social protection programmes in Dominica. These include the Yes We Care Programme for Seniors and Persons with Disabilities, Public (Cash) Assistance National Employment Programme, Housing Revolution, Home Renovation And Sanitation *Programme*, Adult Education (Community-Based Vocational Skills Training; Literacy And Numeracy; Continuing Education Programmes), Small Business Unit Fund Bureau Of Gender Affairs Small Business Revolving Loan Fund, Dominica Youth Business Trust Fund, and Youth Development Division Skills Training Program. These programmes allow for housing support to single mothers, cash transfers for eligible persons, support to elderly persons and the disabled, and youth training programmes.

Prior to TS Erika challenges were highlighted regarding the need for additional cash to support the programmes, the lack of a CBR, and the lack of a gender and child responsive approach these will be exacerbated in the aftermath of TS Erika, as more persons will be in need of social protection. Social protection analysis and reform in the wake of TS Erika to meet the needs of the population will be required. This should include an impact assessment on National Employment Programme support to ensure equal opportunities for women and men, a Gender Aware Beneficiary Analysis and a Costing and Budgeting Framework.

Social Protection Recommendations:

Immediate Actions:

- Track vulnerable groups such as affected single women headed households, children, pregnant women, breastfeeding mothers, young men, disabled people, and the elderly to better understand their increased risks and vulnerabilities and how further risks can be mitigated.
- Ensure measures are put in place to identify vulnerable persons who need to benefit from social protection, additional psychosocial support, and medical care

Medium and Long-term Actions:

- Complete assessment through GABA and CBF of key social protection programmes to support the recovery process in a gender and child responsive manner.
- Develop Central Beneficiary Registry.
- Develop job training and continuing education programmes linked to already functioning social protection programmes such as the Adult Education (Community-

Based Vocational Skills Training; Literacy and Numeracy; Continuing Education Programmes), Small Business Unit Fund, Bureau of Gender Affairs, Small Business Revolving Loan Fund, Dominica Youth Business Trust Fund, and Youth Development Division Skills Training Program.

GENDER INCLUSION

Disaster impacts are often not distributed uniformly within a population. Due to existing socio-economic conditions, cultural beliefs and traditional practices, women face disproportionate risks. In many cases, the mortality rates for women in the aftermath of a disaster are much higher than those of men.

In the case of Dominica, according to the preliminary 2011 Population Census report, the country's population stood at 71,293 comprising of 36,411 males and 34,882 females. Dominica has a growing young population with children below 14 years accounting for slightly more than a quarter of the population, and approximately 41.9% of the population comprising children and youth below 25 years. The elderly population (60 years and above) in Dominica accounted for 14.8%, the majority of this population is female.

While steps have been taken to promote gender equality and women's empowerment in Dominica, there remain significant challenges. Women, children and youth are among the most vulnerable groups. Poverty assessments indicate that more than half of Dominica's children and youth live in poor households (52.1%). Tropical storm Erika caused widespread damage to the housing sector, which has a direct bearing on gender equality and social inclusion. Ownership rights and land titling variations among men and women could limit participation in the housing recovery programme and the benefits accruing from them. Housing losses as a result of TS Erika will also impact men and women's livelihoods because of the loss of potential income experienced by many of the displaced due to home-based livelihood activities, such as home-based businesses (hairdressing and other shops) and/or those who practiced commercial and subsistence farming in the spaces directly around their homes, which is the majority of the population of one of the hardest hit communities, Petite Savanne.

The recovery stage in the aftermath of a disaster offers an opportunity to engage women, men and youth in better and more innovative ways, which is important because disasters affect women, men and children differently. Factoring in gender issues into recovery and reconstruction efforts can make a difference through participation and empowerment in the planning, decision-making and implementation processes. Failure to consider both women's and men's concerns in the design and implementation of DRM programs are likely to lead to overlooking the true costs of disasters and making DRM support less effective. Gender-blind responses can also reinforce, perpetuate and increase existing gender inequalities, making bad situations worse for women and other vulnerable groups.

A comprehensive assessment of gender considerations to be factored into the recovery phase has been prepared by UN Women, which includes detailed recommendations by sector. Below are some of the key recommendations:

Short term Actions:

- Ensure that any additional data collected is sex and age disaggregated and also ensure the inclusion of gender-sensitive indicators.
- Create opportunities to involve more women and youth, women's organisations, state gender focal points, and other organizations working on gender issues as partners in the recovery work to act as agents of change. These groups can take leadership roles in disaster assessment and management, for example in designing livelihood recovery programs and/or determining housing reconstruction priorities.

Medium to Long-term Actions:

- Build on and implement the multi-sectoral Gender and Child Responsive considerations within the Strategic Program on Climate Resilience (SPCR) and the Low Carbon Climate Resilient Development Strategy
- Examine and apply, as appropriate, the considerations for mainstreaming gender considerations in DRM being developed by CDEMA and other regional stakeholders

CHAPTER SIX – RECOVERY, RECONSTRUCTION AND RISK REDUCTION RECOMMENDATIONS

The devastating human and economic losses caused by Tropical Storm Erika have highlighted Dominica's vulnerability to hydro-meteorological and climate hazards. Restoration of lifeline facilities and basic services requires immediate decisions and investments of both public and private sectors to pursue rapid recovery. At the same time, the aftermath of the disaster offers the country a window of opportunity to utilize disaster and climate resilience as a pillar of Dominica's sustainable development strategy.

The government is acutely aware of the country's exposure to natural disaster events and impacts of climate change. Dominica has adopted its Low Carbon Climate Resilient Development Strategy, which includes the country-driven Strategic Program for Climate Resilience (SPCR)¹⁵ and provides an overview of the country's climate change circumstances and its development context; it also identifies climate change vulnerabilities in key sectors, including agriculture, ecosystems, and natural resource systems, and to some extent, the infrastructure sector. As part of this strategy, key elements of disaster risk reduction and climate resilience across sectors have been identified.

The challenge for the country now is to continue to implement these strategies in view of the urgent recovery and reconstruction priorities: to promote resilience in both reconstruction programs as well as longer term development efforts. The post-disaster context also provides Dominica with the space for the operationalization of the resilience principles, policy scope and strategies embedded in the CARICOM endorsed Comprehensive Disaster Management Strategy (CDM) 2014, and the Regional Framework for Achieving Development Resilient to Climate (2009 and after).

The urgency for considering resilience as a central element of development planning is supported by International Development Partners within the framework of "Resilient Champions Group" comprising high level representatives from the World Bank, EC, DFID, Japan, UNDP and CARICOM Secretariat.

Reconstruction and Recovery Planning. Based on the results of the Rapid Damage Impact Assessment, the next step is to prioritize specific reconstruction investments and recovery programs. In order to design the reconstruction and recovery plan, the government may consider adopting a policy framework to guide sector reconstruction strategies and development of reconstruction and recovery projects and investments. Based on international experience, prioritization methodologies often include the following criteria:

¹⁵ See the CIF website for more details on the SPCR: <http://www.climateinvestmentfunds.org>

- Potential for direct and widest humanitarian impact
- Restoration and rebuilding of critical infrastructure and services
- Potential to generate sustainable livelihoods
- Balance between public and private sector recovery
- Balance between physical infrastructure reconstruction and less visible recovery (such as capacity building and governance)
- Pro-poor, pro-vulnerable, and gender-sensitive agendas¹⁶

In order to carry out a large scale reconstruction program, the government will also need to assess its capabilities and capacities in the construction sector as well as in the public service to be able to implement the required investments.

In this context, below are key interventions that the government may prioritize for recovery and reconstruction divided into four key areas: (i) risk identification/hazard data collection and analysis; (ii) increasing resilience through disaster risk reduction mitigation investments; (iii) strengthening disaster preparedness; and (iv) introducing disaster and catastrophe risk financing. The underlying principles of this framework are that both loss of life and the economic impact of disasters can be reduced through advance planning and investment.

A. Risk Identification/Hazard Data Collection and Analysis

Reliable hydrological, meteorological and climate data are of utmost importance for planning and designing investments that are resilient to the impacts of climate change. Hydro-meteorological data management systems need to be upgraded and maintained to provide a source of information on rainfall events and patterns. Fundamental datasets (e.g. topography, bathymetry, soil map, etc.) for analyzing the physical environment of Dominica need to be collected and made readily available. A stock taking of available hazard data needs to be carried out in the short term. In addition, new surface water run-off models need to be developed and applied to develop better flood risk mapping capability for infrastructure design and urban planning. Flood models in urbanized or populated watersheds will have to be prioritized. LiDAR mapping should be carried out urgently to provide topography and other data to inform the watershed modeling work. In conjunction with this, landslide identification and mapping work should be carried out to ensure that new construction is not at risk.

A comprehensive asset condition assessment is key to understand the extent of economic exposure to natural disaster and to develop a multiyear reconstruction investment plan.

¹⁶ Adapted from the Global Facility for Disaster Reduction and Recovery: *Developing Disaster Recovery Frameworks*, 2015.

Deteriorating infrastructure condition leads to an increase in vulnerability and failure which in turn leads to significant economic losses. A combination of ageing infrastructure, low rehabilitation/renewal funds and an increase in frequency of natural disasters due to climate change calls for a proactive approach to managing infrastructure. The biggest challenge in minimizing contingent liability is the difficulty to assess the risk of failure of different components of an infrastructure network. This requires a systematic condition assessment of infrastructure that incorporates vulnerability and risk analysis. This assessment should include all the major sectors such as transport (including airports and seaports), telecommunication, water, sanitation, energy, health, and education sectors. The key outcomes for the government will be (i) understanding of long-term average annual losses under different scenarios of levels of asset management, (ii) full assessment of major system failures creating opportunities for targeted investments and increasing financial efficiency and (iii) reduce disaster risk vulnerability and loss of infrastructure by improving maintenance protocol

B. Increasing Resilience through Disaster Risk Reduction Measures

Territorial and urban development plans, infrastructure design standards and construction regulations need to be revised to account for flood and landslide risk. The Rapid Damage and Impact Assessment highlighted that a significant number of relatively new infrastructure (including bridges; retaining walls; river protections; etc.) were destroyed due to poor design and/or quality of construction. The probability of occurrence (return period) of extreme events should be reevaluated as the intensity and frequency of some hazards such as flooding, wind storm and storm surge has evolved over time due to climate change and their impact has increased because of urbanization and overall increase in economic exposure. To enhance the resilience of infrastructure new construction, design standards, technical guidelines and codes should be developed, adopted and enforced.

Assess watershed management practices and prepare investments to reduce the risk of flooding of communities and infrastructure. A significant number of properties were affected by flash flooding, caused by various factors including inappropriate zoning, lack of adequate flood protection measures and poor construction quality. The upgrading of flood protection infrastructure, in conjunction with better zoning of communities would help prevent similar events in the future.

Develop a resilient transport infrastructure recovery and reconstruction strategy around the following priorities: (i) avoiding further casualties and damage to assets weakened by the Storm; (ii) restoring access and resuming socio-economic activities critical for recovery; (iii) developing a long term reconstruction and multiyear maintenance program that is informed by full condition assessment of assets and robust cost/benefit analysis. In the short term, a no regret and conservative designs and construction methods should be adopted until all necessary country-wide flood models and construction guidelines are developed.

Design a resilient housing recovery and reconstruction strategy which focuses on: (i) safety assessment (covering both structural integrity as well as exposure to landslides, flash floods, etc.) of existing housing stock; (ii) housing program for those displaced by the storm with options targeting different tenure and socio-economic status (e.g. owners/renters; female-headed households; etc.); (iii) disaster and climate risk-based program to retrofit existing housing stock and introduce/revise regulations for unsafe areas; (iv) enforcement of building code/regulations, improvement of building practices, certification of materials, etc.

Promote resilience in the Agricultural/fisheries sectors through improved watershed analysis (based on high resolution core datasets) to provide a foundation for advising sector activities and assisting with risk avoidance through improved planning and design. Given the terrain and soils distribution there will always be a risk of crop losses due to flooding and landslip however losses can be mitigated through improved analysis and planning. This is particularly true with the construction and location of critical processing and storage facilities. As most of the agricultural activity occurs in the private sector on private lands, the Ministry of Agriculture generally operates in an advisory capacity. Adding modeling and analysis capacity to the Ministry provides a powerful tool to assist farmers with risk avoidance/reduction activities. The Ministry should regularly also engage with the Ministry of Planning to ensure that development plans do not place agriculture at undue risk.

C. Strengthened Disaster Risk Preparedness

Develop a culture of resilience to natural hazards and climate change by pre-positioning essential supplies, safety and recovery equipment. The government should pre-position essential supplies such as water, medication, dry food to support communities in the immediate aftermath of disaster. It should also continue to assess the adequacy and safety of shelters for all major types of hazards on a continuous basis. In addition, emergency respondents should be well equipped to respond to disasters effectively. This includes, for example, having appropriate road signs that could be used to warn drivers about dangerous areas or to close traffic in sections of roads that pose extreme threat. The disaster risk management agency should lead this program to ensure that all government agencies have business continuity plans and are well equipped to get their sector back to business in the shortest time possible.

Enhance disaster preparedness and crisis response capacity by improving communication. Communication between affected communities and government authorities should be enhanced to ensure that (i) communities are informed of imminent danger before a natural disaster and (ii) government authorities are continuously informed about situation on the ground. This flow of information on both directions will help to better adopt and respond to a crisis. In the weeks following TS Erika, new precipitations have triggered additional floods and landslides. Dominica's vulnerability to hydro-meteorological and climate hazards has been made even more acute and immediate measures need to be taken to inform communities of the increased risk. In

the short term communication tools targeting decision makers as well as the broad population have to be made rapidly available to avoid additional casualties from subsequent precipitations.

Improve early warning systems. The early warning systems in Dominica are rather limited; currently there is lack of capacity to produce very short term weather forecasts or real time observations. Effective and efficient early warning systems are required for disaster operations. An improved early warning system enables better responses to be put into action quickly and improve safety to the public and civil protection staff. This system will require real time inputs from rain gauges, rain radar and river gauging stations and would comprise of a metrological model to predict rainfall and a hydraulic model to forecast river flows and levels and the consequential impacts on flooding and debris flow events. Continuous Improvements to the system will be necessary to deal with the inherent uncertainties in regional forecasting and to improve its reliability.

Increase the capacity of the private sectors to respond to disasters. Private sector actors should take measure to reduce the likelihood and impact of floods and landslides by strengthening the capacity of employees to respond in a timely manner. Some of the key steps that the private sector could take include (i) preparing evacuation plans, (ii) preparing facility maps showing critical equipment (iii) a business continuity plan, (iv) buying insurance, (v) backing up all computer data, and (vi) raising electrical outlets, ventilation systems and other equipment to avoid flood damage.

D. Disaster Risk Financing

Reduce fiscal exposure to natural disaster shocks by developing a risk financing strategy that could include a risk layering approach as well as the potential for adopting risk financing instruments or contingent financing mechanisms to cover the losses caused by low frequency, high impact disaster events.

Establish a broad based catastrophe risk financing and insurance strategy. Given the wide spread damages and losses due to TS Erika to the agricultural sector, public infrastructure, private properties, livelihood and its overall impact on the country's budget, various risk financing and transfer mechanisms would be beneficial for Dominica to ensure that government, communities and businesses more resilient to disaster. The following are different risk financing options that Dominica could consider to manage natural disasters.

- **Sovereign disaster risk financing:** Development of financial strategies to increase the financial response capacity of governments in the aftermath of natural disasters, while protecting their long-term fiscal balances.
- **Property catastrophe risk insurance:** Development of competitive catastrophe insurance markets to increase property catastrophe insurance penetration among homeowners and small and medium enterprises.

- **Agricultural insurance:** Development of agricultural insurance programs for farmers, and agricultural financing institutions (e.g., rural banks, microfinance institutions) to increase their financial resilience to adverse natural hazards.
- **Disaster micro-insurance:** Facilitate access to disaster insurance products to protect the livelihood of the poor against extreme weather events and promote disaster risk reduction in conjunction with social programs such as conditional cash transfer programs.

Annex A: Summary Table of Recovery and Reconstruction by Sector

Sector	Short Term (6-12 months)	Medium Term (12-24 months)	Long Term (24 months+)
Transport Infrastructure	<ul style="list-style-type: none"> - Clean up rivers, drainage systems and restore hydraulic capacity of bridges by removing blocks, trees or materials - Safely trigger active landslides (blocks, trees, unstable materials, etc.) and conduct initial assessment of landslides. - Undertake urgent abutment reconstruction, foundation stabilization and approach protection of partially damaged or undermined bridges - Install temporary crossings, place blocks or gabion cages to stabilize walls 	<ul style="list-style-type: none"> - Continue with road and bridge repairs, - Prepare technical design and construction guidelines - Strengthen meteorological services, develop flood models and assess landslide risks - Conduct preliminary technical studies, prepare designs and bidding documents for repair and reconstruction of severely damaged sections. - Perform a comprehensive and detailed condition assessment of the road network and prepare a multiyear investment mitigation action plan. 	<ul style="list-style-type: none"> - Continue with the reconstruction of roads and bridges - Ensure that all major reconstruction and new development adhere to the design and technical guidelines developed - Use an asset management system to track reconstruction and to prioritize investments - Continuously assess the condition of infrastructure and identify vulnerable sections
Air and Sea Ports	<ul style="list-style-type: none"> - Immediate replacement of damaged electrical equipment and electronics. This would include all security installations, luggage handling, computers, and both ground to ground and ground to air communications equipment. Landing lights and precision approach lighting are essential. - Immediate repair of physical infrastructure, including the end of runway 60, the washed away portions of the apron, the drive-up and car parking areas affected, and the security fence. - Immediate repair of any emergency response infrastructure (fire engines, ambulances) that are currently not operating. - Reinforce the earthen dam with more permanent materials such as concrete 	<ul style="list-style-type: none"> - Develop a feasibility study to evaluate: <ul style="list-style-type: none"> o the probabilities and risks facing the airport and their mitigation by, for example, building river defenses, and; o Identification of potential future sites for constructing a new, safer airport. 	<ul style="list-style-type: none"> - Carry out the findings of the feasibility study be they extensive fortifications of the current airport, or the building of a newer facility with higher capacities on a more secure site.

Sector	Short Term (6-12 months)	Medium Term (12-24 months)	Long Term (24 months+)
Water and Sanitation	<ul style="list-style-type: none"> - Clean up debris from intakes and stabilize slopes in the vicinity of intakes - Fix access roads to intakes - Provide water filtration units to badly affected communities - Fix damaged sanitary pipes and clean up affected areas 	<ul style="list-style-type: none"> - Consider liaising with Ministry of Works, on the design of new bridge infrastructure to include protected utility corridors in the bridge design rather than hanging transmission lines externally. - Reduce sediment build-up or promote rapid excavation after an event. 	<ul style="list-style-type: none"> - Consider the application of stream bed infiltration galleries (if possible) in lieu of surface water abstraction systems to reduce exposure to heavy debris during flooding events. - Review current locations of abstraction points to identify if less vulnerable locations can be utilized to lessen the impact of flood debris and battering from main channel flows (e.g. upstream locations, stream side diversion designs)
Environmental Health	<ul style="list-style-type: none"> - Work with ODM, local governments and DOWASCO to consider prepositioning vector control and drinking water treatment supplies at strategic locations as part of the disaster preparedness program. 	<ul style="list-style-type: none"> - Consider the use of waste transfer stations around the island and analyze the use of these stations for both improved solid waste management and as staging areas for post-disaster waste storage. 	<ul style="list-style-type: none"> - Consider improvements to public sanitary facilities that include onsite water storage to maintain facility operations when public water is disrupted.
Telecommunications	<ul style="list-style-type: none"> - Volunteers should be trained in the operation of this system during a disaster. - The existing emergency radio communications network needs to be reviewed and upgraded. 	<ul style="list-style-type: none"> - All sites should be inspected to ensure that they have adequate backup fuel supplies and properly serviced backup equipment. - Locations of equipment should be assessed for their vulnerability to hazards. - Design of new bridge and road infrastructure should take into consideration the reduction of hazards to telecommunications equipment. 	<ul style="list-style-type: none"> - Upgrade all existing hydro-meteorological and seismic monitoring stations to automatically report through either radio or satellite. Information from stations should be available in real time and not be entirely reliant on wired communications. - Strengthen an emergency communications system that could be maintained by the GoCD in partnership with the major telecommunications companies.
Electricity	<ul style="list-style-type: none"> - Consider an assessment of the resilience of DOMLEC's Supervisory control and Data Acquisition system to ascertain control over its power generating capability at all times 	<ul style="list-style-type: none"> - Consider conducting a comprehensive risk assessment with respect to landslide and flood risks for DOMLEC infrastructure - Consider slope stabilization and flood impact proofing of DOMLEC infrastructure if and as needed. 	<ul style="list-style-type: none"> - Review vulnerability of power generation sites and distribution systems - Develop a business continuity plan - Build redundancy and control stations to manage blackouts

Sector	Short Term (6-12 months)	Medium Term (12-24 months)	Long Term (24 months+)
Agriculture, Forestry and Fisheries	<ul style="list-style-type: none"> - Assess impact on farm roads and prioritize interventions - Clean up affected areas - Conduct an inventory of affected areas and determine whether reforestation would be effective as a soil stabilization measure. - Examine associated infrastructure to determine whether storm related impacts have placed facilities at greater risk and develop plans to mitigate risks identified. 	<ul style="list-style-type: none"> - Review with ODM, coops and farming community the locations of critical facilities (e.g. collection and storage facilities, processing facilities etc.) to optimize locations that reduce vulnerability. - Review damages to tertiary roads and explore options with Ministry of Agriculture and Ministry of Works to harden infrastructure and consider engaging the users in drainage and erosion control on a routine basis. 	<ul style="list-style-type: none"> - Develop a detailed mapping of forest resources/forest cover, - Implement a classification scheme that defines forest types based on their biological characteristics. This will provide a basis for informed reforestation activities that preserves the ecological characteristics of islands habitats and improve resilience of forest management investments.
Tourism	<ul style="list-style-type: none"> - Ensure Douglas-Charles airport is fully operational - Ensure access to main touristic sites before the tourist seasons starts - Invest more in promoting tourism and Dominica to make up for potential losses 	<ul style="list-style-type: none"> - Assess the location and zoning of hotel sites. The recommendation falls in line with the issues facing the housing sector overall. - Prepare a comprehensive plan for evacuation of hotels, tailored to the uniqueness of each property's location. 	<ul style="list-style-type: none"> - Create the economic environment to increase the penetration of small and medium enterprise insurance - Develop a business continuity plan to ensure that service interruptions do not have long term effect on the economy
Industry and Commerce	<ul style="list-style-type: none"> - Coordinate recovery planning with the private sector (industry) with a view to create jobs. - Promote the dissemination of hazard maps and risk analysis with small and medium enterprises to create awareness of hazard risk and preparedness planning. 	<ul style="list-style-type: none"> - Rebuild facilities to increase production to full capacity - Assess the vulnerability of the facilities to natural disasters and invest in risk mitigation measures 	<ul style="list-style-type: none"> - Encourage all enterprises to develop business continuity plans. - Review hazard insurance options for small and medium enterprises.
Education	<ul style="list-style-type: none"> - Facilitate the design and implementation of an education specific sector assessment determining the current status of education service provision referenced to existing national standards. - Revise and develop a response framework, strategy and plan of action for education response, based on assessment findings. 	<ul style="list-style-type: none"> - Ensure that the rehabilitation and reconstruction of schools and recreational facilities are in accordance with established standards for child-friendly and structurally resilient "Build Back Better" designs. - Integrate immediate emergency response with long-term vision and recovery planning within the education system. 	<ul style="list-style-type: none"> - Monitor implementation of long term program activities, and ensure that capacity is in place to effectively address reconstruction - Develop programs and protocols that ensure that new school facilities are resilient to multi-hazard disasters

Sector	Short Term (6-12 months)	Medium Term (12-24 months)	Long Term (24 months+)
	<ul style="list-style-type: none"> - Provide appropriate basic education, early learning and recreational materials; and include special measures for children needing help to re-engage in education. - Work with Child Protection to address violence in and around learning spaces and schools with a focus on the most vulnerable. - Take an inter-sectoral approach to the provision of support in temporary learning spaces and child-friendly spaces by mobilizing available psychosocial support for teachers and students through the 'Return to Happiness' program. 	<ul style="list-style-type: none"> - Advocate for and support the redevelopment of schools according to safe, inclusive, equitable and child-friendly models. 	
Health	<ul style="list-style-type: none"> - Install additional water tanks, standby generators ,refrigeration equipment, - Carry out assessment of all electrical wiring at flooded facilities. - Replace damaged external doors. 	<ul style="list-style-type: none"> - Construct retaining walls for protection - Construct additional storm drains - Expansion of Building to provide storage capacity. - Stabilise and secure access roads to health facilities. - Installation of rainwater roof catchment systems at health facilities. 	<ul style="list-style-type: none"> - Consider relocation of some facilities such as Mahaut, Newtown, and upgrading of the Marigot Hospital and Portsmouth Hospital.
Housing	<ul style="list-style-type: none"> - Develop a strategy for addressing the loss of housing stock whilst considering options for implementing a temporary housing program for homeless people and people currently residing in shelters - Develop and conduct a Building Assessment Program to develop a prioritized approach to Building Back Better for new housing stock - Develop a financing strategy for replenishing the diminished housing stock - Enhance sex and age disaggregated data for HOH who have lost houses in order to inform relocation lists. 	<ul style="list-style-type: none"> - Consider options and implement a temporary housing program for people who were evacuated from the disaster areas or lost their home due to storm impact and found refuge with families in non-affected areas. - Develop a risk-based approach to housing and residential/urban planning based on best practice building asset management principles (building inventories, condition assessments, inspection programs, building permitting, etc). 	<ul style="list-style-type: none"> - Implement a long term asset maintenance strategy and system for existing and new houses and buildings if they remain in public ownership. - Engage women and youth in non-traditional rebuilding relocation efforts through training programs linked to social protection (see social protection section).

<i>Sector</i>	<i>Short Term (6-12 months)</i>	<i>Medium Term (12-24 months)</i>	<i>Long Term (24 months+)</i>
	<ul style="list-style-type: none"> - Identify houses that were rented vs mortgaged. 	<ul style="list-style-type: none"> - Review existing building code for Dominica and enhance its application/enforcement to ensure it adequately addresses requirements for resilient housing for hurricanes, flood and landslide risks. - Commence with the implementation of a program to replenish the housing stock. 	
Social Protection and Gender Inclusion	<ul style="list-style-type: none"> - Identify vulnerable persons who need to benefit from social protection, additional psychosocial support, and medical care. - Track vulnerable groups to better understand their increased risks and vulnerabilities and how further risks can be mitigated. - Identify vulnerable persons who need to benefit from social protection, additional psychosocial support, and medical care - Ensure that any additional data collected is sex and age disaggregated. - Create opportunities to involve more women and youth, women's organisations, state gender focal points, and other organizations working on gender issues as partners in the recovery work. 	<ul style="list-style-type: none"> - Complete assessment of key social protection programmes to support the recovery process in a gender and child responsive manner. - Prepare a Central Beneficiary Registry. - Build on and implement the multi-sectoral Gender and Child Responsive considerations within the Strategic Program on Climate Resilience (SPCR) and the Low Carbon Climate Resilient Development Strategy. - Apply as appropriate considerations for mainstreaming gender considerations in DRM being developed by CDEMA and other stakeholders. 	<ul style="list-style-type: none"> - Develop job training and continuing education programmes linked to already functioning social protection programmes such as the Adult Education (Community-Based Vocational Skills Training; Literacy and Numeracy; Continuing Education Programmes), Small Business Unit Fund, Bureau of Gender Affairs, Small Business Revolving Loan Fund, Dominica Youth Business Trust Fund, and Youth Development Division Skills Training Program.

Annex 1: List of People Consulted

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