Rapid Damage and Loss Assessment

November 9-11 and November 28, 2016 Floods

A report by the Government of Saint Vincent and the Grenadines

December 14, 2016

With financial support from the European Union
In the framework of the ACP-EU Natural Disaster Risk Reduction Program managed by the GFDRR

FOREWORD

In November 2016, two tropical trough systems produced heavy rains in Saint Vincent and the Grenadines, which resulted in intense flooding across the island chain. The torrential rains, ensuing flash flooding, and landslides resulted in widespread damage to road, bridges, water infrastructure, and housing.

Our extreme vulnerability to natural disasters and the impacts of climate variability continues to be of grave concern.

This 'Saint Vincent and the Grenadines Rapid Damage and Loss Assessment, November 9–11 and November 28, 2016 Floods' Report serves as a reminder and proof of the Government's resolve and commitment to risk reduction as well as the well-being of our people.

The Government recognizes the necessity to better understand our climate and disaster risk context and is continuing the battle to reduce this risk and improve resilience across all sectors.

This report provides a rapid damage and loss assessment of the affected sectors, with particular focus on infrastructure damage to inform the Government's recovery, reconstruction, and financial planning. It also includes short- and medium-term recommendations designed to further incorporate disaster risk reduction and management into land use and physical planning decision-making processes so that we continue to develop into a country that is more resilient to natural disasters and climate change.

The Honourable Dr. Ralph E. Gonsalves
Prime Minister and Minister of Finance

ACKNOWLEDGEMENTS

This report reflects the relief and recovery efforts of the Government to reduce the social and economic impacts caused by the heavy rains throughout November 2016, particularly the troughs starting November 9 and November 28, 2016.

The Government wishes to extend profound gratitude to the World Bank Group for rapidly responding to our request for support and sending a team of experts to conduct a 'Rapid Damage and Loss Assessment'.

The report is a joint collaboration of the Government and the World Bank Group. This report has been produced under the guidance of the Honourable Dr. Ralph E. Gonsalves, Prime Minister and Minister of Finance; Ms. Laura Anthony Browne, Director of Planning; Ms. Michelle Forbes, Acting Director of the National Emergency Management Office; and Mr. Brent Bailey, Chief Engineer at the Ministry of Transport and Works. A World Bank team, led by Keren Charles (Disaster Risk Management Specialist) together with Gerald Meier (Senior Technical Specialist), provided additional support in the preparation of this assessment.

The authors are grateful to the team at the Ministry of Economic Planning, the Ministry of Transport and Works, the Central Water and Sewage Authority, the Saint Vincent Electricity Services and the MET Office in particular, Ms. Decima Corea, Ms. Louise Tash, Mr. Trelson Mapp, Mr. Damion Allen, Mr. Brian Da Silva, Mr. Danroy Ballantyne, Mr. Vialey Richards, Mr. Thornley Myers and Mr. David Burgin for their technical inputs and review of the document. In addition, Mr. Richard MacLeish, Mr. Cecil Harris, and Ms. Nerissa Pitt from the Ministry of Economic Planning for their technical and logistic support.

Finally, this assessment would not have been possible without the support of all the individuals from their respective ministries, agencies, and development organizations that contributed to the preparation of this report. Their efforts are greatly appreciated.

The Government wishes to thank the European Union for providing financial support for this Damage and Loss Assessment under the framework of the Africa, Caribbean and Pacific, European Union (ACP-EU) Natural Disaster Risk Reduction Program, managed by the Global Facility for Disaster Reduction and Recovery (GFDRR).

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ABBREVIATIONS

ACP	Africa, Caribbean, Pacific
BOP	Balance of Payment
BRAGSA	Buildings, Roads, and General Services Authority
CWSA	Central Water and Sewage Authority
DaLA	Damage and Loss Assessment
EU	European Union
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Risk Reduction and Recovery
I&C	Industry and Commerce
MoEP	Ministry of Economic Planning, Sustainable Development, Industry, Information and Labour
MoH	Ministry of Housing, Informal Human Settlements, Physical Planning, and Lands and Surveys
MoTW	Ministry of Transport, Works, Urban Development and Local Government
NEMO	National Emergency Management Organization
NEOC	National Emergency Operation Centre
PDNA	Post Disaster Needs Assessment
RDVRP	Regional Disaster Vulnerability Reduction Project
SVG	Saint Vincent and the Grenadines
UN	United Nations
VINLEC	Saint Vincent Electricity Services
W&S	Water and Sanitation

EXECUTIVE SUMMARY

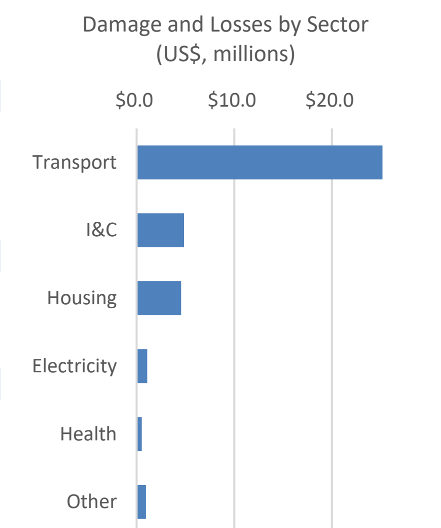
From September through November 2016, Saint Vincent and the Grenadines (SVG) experienced a series of significant rainfall events beginning with the passage of Hurricane Mathew in September 2016 and culminating with the passage of two trough systems on November 9 and November 28, 2016. Due to the consistent rainfall over the period, ground conditions were largely saturated which set the stage for intense flash flooding associated with the two troughs. A single death was reported from Bequia.

As a result of intense rainfall, numerous landslides were triggered, resulting in significant damage to national road infrastructure. Flash floods, several of which were associated with debris flows, damaged bridges and private property with particularly devastating impact to lower-income communities. These effected were particularly focused in the northeastern and northwestern portions of the island of Saint Vincent (mainland).

On November 22, 2016, the Government requested support from the World Bank Group for developing a Rapid Damage and Loss Assessment (DaLA). Working closely with Government agencies, preliminary assessment data were collected to characterize the impacts of the disaster. In summary, presented in table 1, the transport sector accounted for 67 percent of the impact experienced because of the two events, accounting for approximately US$24.3 million (EC$65.7 million) of the total US$36.3 million (EC$97.9 million) in assessed damage and losses.

TABLE 1: SUMMARY OF DAMAGE AND LOSSES BY SECTOR (MILLIONS)

Sector	Damage (US$)	Losses (US$)	Total (US$)	%	Damage (EC$)	Losses (EC$)	Total (EC$)
Infrastructure							
Transport	23.5	0.8	24.3	67	63.5	2.2	65.7
Electricity	0.9	0.2	1.1	2	2.3	0.6	2.9
Water & Sanitation	0.1	0.0	0.1	0	0.3	0.0	0.3
Social							
Housing	4.3	0.3	4.6	13	11.5	0.8	12.3
Health	0.5	0.0	0.5	1	1.4	0.0	1.4
Agriculture[a]	0.5	0.3	0.8	2	1.3	0.9	2.2
Productive							
Industry & Commerce	0.0	4.9	4.9	13	0.0	13.1	13.1
Tourism	0.0	0.0	0.0	0	0.0	0.0	0.0
Education[b]	0.0	0.0	0.0	0	0.0	0.0	0.0
Total	**29.7**	**6.5**	**36.3**	**100**	**80.3**	**17.6**	**97.9**



Note: Total losses are expected to increase over time when the full extent of the damage is known. Conversion factor: US$1.00 = EC$2.70.

Source: Numbers based on reports provided by and/or discussions with the relevant ministries and agencies including: National Emergency Management Office (NEMO), Ministry of Transport, Works, Urban Development and Local Government (MoTW), Ministry of Housing, Informal Human Settlements, Physical Planning, and Lands and Surveys (MoH), Saint Vincent Electricity Services (VINLEC), Central Water and Sewerage Authority (CWSA), and the Ministry of Economic Planning, Sustainable Development, Industry, Information and Labour (MoEP).

a Includes forestry losses.

b Educational impacts difficult to quantify.

The housing sector accounted for US$4.6 million (EC$12.3 million) of the total damage and losses, with a total of 189 houses affected. While accounting for only 13 percent of the total damage and losses suffered, the impact is particularly severe as low-income families who are least capable of recovering from disaster events were disproportionately affected.

Finally, Industry and Commerce (I&C) impacts of US$4.9 million (EC$13.1 million) are reflected primarily as losses due to closure of the airport, businesses, and Government offices during the disaster event which resulted in the inability to conduct business and reduced productivity. The final economic impact is expected to be higher as the disaster events occurred during a period that is seasonally high for the retail industry as it is before the Christmas season when commerce usually increases.

The macroeconomic impact of the floods and landslides will take longer to become apparent. The possible increase in the imports of food, agriculture supplies, material for the reconstruction or rehabilitation of public infrastructure such as roads and bridges, and private infrastructure such as houses could result in a worsening of the BOPs. Moreover, given the increase in the demand for labor for civil works, it is expected that there will be an increase in the cost of labor, thereby increasing construction costs, all of which may contribute to a worsening of macroeconomic conditions. Further analysis is required to fully quantify the impact on the BOPs.

In the fiscal sector, some of the increased expenditures were accommodated by making use of the Government's budget framework, which allows for the reallocation of funds. Funds budgeted for existing programs would have to be diverted to cover the immediate expenditures for emergency response. The total estimated costs of the disaster represent approximately 49.5 percent of the projected 2016 capital budget (US$73.2 million or EC$197.7 million) and 10.7 percent of the total budget US$338.1 million (EC$912.9 million)[1] programmed for 2016.

This report summarizes the findings of the Rapid DaLA, which was prepared using information available within the first month after the disaster event. It is a rapid assessment and presents what is certainly a low estimate of the total impacts of the two events, particularly with respect to losses incurred. The currency conversion factor used throughout this report is EC$2.7 to US$1.0.

[1] SVG, Ministry of Economic Planning, Sustainable Development, Industry, Information and Labour (MoEP). 2016.

1 COUNTRY OVERVIEW

1.1 COUNTRY CONTEXT

Demographic. Saint Vincent and the Grenadines (SVG) is a small island developing state with an estimated population of 110,255 (2015) and a gross domestic product (GDP) per capita of US$6,691 (2015). Females account for 49.5 percent of the total population while males account for the remaining 50.5 percent. The urban population, now at 50.5 percent, continues to grow as people migrate to the urban areas predominantly in the south of the country.[2] The archipelagic state in the Eastern Caribbean comprises a mainland island, Saint Vincent, which is 344 km^2, and a chain of 32 islands and cays for a total area of 390 km^2 (World Bank Group 2016).

Economic. The GDP in 2015 was US$737.7 million with the tertiary sector accounting for 75 percent of the GDP, industry for 17 percent, and the primary sector accounting for the remaining 7 percent. About 80 percent of the GDP is generated from the national capital in Kingstown.[3] Over the past two decades, the economy has been transitioning away from the agricultural sector toward tourism and related services as well as construction. Economic recovery from the last global financial crisis was adversely affected by a series of natural disasters, sluggish global demand, and slow implementation of key infrastructure projects (IMF 2016). GDP grew by 1.3 percent in 2012 and 2.5 percent in 2013 but only by 0.2 percent in 2014,[4] partially due to the negative impact of the floods on agriculture and the disruption of transport infrastructure. The economy is slowly rebounding with GDP growth of 0.6 percent[5] in 2015. Public debt, at 74 percent of GDP in 2015, has increased steadily primarily due to the impact of the global financial crisis, construction of the new international airport, and rehabilitation costs associated with three back-to-back natural disasters (IMF 2016). Table 2 shows select socioeconomic statistics.

TABLE 2: SELECTED SUMMARY STATISTICS

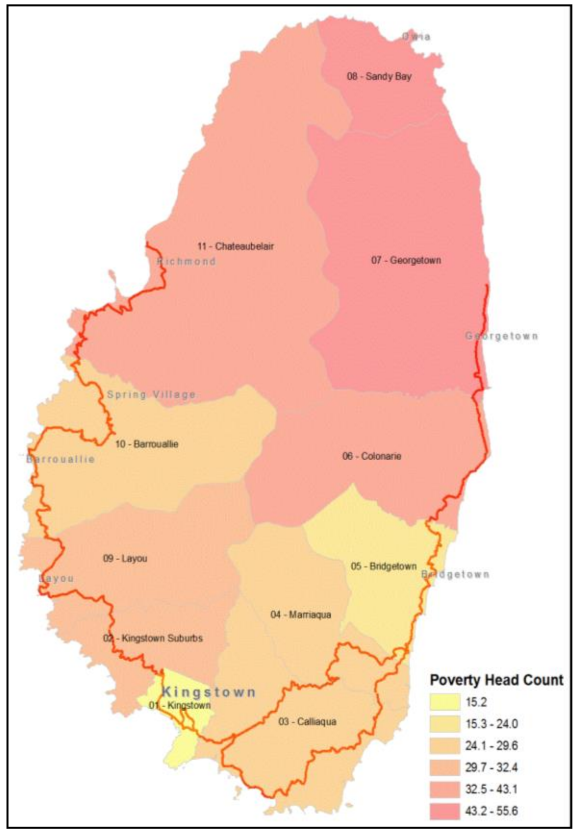
	2011	2012	2013	2014	2015
Demographic					
Population, total	109,903	109,991	110,079	110,167	110,255
Population density (people per sq. km of land area)	282.5	282.8	283.0	283.2	283.4
Female (% of total)	49.5	49.5	49.5	49.5	49.5
Urban (% of total)	49.1	49.5	49.8	50.2	50.5
Economic					
GDP (current US$, millions)	676.1	692.9	721.2	727.9	737.7
GDP growth (annual %)	0.3	1.3	2.5	0.2	0.6
GDP per capita (current US$)	6,152	6,300	6,552	6,607	6,691
Agriculture (% of GDP)	7.0	6.8	7.1	7.3	7.0
Industry (% of GDP)	18.4	17.8	17.8	17.0	17.0
Services and related activities (% of GDP)	74.2	75.0	74.7	75.2	75.2
Inflation, consumer prices (annual %)	3.2	2.6	0.8	0.2	(1.7)

Source: SVG, MoEP. 2016.

[2] SVG, MoEP. 2016.
[3] SVG, MoEP. 2016.
[4] SVG, MoEP. 2016.
[5] SVG, MoEP. 2016.

Poverty. The Country Poverty Assessment, last conducted in 2007/2008, indicates that 30.2 percent of the population is below the poverty line, with 2.9 percent living in abject poverty and 48.2 percent vulnerable to falling into poverty. The poverty distribution is geographically correlated with the highest poverty rates—55.6 percent found at the northern end of the mainland with the highest rates found in the villages of Sandy Bay and in Georgetown. Figure 1 shows the poverty by census district.

FIGURE 1: POVERTY HEADCOUNT



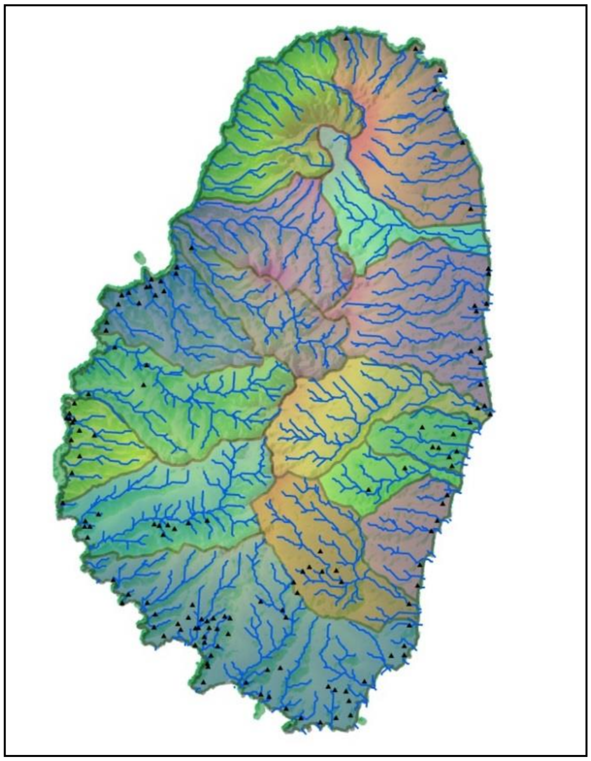
Source: Country Poverty Assessment, 2007/2008.

1.2 VULNERABILITY TO NATURAL HAZARDS

SVG is exposed to high levels of risk to meteorological (high wind, excess rainfall, hurricanes, and drought) and geophysical (seismic, volcanic, tsunami) hazards, which have significant negative impacts on economic development, fiscal stability, and communities. These natural hazards are being exacerbated by the adverse impacts of climate change, which put increased stress on coastal investments, national infrastructure, water availability, and livelihoods, especially of the poor and vulnerable groups. Of the disasters regularly affecting SVG, hydro-meteorological (hydromet) events occur most frequently and represent a significant source of average annual losses, which from 1996 to 2015 were estimated to be around 1.2 percent of GDP (ranked 16th globally) (Kreft et al. 2016). More recently, the trough in December 2013 resulted in extensive physical damage and economic losses estimated at approximately US$108.4 million (15 percent of GDP). The trough hit at a time when SVG was just showing signs of recovery from the global financial crisis, and the natural disasters exerted further strain on an already challenging fiscal context.

Given its geographic location, small land mass, and topography, the entire nation is highly vulnerable to natural disasters. Because of its volcanic origin, steep slopes dominate the islands' landscape and tilted volcanic layers define the geology and soils (DeGraff 1988). It has more than 40 rivers and tributaries, which originate in the central mountains and discharge to the Caribbean Sea or the Atlantic Ocean (DLN Consultants 2006). These are distributed among 15 principal watersheds, as shown in Figure 2.

FIGURE 2: PRINCIPAL RIVERS AND WATERSHEDS



Source: DLN Consultants, 2006.

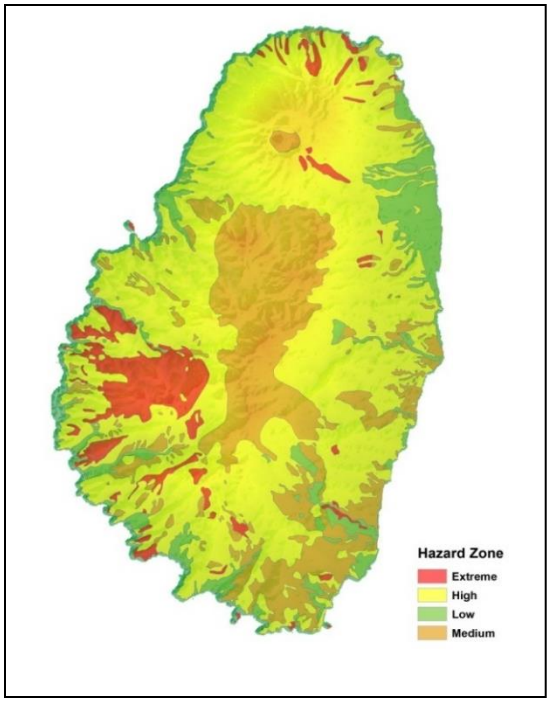
The combination of tropical temperatures and abundant rainfall leads to slope instabilities and the high potential for landslides. In 1988, DeGraff produced an analysis of landslide susceptibility (Figure 3) and during the study identified about 475 landslides, covering about 1 percent of the country's surface. The most common type of landslides in SVG are debris avalanches, which are defined as rapid movements of an unconfined mass of soil and rock falls. Depending on the topography, another common type of landslide is debris flow, for which the movement of debris is confined to a channel. In SVG, debris flow is usually associated with river channels in the mountainous sections of the country. Debris flows can travel long distances, particularly when river flooding has occurred. They approach quickly and exhibit a considerable destructive force. Volcanic eruptions have affected the country in 1789, 1812, 1902, 1971, and 1979 (NEMO 2005). SVG is located in the Atlantic hurricane belt and has suffered periodic damage from past events, for example, from Hurricane Allen (1980), Hurricane Lenny (1999), and Hurricane Tomas (2010).

SVG is highly vulnerable to flash flooding. The extreme topography coupled with short (6 km) distances from the coast to the center mountain ridge creates a hydraulic system where stream concentration times are short (nominally 30 minutes). High rainfall, such as rain associated with a thunderstorm, quickly concentrates in stream channels, promoting rapid flooding. In this type of system, early warning of an actual flood event cannot be accomplished by monitoring stream levels because once they rise, it is too late. Any warning would need to be based on rainfall observations to trigger an alert.

Climate vulnerabilities are further exacerbated by the country's limited human and financial resources as well as highly exposed social and economic infrastructures—much of which are located in low-lying coastal areas. The considerable economic dependence on primary production and the service industry further contributes to such vulnerabilities as the success of both sectors is heavily influenced by climate.

The Government has been taking steps to address these risks by implementing multiple projects around disaster risk management and climate change adaptation, including the Regional Disaster Vulnerability Reduction Project (RDVRP). The project is a combination of risk reduction investments and emergency reconstruction activities and institutional strengthening and capacity building to better collect, manage, and apply climate risk and spatial information in development and planning decision making. Through the RDVRP, the Government has leveraged Climate Investment Funds, under the Pilot Program for Climate Resilience, to specifically target interventions aimed at reducing its climate risk. The Government has also participated in the Climate Risk Information Program, which has increased its baseline data on risks.

FIGURE 3: LANDSLIDE SUSCEPTIBILITY ZONES



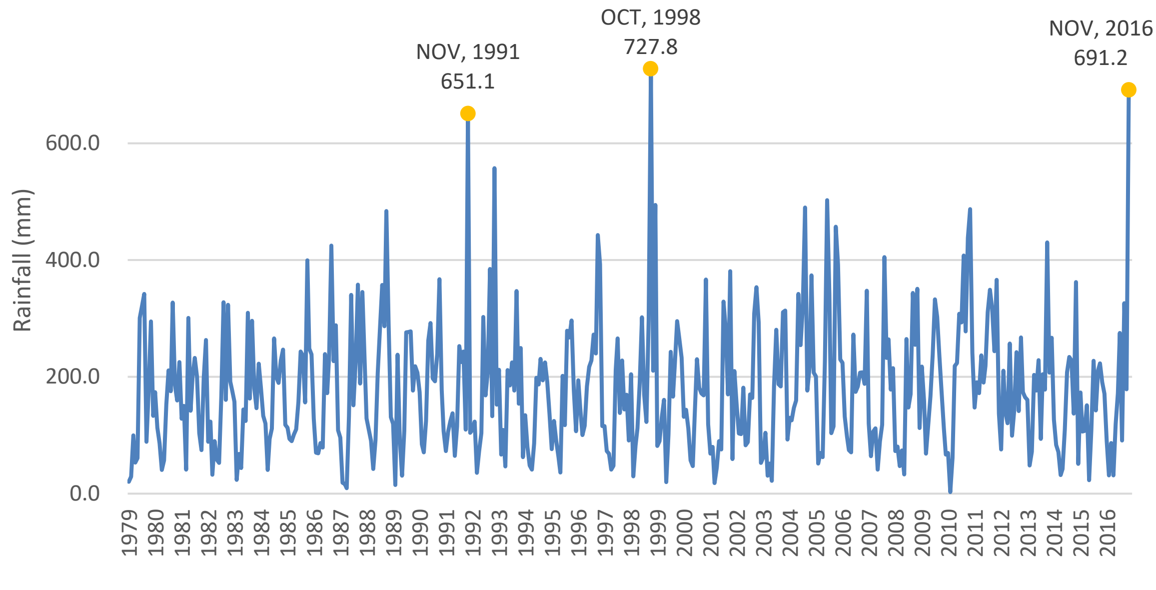
Source: DeGraff 1988.

1.3 OVERVIEW OF THE DISASTER

As result of the passage of two low-pressure trough systems on November 9 and November 28, 2016, SVG experienced heavy and sustained rainfall that resulted in several flash flooding events and numerous landslides principally affecting mainland Saint Vincent.

On September 28, 2016, Tropical Storm Mathew passed over SVG, depositing over 203 mm of rain over a 24-hour period, resulting in one fatality, damage to infrastructure, flooded rivers, and landslides around the island. This was the first in a series of systems that served to hydrologically saturate the island, a condition that remained constant through the months of October and November. According to records from the National Meteorological Service, monthly rainfall totals recorded at the E.T. Joshua Airport for September, October, and November were 326.3 mm, 170.7 mm, and 691.2 mm, respectively. Of note is November 2016, which recorded the second highest monthly rainfall of all months since 1979 (Figure 4). A total of five trough systems passed over Saint Vincent during the month of November 2016.

FIGURE 4: MONTHLY RAINFALL TOTALS AT METEOROLOGICAL OFFICE, MM (E.T. JOSHUA AIRPORT)



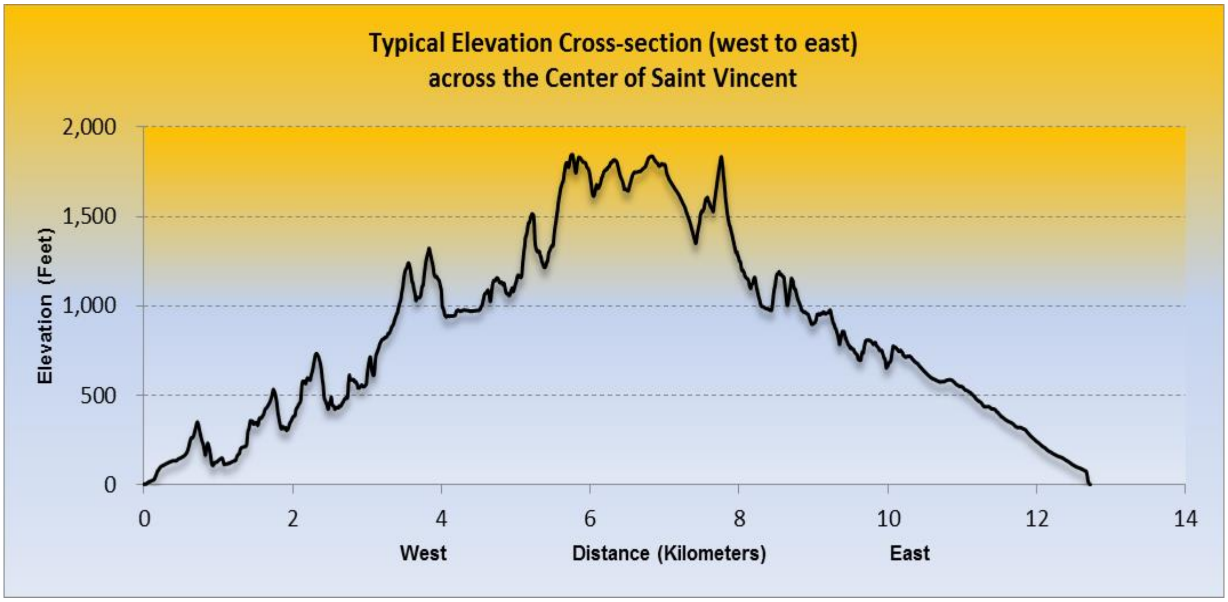
Source: SVG Meteorological Office, December 2016.

On November 9, 2016, a low-pressure system (trough) passed over the islands, resulting in three days of heavy rain and thunderstorms. Given the already saturated condition of the islands' soils, most of the rainfall was converted to runoff, which resulted in flash flooding and numerous landslides throughout the mainland. This event affected the southern portions of the island more than the northern areas, as well as the Grenadines. Following that system, a second trough arrived on November 28, again resulting in heavy rains and thunderstorms that lasted from November 28 through December 1, 2016. With an already saturated landscape and previous damage experienced from the November 9, 2016 event, existing damage was compounded and additional damage from flash flooding and landslide accumulated. Significant damage resulted particularly in the northeastern and northwestern portions of the island.

A meteorological trough is a linear low-pressure band that, in the tropics, is usually associated with increased convection activity (thunderstorms) and significant rainfall. In the case of the eastern Caribbean islands, these systems interact with the mountainous landscape (orographic effect), which serves to locally amplify the intensity of rainfall and thunderstorm activity.

Mainland Saint Vincent is of volcanic origin and is characterized by a deeply dissected terrain and mountainous interior. As the island is nominally 13 km wide (east-to-west), distances from the high elevations in the center to the coast are relatively short, approximately 6 km. On the north end of Saint Vincent, elevations (Figure 5) vary from sea level to over 2,000 ft. over a 4-km distance. This topographic variability promotes rapid rainfall runoff concentrating in streams with very high velocities. Flash flood development occurs in less than 30 minutes, depending on the intensity and duration of a particular rainfall event. Additionally, due to the topography, rainfall is highly localized. As weather systems interact with the landscape, the mountainous terrain facilitates the formation of local thunderstorms and increased rainfall intensities. For this reason, for example, the southern portion of the island may be experiencing a sunny day while there are floods and landslides in the north though the island is only about 29 km long (north-to-south).

FIGURE 5: TYPICAL ELEVATION FROM WEST TO EAST ACROSS THE CENTER OF SAINT VINCENT



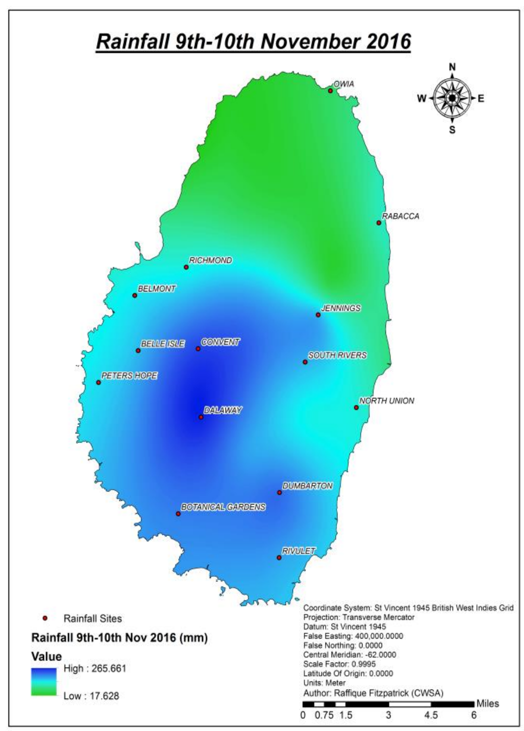
Source: author's analysis.

The aforementioned factors contributed greatly to the level and distribution of the damage associated with the two trough systems.

1.3.1 NOVEMBER 9, 2016 TROUGH

During the November 9, 2016 trough, rainfall intensities were generally greater in the southern portion of Saint Vincent. The rainfall event lasted about 96 hours, from November 9 to November 11, 2016. Rainfall recorded at the E.T. Joshua Airport totaled 297.8 mm. The Central Water and Sewage Authority (CWSA) maintains a system of rain gauges located throughout SVG and, on mainland Saint Vincent, maintains a constellation of 14 gauges. Accumulated rainfall for the interior areas in the southern portion of the island, as observed by the CWSA, was in the range of 265 mm over the 48-hour period, November 9 to 10, 2016. Based on their inter-station analysis, presented in Figure 6, most of the central southern interior experienced this level of rainfall intensity. In contrast, northern areas experienced considerably less rainfall generally in the range of 17–60 mm over the two-day period. This is a more representative accounting of the distribution of rainfall for the island.

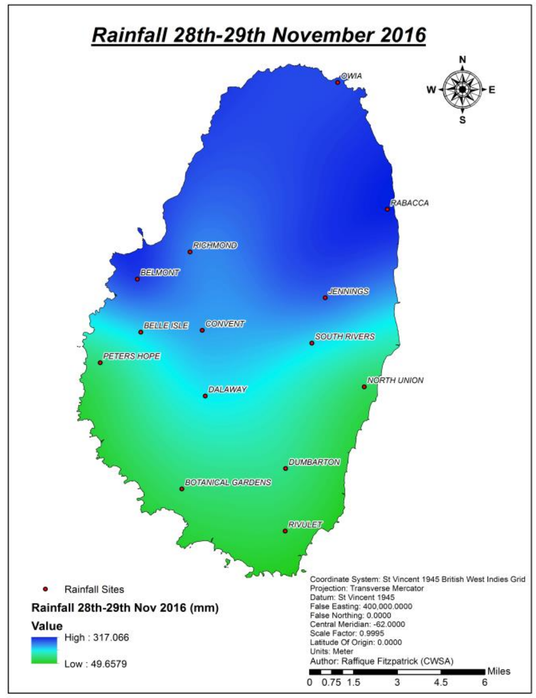
FIGURE 6: RAINFALL TOTALS FOR NOVEMBER 9, 2016 TROUGH



1.3.2 NOVEMBER 28, 2016 TROUGH

On November 28, 2016, an easterly trough arrived, bringing heavy rains and thunderstorms, producing the most intense rainfalls in the northern portion of the island, where the highest elevations are encountered, and affecting the east and west coasts. The three-day event rainfall measured at the E.T. Joshua Airport totaled 102.1 mm; however, the airport was not in the region where the intense rainfall developed. Based on the CWSA observations (Figure 7), accumulated rainfall for two days, November 28 and 29, 2016, was more than 300 mm over much of the northern half with the southern portions receiving amounts generally less than 100 mm over the same two-day period.

FIGURE 7: RAINFALL TOTALS FOR NOVEMBER 28, 2016 TROUGH



1.3.3 IMPACTED POPULATION

1.3.3.1 NOVEMBER 28, 2016 TROUGH - DIRECTLY AFFECTED PERSONS

According to the Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth,[6] 264 households, or 789 persons, from the following 23 communities and 8 census divisions were directly affected by the November 28, 2016 event.

TABLE 3: SUMMARY OF AFFECTED AREAS

Dark View	Coulls Hill	Magum
Petit Bordel	Troumaca	Hadley's Village
Rose Bank	Buccament	Overland
Rillan Hill	Layou	Dickson
Vermont	Fitzhughes	O'Briens Valley
Keartons	Orange Hill	Paget Farm
Spring Village	Sandy Bay	Water Gut
Chateaubelair	Owia	

Source: Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth.

Of the households affected, 40 percent were female-headed households, 30 percent were male-headed households, and the remaining 30 percent were not classified.[7]

[6] The Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth's Social Protection Report (2016) is included as an annex to this report. More details are included on the impact to communities and the available social protection needs.
[7] Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth 2016.

1.3.3.2 COMBINED TROUGHS - INDIRECTLY AFFECTED PERSONS

Combined, the impact of the troughs indirectly affected about 80.5 percent of the population (Table 4) due to the flooding, landslides, damage to homes, loss of electricity, loss of water supply, and obstruction of roadways, as well as the closing of the airport, schools, government offices, and businesses. As a result of landslips, the population above the Sandy Bay area was completely cut off from the rest of the country and water trucks were unable to reach the communities in Owia who had lost their water supply due to damage to the system. The impact of the November 9, 2016 trough was concentrated in the southern part of the country where the center of commerce and the airport are located; as a result, the macroeconomic impacts are expected to be high. Conversely, the impact of the November 28, 2016 trough was concentrated in zones where the economic activities focus on agriculture, fishing, and services, with high levels of poverty, such as Georgetown (55.6 percent) and Sandy Bay (55.6 percent).[8] A more detailed social assessment would be required to determine the full social impact of the disaster.

TABLE 4: SUMMARY OF PERSONS AFFECTED

Locations	Impacted Population[a]	%	Poverty Ratio (%) (2008)[b]	Main Economic Activity[c]
Calliaqua - all including Cane Hall to Queens Drive, Gomea, Belmont, Fairbane Pasture, Ratho Mill, Stubbs, Calder, Carapan, Diamond, Mesopotamia, Rawacou, Yambou	23,908	27.1	29.2	Commerce - factories, wholesale, and retail outlets; fishing; education institutions; health institutions; residential
Kingstown - all including Sion Hill, Dorsetshire Hill, Arnos Vale, Murrays Village, London	12,712	14.4	15.2	Commerce
Marriaqua - all including Yambou, La Croix, Mesopotamia, Glenside, Mt. Pleasant	7,798	8.9	29.6	Agriculture
Suburbs of Kingstown - including Campden Park, Lowmans Leeward, Green Hill, Buddy Gutter	7,317	8.3	31.3	Residential
Colonarie - all including Colonaire, South Rivers, Park Hill, Mt. Greenan, Diamonds Village, Lowman Windward, New Grounds	6,849	7.8	40.2	Agriculture
Georgetown - all including Mt. Bentick, Orange Hill, Overland, Byera, Dickson, O'Briens Valley, Spring, Langley Park, Chapmans Village, Tourama, Congo Valley, Mannings Village, Mt. Young, Perseverance, Rabacca	6,585	7.5	55.6	Agriculture, commerce - factories
Chateaubelair - all including areas from Coulls Hill to Richmond, from Richmond to Cumberland	5,756	6.5	43.1	Agriculture, fishing, tourism
Barraouallie - all including Cumberland, Kearton's Hill, Riversion, Hermitage	5,625	6.4	28.5	Agriculture, fishing, commerce, construction
Bridgetown - all including Peruvian Vale, Spring, Argyle, Hadley's Village, North Union, South Union, Cedars, Biabou	3,006	3.4	24.0	Agriculture
Sandy Bay - all including Owia, Point, Fancy, Magum	2,576	2.9	55.6	Agriculture, fishing, tourism
Layou - including Cane Grove, Vermont, Hope	2,426	2.8	32.4	Agriculture

[8] SVG, Country Poverty Assessment 2007/2008. We note that although this information is about a decade old, it is the most recent poverty assessment conducted in the country.

Locations	Impacted Population[a]	%	Poverty Ratio (%) (2008)[b]	Main Economic Activity[c]
Southern Grenadines - including Union Island, Canouan, Ashton, Clifton, Friendship Bay	2,022	2.3	15.6	Tourism, construction
Northern Grenadines - including Paget Farm	1,529	1.7	12.0	Fishing
Total	**88,109**			

Source: Own analysis of disaster impacts and 2012 census data.

a. 2012 Census.

b. SVG, Country Poverty Assessment 2007/2008. Although this information is about a decade old, it is the most recent poverty assessment conducted in the country.

c. Provided by the MoEP.

1.4 THE IMMEDIATE RESPONSE

1.4.1 NOVEMBER 9, 2016 TROUGH

On November 9, 2016, the National Emergency Council of the National Emergency Management Office (NEMO) activated the National Emergency Operation Centre (NEOC) to coordinate emergency response. Three emergency shelters were opened for 10 persons. The Government closed all schools and asked nonessential personnel to remain at home. The only airport in Saint Vincent, the E.T. Joshua Airport, was closed for a full day to remove silt and debris. In addition, all stores and business places were closed in Kingstown, one of the hardest hit areas. Within the first few hours, the Buildings, Roads, and General Services Authority (BRAGSA) had started clearing landslips from the main road from South Central Windward through to North Central Windward as well as in Colonarie (near the low-income houses), La Croix, Fairbaine Pasture, Belmont, and Ratho Mill. As a result of the damage, the Government requested support from the World Bank Group for technical assistance in conducting the damage assessment.

1.4.2 NOVEMBER 28, 2016 TROUGH

The Barbados Meteorological Services, through the SVG Meteorological Services initially placed a flood warning from 6:00 p.m. on November 28, 2016, to 12:00 p.m. November 29, 2016; however, they extended the warning until 8:00 a.m. November 30, 2016. The NEOC was activated and NEMO coordinated the emergency response activities, which included opening five emergency shelters to accommodate 180 persons. The Government closed all schools during this period and asked non-essential personnel to remain at home.

1.5 THE RAPID DALA APPROACH

Rapid DaLA preparation. After the initial assessment of the damage by the Government, it was concluded that the infrastructure had been severely impacted. On November 22, 2016, the Government requested the technical assistance of the World Bank Group to conduct a Rapid DaLA and to support reconstruction efforts in the country. In response to the Government's request, the World Bank Group mobilized a team of experts to conduct the Rapid DaLA on December 5, 2016. On November 28, 2016, days before the start of the mission, another trough hit the country, bringing with it more torrential rains. The team worked jointly with the national authorities, visited the affected areas, gathered information, and analyzed the results. The information in this report reflects the results of the assessment and information available as of December 13, 2016; however, the team notes that given the limited time since the passage of the November 28, 2016 trough, damage and losses are expected to increase significantly as more data becomes available.

Rapid DaLA Methodology. The Rapid DaLA methodology calculates the damage and losses as well as the social, economic, and environmental impacts of a disaster. This report provides—based on the available information—a close approximation of damage to assets and losses to the economic flows and provides some inputs to summarize the total macroeconomic impacts.

The Rapid 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 and sanitation); social (housing, education, and health); and cross-cutting issues (for example, the environment and gender).

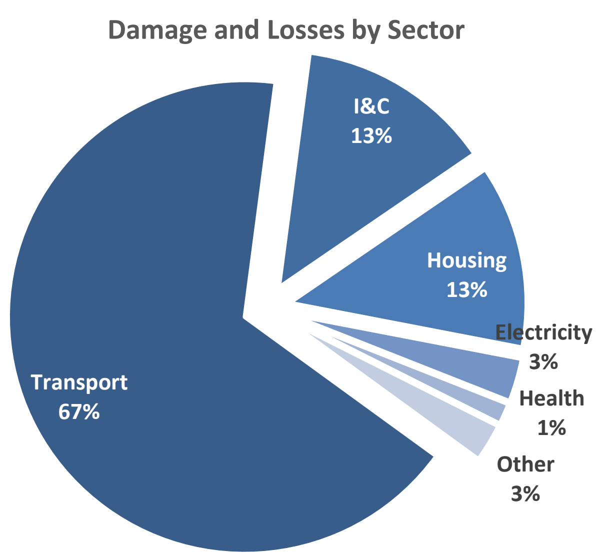
> ***Damage*** *is defined as the monetary value of fully or partially destroyed assets. It is initially assumed that assets will be replaced to the same condition—in quantity and quality—that they had before the disaster. In cases where the conditions are below United Nations (UN) standards, the damage amount reflects the cost to restore assets to minimum UN living standards. In the case of infrastructure, damage also includes the cost of building back better.*
>
> ***Losses*** *are defined as the changes in the flows of goods and services that will not be forthcoming in the affected area until full economic recovery and reconstruction has been achieved. They include production of goods and services that will not be obtained or provided, higher costs of operation and production, and the cost of the humanitarian/emergency assistance activities. Losses are expressed in current values.*

2 RAPID DAMAGE AND LOSS ASSESSMENT

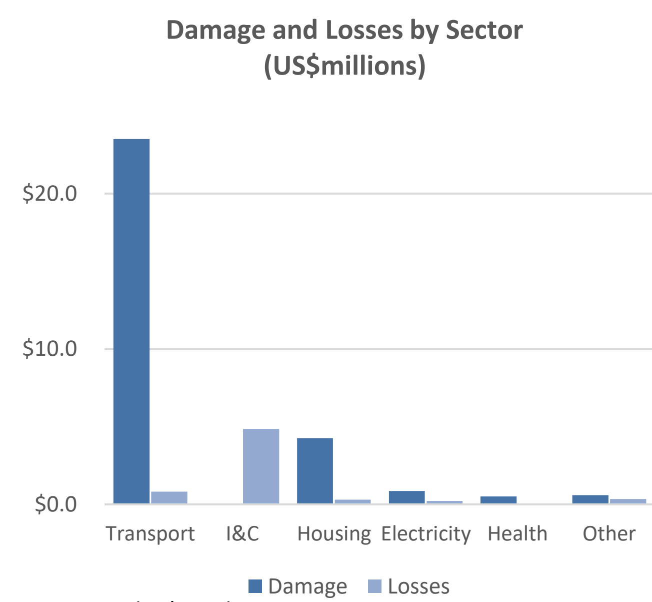
2.1 RAPID DAMAGE AND LOSS SUMMARY

According to the summary of the data reported from each affected sector, the November 2016 trough events and the associated landslide and flash flooding resulted in total damages and losses of US$36.2 million (EC$97.9 million), equivalent to approximately 5 percent of the country's GDP (2015). Most of the flood damage (figure 8) was sustained in the infrastructure sector, including utilities (70 percent), followed by the social sector (17 percent) and productive sectors (13 percent). Figure 8 presents a detailed summary of losses and damages by subsector.

FIGURE 8: RATIO OF DAMAGE AND LOSSES BY SECTOR



Source: Author's analysis.



Source: Author's analysis.

This Rapid DaLA is based on the initial estimates provided by the Government and losses will continue to accrue throughout the recovery phase. Damage costs will also likely rise as repair and reconstruction activities progress. A major factor affecting these costs is the potential for discovered damage, not observable during the initial assessment. Such damages are often discovered during the active construction phase and can result in as much as 25 percent increase in estimated costs for a particular construction project.

TABLE 5: SUMMARY OF DAMAGE AND LOSSES BY SECTOR

	Disaster Effects (US$)				Disaster Effects (EC$)		
	Damage	**Losses**	**Total**	**%**	**Damage**	**Losses**	**Total**
Sector							
Infrastructure							
Transport	23,515,578	811,111	24,326,689	67	63,492,061	2,190,000	65,682,061
Electricity	855,556	216,703	1,072,258	3	2,310,000	585,097	2,895,097
Water & Sanitation	92,600	9,300	101,900	0	250,000	25,000	275,000
Social							
Housing	4,254,148	303,805	4,557,953	13	11,486,200	820,273	12,306,473
Health	518,500	0	518,500	1	1,400,000	0	1,400,000
Agriculture[a]	486,888	333,333	820,221	2	1,314,597	900,000	2,214,597
Productive							
Industry & Commerce	0	4,850,600	4,850,600	13	0	13,096,600	13,096,600
Tourism	16,300	800	17,100	0	44,000	2,200	46,200
Education[b]	0	0	0	0	0	0	0
Total	**29,739,570**	**6,525,652**	**36,265,222**	**100%**	**80,296,858**	**17,619,170**	**97,916,028**

Note: Some ministries and agencies are still in the process of analyzing and quantifying their losses; as a result, total losses are expected to increase in some sectors.
Conversion factor: US$1.00 = EC$2.70.
a Includes forestry.
b Educational impacts difficult to quantify.

2.2 DAMAGE AND LOSSES BY SUBSECTOR

The following report is based on estimates from national authorities in each sector using the same template and the same Rapid DaLA methodology. It will be presented by sectors under categories of infrastructure, productive sectors, social sectors, and cross-cutting sectors.

Damage from the two trough systems was primarily due to landslip and flash flooding. Principal sectors affected were transport, water, housing, and electricity. Agricultural damage was isolated and crops were marginally affected; however, there was damage to local agricultural infrastructure and blockage of farm-to-market roads.

2.2.1 TRANSPORT AND PUBLIC INFRASTRUCTURE

FIGURE 9: WINDWARD HIGHWAY - ARGYLE ROAD RECONSTRUCTION

During the two trough events, damage to the transportation sector was primarily due to flooding, landslip, and rock fall. On Saint Vincent, road blockages were the predominant impact; however, bridges and culverts suffered significant damage, particularly along the upper east coast. Road failure occurred in several locations including along the main east coast highway to the west of the Argyle Airport, [9] where a section of road (figure 9) failed completely, requiring a major reconstruction. This resulted in the rerouting of traffic along the old coast road that is currently serviced by a temporary one-lane bridge, which is also the focus of emergency construction activities.

As a result of flash flooding events, 18 bridges suffered damage or were left in a vulnerable condition due to scouring and exposure of foundation elements. In the latter case, the bridges appear unaffected, but the underlying damage increased the vulnerability of the structures to future events, including increased river flows simply due to normal weather events. Northern portions of the island are particularly susceptible to debris flows, which greatly increase the damage potential of the flooding event. Other works identified relate to landslip protection and river stabilization to protect infrastructure and minimize risk of future deterioration.

[9] During October–December 2016, the Argyle Airport was not opened for use.

Based on the assessment provided by the MoTW, a total of 62 infrastructure reconstruction or rehabilitation projects were identified relating to the transport and public infrastructure sector (Table 6). These works include bridge replacement and repair works, road repair replacement and associated protective works, and protective works to stabilize landslips and river erosion threatening property and communities. Protection works include bank stabilization for landslip, river training, and bank protection such as gabions, concrete walls, and other measures. Notably, of the 18 bridge-related works, 7 of the projects require the complete demolition and replacement of existing structures.

TABLE 6: SUMMARY OF REQUIRED TRANSPORT AND INFRASTRUCTURE WORKS PROJECTS

Location	Bridge Repair/Replacement	Road Repair and Protective Works	Protection Works	Total
Windward	15	29	4	48
Leeward	3	4	7	14
Total	**18**	**33**	**11**	**62**

Source: Reports from the MoTW and BRAGSA based on field studies.

Damage costs (table 7) are broken down by area affected and type of works. As a result of the storms, damages are estimated at a total of US$23.5 million (EC$63.5 million).

TABLE 7: ESTIMATED DAMAGE COSTS TO THE TRANSPORTATION INFRASTRUCTURE SECTOR

Location	Bridge Repair/ Replacement (EC$)	Road Repair and Protective Works (EC$)	Protection Works (EC$)	Total (EC$)	Total (US$)
Windward	18,695,880	28,340,473	5,171,344	**52,207,697**	**19,336,184**
Leeward	4,040,543	844,557	6,399,265	**11,284,365**	**4,179,394**
Total	**22,736,423**	**29,185,030**	**11,570,609**	**63,492,062**	**23,515,578**

Source: Reports from the MoTW and BRAGSA based on field studies.
Conversion factor: US$1.00 = EC$2.70.

BRAGSA spearheaded the cleanup works by employing local labor to accomplish the required labor-intensive activities and providing heavy equipment to assist with the efforts. Specific activities primarily involved clearing of landslides and drainage structures. With respect to BRAGSA, losses incurred are estimated to be US$211,111 (EC$570,000). However, this is considered a low estimate and actual losses are expected to rise significantly as more data become available. Losses in this sector, related to costs of temporary cleanup activities to restore access, have not been well captured.

Other losses incurred relate to lost vehicles, increased transport costs in lost time and fuel, ongoing vehicle damage from poor road conditions, and increased maintenance costs resulting from deteriorated infrastructure. Losses of this nature have not been quantified.

Finally, apart from the costs associated with engineering design and construction of infrastructure, additional studies will be required where floods and landslide are to be mitigated. These are specialized studies designed to provide a design basis for engineering interventions and include hydrology and hydraulic analysis, slope stabilization analysis, and other studies designed to characterize the issues to be addressed during the engineering phase of a project. Based on previous projects requiring such analysis and the number of sites requiring interventions, it is estimated that these supporting studies will require a budget of approximately US$600,000 (EC$1.6 million).

In summary, losses and damage in the transportation and infrastructure sector total US$24.3 million (EC$65.7 million), as presented in Table 8.

TABLE 8: DAMAGE AND LOSSES TO THE TRANSPORTATION AND INFRASTRUCTURE SECTOR

	EC$	US$
Damage		
Saint Vincent Mainland Roads and Bridges	63,492,062	23,515,579
Total Damage	**63,492,062**	**23,515,579**
Losses		
Cost of Clean up	570,000	211,111
Hydrology and hydraulic studies	1,620,000	600,000
Total Losses	**2,190,000**	**811,111**
Total Damage and Losses	**65,682,062**	**24,326,690**

Conversion factor: US$1.00 = EC$2.70.
Assumptions. Damage includes the cost of reconstruction or repair to transport and public infrastructure including an estimated contingency amount (20 percent) and engineering designs and supervision (15 percent).

2.2.2 HEALTH, WATER, AND SANITATION

2.2.2.1 HEALTH

Damage in the health sector was generally limited to water and sanitation (W&S) services. A summary of the health impacts is listed:

- A clinic in Sandy Bay was flooded but was rapidly cleaned up and returned to operation.
- Few injuries were reported.
- A boiled water alert was issued for areas without piped water services.
- Psychological counseling services were provided for those who required them.

No significant disease-related issues were identified, such as potential for transmission of vector-borne disease or increased potential for water-borne illness.

During the two events, three graveyards in Old Park Hill, London, and Rose Bank were overwhelmed by floodwaters and land failure. Some graves were scoured, discharging their contents to the sea. Although there were no public health consequences, the psychological impacts are high, particularly given the socio-cultural implications of the loss. For example, on November 1 and 2 each year, family members remember their deceased and place flowers on their tombstones.

It is expected that the Government will spend US$518,500 (EC$1.4 million) to move the 200 graves that have been compromised, provide memorial tombstones for the 70 graves that were lost, provide counseling services to the affected families, and stabilize the slopes at the graveyards including conducting geotechnical and pre-engineering studies as well as the public consultations.

It is noteworthy that these graveyards are located in a section of the country where local fisherfolk collect a small, seasonal fish known locally as Tri-Tri (*Sicydium plumieri*). This is a local delicacy, and the harvest season is limited owing to their migration schedule. Due to the graveyard damage, there is a general reluctance on the part of the population to purchase Tri-Tri from the affected areas, owing to the belief that they may be contaminated. While it is seasonal and relatively short-lived, this harvest is a significant source of income for the fisher folk involved.

2.2.2.2 WATER AND SANITATION

The Ministry of Health, through the CWSA, administers the W&S infrastructure, supplies piped drinking water, manages solid waste, and provides limited wastewater treatment services. Over 98 percent of the population has access to piped water.

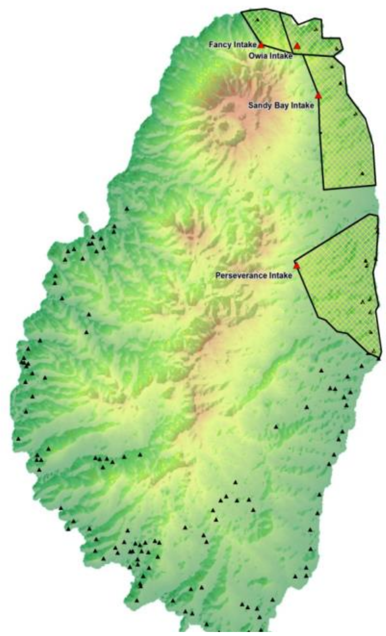
2.2.2.2.1 WATER

Impacts from both troughs resulted in the interruption of piped water services to the affected localities. While some pipe breakages in the transmission system were experienced, most of the damage was experienced in the abstraction system owing to sediment accumulations at the abstraction points. Four main abstraction points were particularly affected, leaving their service areas (Figure 10) without piped water for varying periods up to one week. Following the November 9, 2016 trough, water supply was rationed in some areas for weeks due to the damage to the water system. Table 9 summarizes the population affected by these outages.

TABLE 9: WATER SERVICE IMPACT

Intake	Population Served	Days Without Piped Water
Perseverance	7,000	7
Sandy Bay	2,700	7
Fancy	500	1
Owia	1,000	9
Total	**11,200**	

FIGURE 10: NOVEMBER 28, 2016 TROUGH WATER SERVICE OUTAGES



Source: Author's analysis based on CWSA data.

2.2.2.2.2 TEMPORARY WATER DISTRIBUTION

Water trucks were used to distribute water to the affected communities during the emergency construction period for the water systems. However, in the Owia District, trucks were unable to get to the communities due to the road blockages from landslips. Total costs from the distribution of water were not estimated at the time of this report.

2.2.2.2.3 SANITATION

Sanitation services were largely unaffected. Most of the island inhabitants have private septic systems (soak-aways), several of which throughout the island were damaged due to flooding. Solid waste was slightly affected due to the inability to temporarily provide collection services due to roadway blockages. Service was quickly restored once the roads were reopened. Disposal facilities were unaffected.

Total damage and losses for the W&S sector are estimated at US$92,600 (EC$250,000) based on information provided by the CWSA.

TABLE 10: WATER AND SANITATION - CALCULATION OF DAMAGE AND LOSSES

		EC$	US$
Damage			
	Cost to replace or repair damaged water infrastructure	250,000	92,600
Losses			
	Cost to truck water and lost revenue	25,000	9,300
Total		**275,000**	**101,900**

Conversion factor: US$1.00 = EC$2.70.

2.2.3 ELECTRICITY

FIGURE 11: ACCESS ROAD TO RICHMOND INTAKE

Damages to the electricity sector were largely associated with hydropower generation. Landslips claimed several local transmission lines, but these were quickly restored. Hydropower represents about 12 percent of the total grid production capacity (details presented in Table 11). Although the generation stations were not damaged during the events, in two cases, hydro-generation was suspended due to pending repair to the water supply system. In the case of Cumberland, a landslip damaged a feed pipe, which was quickly repaired. In the case of the Richmond hydro-generation station, the water intake was damaged and the access road was rendered impassible due to flood damage (Figure 11).

TABLE 11: INSTALLED HYDRO-GENERATION CAPACITY

Location	Capacity (kW)
Richmond	1,100
Cumberland	3,664
South Rivers	870
Total	**5,634**

Due to the events, the Richmond facility (20 percent of the hydro-generation capacity) suffered a significant damage. Access to the water intake is blocked and the access road needs to be rehabilitated. This includes the construction of long-term flood protection to account for the change in riverbed characteristics caused by the flooding events. The road is now susceptible to flooding even during normally occurring rainfall events.

The intake to this system suffered damage due to silting and battering by rocks and debris. A temporary repair has been provided to restore the system to operation; however, the intake needs to be reconstructed to account for changes in the river characteristics and current damage to the structure.

While the interruptions in availability of electric power were negligible, the impact of the loss of hydro-generation capacity served to increase fuel demand as the system compensated with increased diesel generation. This results in an increased cost of production that is ultimately passed to the consumer through a fuel surcharge.

FIGURE 12: LANDSLIDE - CENTRAL FUEL STORAGE

Finally, a landslip at the central fuel storage facility (Figure 12) resulted in minor damage to storage infrastructure. Nonetheless, because of the slide, the facility is at increased risk from future landslip due to the decreased slope stability resulting from the slide. Apart from the cleanup of the immediate slide, slope stabilization measures will need to be taken to mitigate the present unstable condition. This Government-owned site is where Saint Vincent Electricity Services (VINLEC) stores much of its fuel.

TABLE 12: ELECTRICITY - CALCULATION OF DAMAGE AND LOSSES

	EC$		US$
Damage			
Richmond: Cost to permanently repair damaged infrastructure	2,000,000		740,741
Richmond: Cost to repair road after November 9, 2016 trough	90,000		33,333
Richmond: Cost to repair road after November 28, 2016 trough	80,000		29,630
Cumberland: Cost to repair damaged infrastructure	40,000		14,815
Cost to repair fallen poles	100,000		37,037
Total damage	**2,310,000**		**855,556**
Losses			
Richmond: Cost to desilt the intake and replace the pipe covering (temporary fix)	**120,000**		**44,444**
Richmond: Cost of additional use of fuel			
Cost of fuel EC$ per 1,000 kWh		330	
Hours of production per day		22	
Days without service		22	
Estimated loss - 1,000 kWh		532	
Subtotal	**175,692**		**65,071**
Cumberland: Cost of additional use of fuel			
Cost of fuel EC$ per 1,000 kWh		330	
Hours of production per day		22	
Days without service		9	
Estimated loss - 1,000 kWh		725	
Subtotal	**239,405**		**88,669**
Lost revenue	**50,000**		**18,519**
Total losses	**585,097**		**216,703**
Total damage and losses	**2,895,097**		**1,072,258**

Conversion factor: US$1.00 = EC$2.70.

2.2.4 AGRICULTURE

Based on the findings of the Population and Housing Census Report 2012, the agriculture sector contributes approximately 7 percent to the GDP and employs about 11.8 percent of the employed workforce. This sector has experienced significant stresses over the past decade owing to recurrent exogenous shocks, storm damage, plant disease, and economic losses associated with the loss of preferential access to European markets. As of 2012, an estimated 8,000 ha were under cultivation with an additional 2,000 ha in pasturelands, representing approximately 25 percent of the land area available in SVG. Based on an estimated 2015 GDP of approximately US$737.7 million,[10] the agricultural sector is estimated to contribute US$51.6 million.

[10] SVG, MoEP 2016.

Based on the assessment provided by the Ministry of Agriculture, damage in the agriculture sector relates primarily to direct crop damage and loss of agricultural land due to flooding and landslide. Direct damage to physical infrastructure such as farm buildings and related structures was minimal; however, loss of arable land has yet to be quantified. Per the current assessment, an estimated 37 ha of cultivated land were affected because of the passage of the two trough systems. Livestock loss was minimal but agricultural damages were highest among the vegetable crops, particularly with respect to tomato and cabbage produce, as presented in Table 13.

Important losses are largely due to farm-to-market road blockages and damage. Roads, in some cases, were blocked by landslip and debris and, in other cases, washed out due to flooding. The extent of road damage is being assessed and continuing losses due to lack of access to cultivated fields are accruing but cannot be assessed at this time. Over 1,619 ha were estimated to be inaccessible due to access road damage. This represents an estimated 20 percent of the cultivated croplands for SVG.

Finally, in the agriculture sector, high-impact damage and losses are particularly important among the lower-income and disadvantaged population segment. These groups typically cultivate gardens for personal consumption (kitchen gardens) selling surplus yields for additional income. Numerous families lost these gardens due to flooding, resulting in loss of food products and incomes generated from sales of excess production. While the macroeconomic impact is negligible, the impact to the affected families is significant as many rely on these gardens for food and supplemental income.

TABLE 13: AGRICULTURE - CALCULATION OF DAMAGE AND LOSSES

		EC$	US$
Damage			
	Banana and Plantain	187,327	69,380
	Root Crops	480,756	178,058
	Tree Crops	8,609	3,189
	Vegetable crops	372,716	138,043
	Other Crops	181,799	67,333
	Live stock lost	83,390	30,885
	Damaged and Lost Cropland	—	—
	Total	**1,314,597**	**486,888**
Losses			
	Losses, inability to harvest, crops inaccessible - 1,619 ha	—	—
	Lost income and need to buy produce due to loss of kitchen gardens	—	—
	Total	**—**	**—**
Total		—	—

Conversion factor: US$1.00 = EC$2.70.

2.2.4.1 FORESTRY

Damage and losses in the forestry sector is estimated at EC$900,000 (US$333,333). This is largely due to soil loss, damage to drainage, loss of forest, and damage to contouring mainly in Perseverance, Troumaca, Richmond, and Fancy in the Georgetown and Sandy Bay areas. Damage was also noted in the Congo Valley, Cumberland Bay, and Coulls Hill. Additional losses will accrue as forest rehabilitation efforts commence, particularly with respect to clearing of felled trees and replanting efforts to restore forest resources and stabilize landslips. Much of the interior remains to be assessed as it requires an aerial survey to quantify damages and estimate losses. As of this writing, the aerial survey has not been started. It is expected that damage and losses in the forestry sector will total in the several millions of dollars (EC$) when the damage assessment is completed.

2.2.5 EDUCATION

Damage to the infrastructure in the education sector was minimal, as the sector reported no structures damaged by flood or landslip. The primary cause of damage and losses to the sector was from the use of schools as shelters, which resulted in loss of teaching days.

All schools throughout the country were closed for three teaching days in November 2016 because of the heavy rainfall. Schools that were used as emergency shelters lost up to four weeks of teaching days. This came at a particularly crucial time when students were preparing for their end-of-semester exams. In addition, some parents had to take time off from work to take care of their children, resulting in decreased national productivity.

In the Sandy Bay area, one of the poorest in the country, the impacts were high to families that participate in the school feeding program that provides students with a hot lunch each day. Anecdotally, for some students, it is their one complete meal of the day, and so the loss of this meal for up to four weeks would have implications on their health and welfare.

Recommendation: Administrators in schools that are used as emergency shelters should inform NEMO whether they have school feeding programs so that appropriate arrangements could be made to ensure that no student goes without a proper meal because of emergency response.

2.2.6 HOUSING

FIGURE 13: HOUSE IN SANDY BAY DAMAGED BY LANDSLIP

Damage within the housing sector is estimated at US$4.3 million (EC$11.5 million) exclusive of any costs associated with land acquisition to support relocation requirements. Losses for the sector are not available but include furniture replacement, costs associated with alternative housing, loss of savings kept on the property, and in some cases, loss of livelihood for home-based businesses.

Damage to housing stock occurred on both the leeward and windward sides of the island due to the two troughs. Areas particularly affected on (a) the leeward side were Spring Village, Dark View, Chateaubelair, Petit Bordel, and Fitz Hughes and (b) the windward side were Pepper Village, London, Trench Town, Sandy Bay, Sion Hill, and Back Street. Table 14 presents the summary for housing infrastructure damage by area affected using a four-tiered system of classification to describe the extent of damage to housing.

TABLE 14: HOUSING INFRASTRUCTURE AFFECTED

Level	No. of Houses (Leeward)	No. of Houses (Windward)	No. of Houses	Description
1	57	50	107	No signification damage - structure is usable and can be occupied. Repairs required are minimal.
2	16	18	34	Minor damage - structure is usable and can be occupied after urgent temporary measures are taken. Owner will probably need assistance with repairs.
3	5	14	19	Structure is not usable and cannot be occupied until repairs are done.
4	13	16	29	Structure is not usable and cannot be repaired; it must be rebuilt/relocated.
Total	**91**	**98**	**189**	

The MoTW provided the cost estimates for damage based on their damage survey and assessment of the works required to restore both the structure and the surrounding property. This focused on damage resulting from the November 28 event. A partial assessment was conducted by the Ministry of Housing, Informal Human Settlements, Physical Planning, and Lands and Surveys (MoH) capturing damage from the November 9 trough. For most cases of level 4 damage, where the structure was destroyed, reconstruction on the original site is not possible due to the site's vulnerability to future flooding or landslip. In these cases, relocation will be required. A summary of cost estimates for the housing sector damage is presented in table 15. These costs do not include the cost associated with land acquisition in the case of relocation.

TABLE 15: ESTIMATED DAMAGE TO HOUSING SECTOR

Damage Level	Cost of Damage (Leeward) (US$)	Cost of Damage (Windward) (US$)	Total (US$)	Cost of Damage (Leeward) (EC$)	Cost of Damage (Windward) (EC$)	Total (EC$)
1	395,496	525,889	**921,385**	1,067,840	1,419,900	**2,487,740**
2	311,319	444,544	**755,863**	840,560	1,200,269	**2,040,829**
3	173,426	274,787	**448,213**	468,250	741,925	**1,210,175**
4	601,435	896,006	**1,497,441**	1,623,875	2,419,215	**4,043,090**
Other Damage (property)	631,247	None noted	**631,247**	1,704,366	None noted	**1,704,366**
Total	**2,112,923**	**2,141,226**	**4,254,149**	**5,704,891**	**5,781,309**	**11,486,200**

Conversion factor: US$1.00 = EC$2.70.

The Government, through NEMO, organized assistance and established shelters for 180 people who sought refuge at five emergency shelters opened in response to the November 28, 2016 trough. Emergency shelters accommodated families, particularly female-headed households, and other individuals whose homes had incurred damage. At the time of this report, 20 persons were still occupying four emergency shelters. In Sandy Bay, the emergency shelter was a school facility; as such, students were unable to attend classes since the November 28, 2016 trough. The cost to operate an emergency shelter is approximately EC$1,000 per week for 20 or less people. The direct costs associated with operating the emergency shelters are listed in Table 16.

TABLE 16: EMERGENCY SHELTER OCCUPANCY

	November 29, 2016 (Week 1)	December 5, 2016 (Week 2)	December 12, 2016 (Week 3)
People in shelters	180	84	17
Shelters opened	5	4	4
Shelter cost (EC$)	**9,000**	**4,200**	**1,000**
Total cost	**US$5,259 (EC$14,200)**		

Conversion factor: US$1.00 = EC$2.70.

Losses in the housing sector (Table 17) include the cost of emergency shelter operation, the vulnerability analysis to be conducted, and the land acquisitions required for relocation of vulnerable families. The Ministry of National Mobilization, Social Development, Family, Gender Affairs, Persons with Disabilities and Youth estimated additional losses.

TABLE 17: HOUSING - CALCULATION OF DAMAGE AND LOSSES

	Damage (EC$)	Losses (EC$)	Total (EC$)	Total (US$)
Damage				
(a) Houses fully destroyed				
Number of houses	29			
(b) Houses partially destroyed				
Number of houses	160			
Damages - total	**11,486,200**		**11,486,200**	**4,254,148**
Losses				
(c) Cost of temporary housing scheme - emergency shelters				
Shelter costs (3 weeks)			**14,200**	**5,259**
(d) Cost of relocation				
Number of households needing furniture		29		
Cost of replacement furniture per household		15,000		
Total cost of replacement furniture		**435,000**		**161,111**
Number of households needing land		29		
Cost of land per household		5,000		
Total cost of land		**145,000**		**53,703**
Cost of studies and other agreements (20% of land value)		**29,000**		
Total cost of relocation			**609,000**	**225,555**
(e) Other losses				
Appliances and electronics		178,201		
School supplies		4,310		
Basic amenities (furniture, kitchenware, and so on)		14,562		
Total other losses			**197,073**	**72,990**
Losses – total (c) + (d) + (e)			**820,273**	**303,804**
Total damage and losses			**12,306,473**	**4,557,952**

Conversion factor: US$1.00 = EC$2.70.

Assumptions. Based on the MoTW's and the MoH's knowledge and analysis of the current construction and housing environment in SVG, the following factors were applied:

- Damages to housing sector were based on survey data provided by the MoH and the MoTW. Contingency amount for house repair at reconstruction was valued at 20 percent.

- Relocation estimates assume a standard lot of 1,000 sq. ft. at US$1.85 per sq. ft. (EC$5.00 per sq. ft.)

- Where houses were destroyed, a standard replacement value of US$5,600 (EC$15,000) for furniture was used as a minimum requirement.

2.2.7 TOURISM

The Ministry of Tourism reported that no significant structural damage was sustained in the tourism subsector. Cruise ship traffic was uninterrupted and hotels continued business as usual. Losses were largely incurred by those engaged in providing local excursions as road closures, in particular the damage to the Dark View Falls Park access road, prohibited tourist visitations. Losses have not been fully quantified and Dark View Falls (a popular local destination) will remain closed 1 to 3 months, pending road clearance and rehabilitation of the damaged bridge. Remaining tourism activities, including the sailing component, were unaffected. Table 18 shows the preliminary assessment.

TABLE 18: TOURISM - SUMMARY OF DAMAGE AND LOSSES

Site	Activity	Damage (EC$)	Losses (EC$)
Owia Salt Pond	Refilling of and stabilization of area of significant erosion close to staircase leading to pond Removal of blockages from pipelines due to flooding	1,400	—
La Soufriere	Stabilization of slopes where landslides occurred on trail path	600	—
Black Point Heritage Park	Damage of approximately 500 sq. ft. of lawn area due to heavy equipment use to clear debris Removal of blockages from pipelines due to flooding	1,000	1,000
Rawacou Recreation Park	Removal of large logs from pond	1,000	—
Wallilabou Heritage Park	Removal of debris from pool	800	—
Cumberland Recreation Site	Improvement of river and sea defenses and repair and stabilization of jetty caused by river bed erosion and flooding	35,000	—
Dark View Falls	Removal of debris from pool	3,000	—
All sites	Site closure and loss of revenue	1,200	1,200
	Total (EC$)	**44,000**	**2,200**
	Total (US$)	**16,296**	**815**

Conversion factor: US$1.00 = EC$2.70.

2.2.8 INDUSTRY AND COMMERCE

Due the torrential rains, all Government offices, the airport, schools, and commerce were completely shut down for three days on November 2016 in Kingstown and environs, which resulted in a loss of productivity and revenue. Based on information provided by the MoEP, economic activity in Kingstown, the center of commerce, contributed 80 percent to the total national GDP (US$737.7 million). Therefore, as a direct result of the excess rainfall and subsequent shutdowns, the economic loss is calculated as the following:

- Total national GDP: US$737.7 million (MoEP)
- Daily national GDP: US$737.7 million/365 days
- Kingstown's contribution to national GDP: 80 percent (based on estimates from the MoEP)
- Number of days for which Kingstown was completely shut down: 3 days
- Loss to GDP due to shutting down of Kingstown: US$737.7 million/365 days x 80 percent x 3 days = **US$4.85 million (EC$13.1 million)**

Moreover, with further analysis, the loss in the I&C sectors will increase once the following are considered:

- November is a crucial commercial period with the upcoming Christmas season. Given the seasonal nature of major shopping in SVG, the loss of shopping days may have higher financial impacts to the commerce sector.
- Closing the airport for a full day may have compounding affects.
- Some people were unable to go to work due to lack of access to water or loss of electricity.
- Some people were unable to get to work due to landslides and road failure.
- Some parents were unable to get to work because they need to take care of their children who had their schools closed for additional days because of the disaster. This issue is ongoing for families whose children attend schools that are being used as emergency shelters.
- Reduced productivity as commute times to work have increased due to road failure, worsened road conditions, and detours on smaller roads not intended for two-way traffic.

2.3 MACROECONOMIC IMPACT

The macroeconomic impact of the floods and landslides will take longer to become apparent. The increase in the imports, food, agriculture supplies, and materials for the rehabilitation of roads and bridges as well as for the reconstruction of houses may result in a worsening of the BOP. In addition, given the increase in the demand for labor for civil works, it is expected that there will be an increase in the cost of labor, thereby increasing construction costs.

In the fiscal sector, some of the increased expenditures were accommodated by making use of the Government's budget framework, which allows for the reallocation of funds. Funds budgeted for existing programs would have to be diverted to cover the immediate expenditures for emergency response. The total estimated costs of the disaster represent approximately 49.5 percent of the projected 2016 capital budget (US$73.2 million or EC$197.7 million) and 10.7 percent of the total budget US$338.1 million (EC$912.9 million)[11] programmed for 2016.

Poverty levels may also increase given that the impact of the November 28, 2016 trough was concentrated in zones where the economic activities focus on agriculture, fishing, and services, with high levels of poverty, such as Georgetown (55.6 percent) and Sandy Bay (55.6 percent).[12] Moreover, in the agriculture sector, the impact is particularly important among the lower-income and disadvantaged population segment who typically cultivate gardens for personal consumption and may have lost these as a result of the disaster.

Further analysis is needed to assess the impact in BOP, fiscal sector, and poverty level.

[11] SVG, MoEP 2016.
[12] SVG, Country Poverty Assessment 2007/2008. We note that although this information is about a decade old, it is the most recent poverty assessment conducted in the country.

3 RECOVERY AND RECONSTRUCTION PLAN

The two troughs highlight the need for improved hydrologic analysis and planning, strengthening infrastructure designs, and enhancing territorial and land planning activities. While forecasting is generally adequate, the localized nature of weather interactions with the landscape is extremely variable from event to event. The extreme topography of the island, as it interacts with weather systems, is responsible for highly localized rainfall and thunderstorm events. These are spontaneous in nature and cannot be predicted at the watershed level. To establish an effective flood early warning system, observed rainfall is the only useful trigger. This requires real-time monitoring. As such, it is recommended that the CWSA seeks to retrofit its existing rain gauge network to support telemetric reporting. This has been difficult in the past owing to communications limitations. The Government is currently considering the installation of a robust radio repeater network. It is recommended that the CWSA's rain gauge network be considered for integration into that network. These events provide a strong impetus to better understand the localized relationship between rainfall rates and runoff volumes and the system response with respect to flood and landslide events within watersheds. Improving this understanding will be useful in the application of more advanced hazard and risk modeling methodologies to inform the future investment activities and engineering designs.

The following recovery and reconstruction framework is proposed to provide a prioritized and flexible action plan to guide the recovery and reconstruction process that is anchored in comprehensive disaster risk management, in particular flood risk management.

3.1 SHORT-TERM ACTIONS (1 YEAR)

- Repair and clean up damaged houses and infrastructure—including roads, river protection works, drainage, schools—and recover agriculture production.

- Conduct a detailed post disaster needs assessment (PDNA) focused on livelihoods.

- Develop or update the river basin flood risk maps and calibrate concentration times for important steam systems; watershed calibration curves; and intensity, duration, and frequency curves from the CWSA data collected since 2009.

- Update the landslide susceptibility maps to include other interacting risks (for example, flood, rockslide, mudslide, change of river course) with particular attention to areas left unstable after the flood event.

- Evaluate and ensure the effectiveness of operation and maintenance (and in some cases immediate improvement) of drainage network based on informed hydrologic analysis.

- Strengthen emergency communication network.

3.2 MEDIUM- TO LONG-TERM ACTIONS (1–5 YEARS)

- Address critical data gaps needed to generate hazard and risk assessment, particularly with respect to hydromet monitoring systems.

- Formalize and standardize damage assessment protocols and reporting among ministries, designate staff to form the national damage assessment team under the national response plan; provide formal training in conducting damage assessments.

- Formalize the national hydromet data management system (including the conversion to real-time reporting of all rainfall and stream gauges) managed by the CWSA, building on the Government/EU water resources project. Improve interagency data sharing and archiving and formalize the establishment of a national hydromet center of expertise.

- Incorporate watershed and flood risk modeling in the national land-use planning process and to support improved resilience in engineering designs.

- Identify and act on the development of required legislation to manage and enforce land-use practices, particularly high-risk areas.

- Adopt a watershed management legal framework.

- Invest in transportation infrastructure and preventive maintenance and establish formal requirements for new infrastructure design with respect to expected service life and disaster resilience requirements (for example, survives 100, 200, 500 rainfall events, wind, flood, seismic events).

- Advance and adopt risk reduction-based building codes and strengthen training and enforcement.

- Identify capacity gaps and provide tailored training for staff in key ministries in disaster risk management and response.

- Install additional meteorological and stream gauging stations at a density to accommodate engineering scale analysis for design and planning and support gridded rainfall analysis.

- Strengthen disaster monitoring and early warning systems.

- Continue to fund and expand public education with respect to hazard avoidance, particularly with respect to flood awareness. Include hazard awareness in outreach activities among the various ministries (for example, health, agriculture, works) and seek to add disaster preparedness themes to the national education curriculum.

- Provide engineering and non-engineering solutions for vulnerable embankments in the upper watershed and land-use practices.

- Strengthen social protection systems to provide rapid social response following disasters.

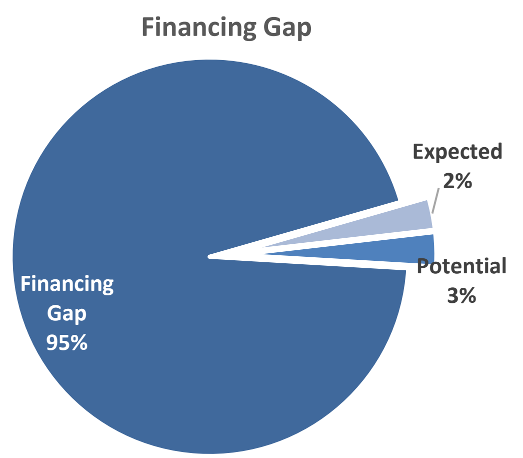
- Develop risk transfer options for Government assets and private sector losses. Considerations should include activities such as setting aside a capital reserve, (Government self-insurance), purchase of insurances, and insurance requirements for the private sector. Recommend that this begins with a comprehensive multi-sectoral fiscal vulnerability analysis and an analysis of needs for periodic rehabilitation of public infrastructure to mitigate direct budget impacts of recurrent disaster events in the future.

- Advance findings under risk transfer analysis to policy and/or legislation.

3.3 FINANCING NEEDS

TABLE 19: FINANCING NEEDS

	US$	EC$
Financing Needs		
Damage and losses	36,265,222	97,916,028
Financing Options		
	Expected	
CDB Grant	200,000	540,000
CDB Loan	750,000	2,025,000
Total	**950,000**	**2,565,000**
Potential		
WBG RDVRP CERC	1,000,000	2,700,000
Financing Gap	**34,315,222**	**92,651,028**



Note: CDB = Caribbean Development Bank; CERC = Contingency Emergency Response Component; WBG = World Bank Group.

ANNEXES

ANNEX 1 - LIST OF PEOPLE MET

Name	Title
Ministry of Economic Planning, Sustainable Development, Industry, Information and Labour (MoEP)	
Laura Anthony Browne	Director of Economic Planning
Decima Corea	Deputy Director of Economic Planning
Marcelle Edwards-John	Senior Projects Officer
Louise Tash	Economist
Trelson Mapp	Economist
Richard MacLeish	Project Coordinator
Keisha Gonsalves	Senior Financial Management Analyst
Nerissa Pitt	Financial Management Analyst
Cecil Harris	Senior Engineer
Cassia Toby	Assistant Social Development Specialist
Sekai Chiaka Bowman	Procurement Officer
Janelle Quow	Engineer
Noretta John	Procurement Assistant
Shineco Sutherland	Procurement Assistant
National Emergency Management Organisation (NEMO)	
Michelle Forbes	Director (Acting)
Ministry of Transport, Works, Urban Development and Local Government	
Brent Bailey	Chief Engineer
Damion Allen	Engineer
Central Water and Sewage Authority (CWSA)	
Brian Da Silva	Chief Engineer
Danroy Ballantyne	Hydrologist
Vialey Richards	Gauging Technician (Hydrology
Saint Vincent Electricity Services (VINLEC)	
Thornley Myers	Chief Executive Officer
MET Office	
David Burgin	Senior MET Officer

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